RUSSELL VALE REVISED UNDERGROUND EXPANSION PROJECT

REVISED PREFERRED PROJECT REPORT AND RESPONSE TO SECOND PAC REVIEW

FINAL

July 2019

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FINAL

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on behalf of
Wollongong Coal Limited

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Executive Summary

Wollongong Coal Limited (WCL) is seeking approval under the *Environmental Planning and Assessment Act 1979* to extend mining operations at the Russell Vale Colliery, referred to as the Underground Expansion Project (UEP).

The UEP application has been through several iterations to minimise its potential adverse impacts. The original UEP application involved a substantial expansion of longwall mining in the Wonga East and Wonga West areas to extract 31 Mt of ROM coal over 18 years. In 2014, a Preferred Project was exhibited based on a reduced mine plan of eight longwalls in the Wonga East area only. The Preferred Project has been reviewed by the Planning Assessment Commission (PAC) on two occasions, most recently in 2016. A key issue for the PAC in its consideration of the Preferred Project was the uncertainty associated with subsidence and groundwater impacts as a result of proposed longwall mining in the multi-seam mining environment present at Russell Vale.

To address the residual uncertainty regarding impacts of longwall mining, WCL has developed a revised mine design based on a non-caving first workings mining system that will result in imperceptible subsidence. Longwall mining is no longer proposed as part of the UEP. This revised mine plan is referred to as the Revised Preferred Project. The revised mine plan has been designed to be long term stable with negligible risk of pillar failure, significantly reducing the potential for subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

Detailed impact assessments undertaken for the Revised Preferred Project conclude that the proposed mining is not expected to result in perceptible surface subsidence, significant interaction with overlying seams or significant interaction with existing groundwater systems. Importantly, the revised mine plan is not considered to have any potential to perceptibly impact natural surface features including upland swamps, cliffs including the Illawarra Escarpment, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

In a further response to concerns from the PAC and community regarding amenity impacts associated with the Russell Vale Pit Top, substantial improvements to the Pit Top layout and adoption of a range of additional feasible and reasonable noise control measures, including restricting hours of operation, have been proposed to reduce the noise impact of the Pit Top and trucks accessing the site. Proposed changes to the Pit Top have been assessed and found to be effective at reducing noise levels from the site to be within acceptable levels for the majority of the time the site is operational, with only negligible (1-2dB) exceedances predicted at surrounding residences during a small percentage (less than 10%) of Winter nights.

Existing management plans and monitoring programs will be reviewed and updated as required to reflect the Revised Preferred Project and ensure they are adequate to confirm the extent of predicted impacts associated with the Revised Preferred Project, as well as historical mining operations within the Colliery lease holding. The updated environmental assessment undertaken for the Revised Preferred Project demonstrates that with the implementation of existing and proposed monitoring, management and mitigation measures, the Revised Preferred Project can proceed within acceptable environmental standards.

Abbreviations and Glossary of Terms

Term	Definition
Adit	An entrance, or an almost horizontal passageway into a mine for the purposes of access or drainage.
AHD	Australian Height Datum
AIP	*Aquifer Interference Policy*
Application Area	The area to which this Project Application applies.
AWS	Automated Weather Station
BCUS	Bellambi Creek Upland Swamp
Bulli West	Area of first workings west of existing workings.
CCL	Consolidated Coal Lease
CCUS	Cataract Creek Upland Swamp
Coal Processing Plant	Coal sizing plant using crushing and cyclone methods to improve coal quality and remove waste rock.
Coking coal	Coal that can be used in the production of coke which in turn is used in the blast furnace in the production of pig iron. Ash content of less than 10% and volatile matter of 21-23%.
Day	A period of 24 hours, from twelve o'clock one night to twelve o'clock the next night
Daytime	The period from 7.00am to 6.00pm Monday to Saturday, and 8.00am to 6.00pm on Sundays and Public Holidays.
dB	Decibels
DoEE	Commonwealth Department of Environment of Energy (formerly Department of Environment and Energy)
DPIE	Department of Planning, Industry and Environment (formerly Department of Planning and Environment)
DRG	Department of Resources and Geosciences
Drivage	A horizontal or inclined heading or roadway in the process of construction. The roadway will be used to access a new mining area within the lease.
DSC	Dams Safety Committee
Dyke	A sheet like vertical intrusion of igneous rock cutting across the strata of older rocks.
Early morning shoulder	The period from 5.00am to 7.00am Monday to Saturday.
EEC	Endangered Ecological Communities
EMP	Environmental Management Plan
ENM	Environmental Noise Model
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
ERM	ERM Australia Pacific
Evening	The period from 6.00pm to 10.00pm.
Feasible	Means what is possible and practical in the circumstances

Term	Definition
First workings	Involves the development headings or roadways which will provide access to the coal resource. They are developed using continuous miners with separate and integrated roof and rib bolting rigs. First workings leave the coal pillars intact and the overlying strata fully supported resulting in 'zero' subsidence.
GeoTerra	GeoTerra Pty Limited
GES	Groundwater Exploration Service Pty Limited
GHGEA	Greenhouse Gas and Energy Assessment
GJ	Gigajoule
GPS	Geographical Positioning System
Groundwater WSP	*Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*
Ha	Hectares
ICNG	*Interim Construction Noise Guidelines*
INP	*Industrial Noise Policy*
JORC	Joint Ore Reserves Committee
LDP	Licensed Discharge Point
LGA	Local Government Area
Longwall (LW)	A large continuous block of coal mined in a single slice.
m	Metres
Metropolitan Special Area	An area categorised as Restricted Access under Schedule 1 of the Sydney Water Catchment Management Act 1998. It is managed by the Sydney Catchment Authority.
Mining Lease	Title granted under the Mining Act 1992 that provides rights to mine a coal resource.
Mitigation	Activities associated with reducing the impacts of the project prior to or during those impacts occurring.
MJ	Megajoules
ML	Megalitre
MOP	Mining Operations Plan
Mt	Million tonnes
Mtpa	Million tonnes per annum
Negligible	Small and unimportant, such as to be not worth considering.
NGA	National Greenhouse Accounts
Night	The period from 10.00pm to 5.00am Monday to Saturday, 10.00pm to 8.00am on Sundays and Public Holidays.
NPfI	*Noise Policy for Industry 2017*
NTU	Nephelometric Turbidity Units
Original Application	The mine plan proposed in the EA (ERM, 2013). This mine plan included 11 longwall panels in the Wonga East domain and 8 LW panels in the Wonga West domain.
Planning Assessment Commission (PAC)	A statutory body established under section 23B (1) of the *Environmental Planning and Assessment Act 1979* (Act No.203, 1979) and as part of the New South Wales Government's planning reforms in November 2008.
PMF	Probable Maximum Flood
Preliminary Works Project (PWP)	The approved Stage 1 works which involves the development of the main headings in the Wonga East domain and the extraction of LWs 4, 5 and 6 (365 m to the west).

Term	Definition
Product coal	ROM coal that has undergone a process of beneficiation to improve the economic value of the coal.
Project Noise Trigger Levels	Target noise levels for a particular noise-generating facility.
PNTLs	Project Noise Trigger Levels
RBLs	Rating Background Levels
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements.
RMS	Roads and Maritime Services
RNP	*NSW Road Noise Policy 2011*
ROM coal	Coal delivered from the mine without any further processing
RTS	Response to Submissions
Run-of-mine (ROM)	Raw coal as mined that has not undergone any screening, crushing or washing.
Russell Vale Colliery (RVC)	The main surface facilities for the colliery; also referred to as the site.
RVEA	Russell Vale Emplacement Area
Russell Vale East	The area of the mining domain located to the east of Cataract Reservoir – previously known as Wonga East.
Russell Vale West	The area of the mining domain located to the west of Cataract Reservoir – previously known as Wonga West.
SIOA	Social Impact and Opportunities Assessment
SWCD	Stormwater Control Dam
TARP	Trigger Action Response Plan
TARP	Trigger Action Response Plan
TTIA	Traffic and Transport Impact Assessment
Underground Expansion Project (UEP)	The project. The subject of the current project application (09_0013).
VENM	Virgin Excavated Natural Material
VLAMP	Voluntary Land Acquisition and Mitigation Policy
WAL	Water Access Licence
WCC	Wollongong City Council
Wollongong Coal Limited (WCL)	The current owner and operator of the colliery, and the proponent for the UEP.
Wonga East	The area of the mining domain located to the east of Cataract Reservoir – also referred to as Russell Vale East.
Wonga West	The area of the mining domain located to the west of Cataract Reservoir – also referred to as Russell Vale West.
WSP	Water Sharing Plan

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1.0 Introduction

1.1 Project Background

Wollongong Coal Limited (WCL) owns and operates the Russell Vale Colliery (the Colliery), an existing underground coal mine located in Russell Vale, north of Wollongong in NSW (refer to **Figure 1.1**). The Colliery has been on 'care and maintenance' since 2015 and the current Project Approval applying to mining operations at the Colliery requires that no mining occur after 31 December 2015. WCL is seeking Project Approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act) to expand the mining operations at the Colliery; this ongoing application is referred to as the Underground Expansion Project (UEP).

Mining has been undertaken at Russell Vale Colliery since the 1880s. Mining has occurred in three seams, the Bulli Seam, Balgownie Seam and the Wongawilli Seam. The Balgownie seam is located approximately 10 metres (m) below the Bulli Seam and the Wongawilli Seam is located approximately 20 m below the Balgownie Seam. All three seams outcrop along the Illawarra Escarpment and the seams are accessed by adits[1] directly into the seams. There are two main mining areas within the Russell Vale Colliery lease area, which are referred to as Wonga East and Wonga West. The Cataract Reservoir broadly defines the boundary between the two areas (refer to **Figure 1.2**). In the Wonga East area, the Bulli Seam and Balgownie Seam have largely been fully extracted. Further detail regarding previous mining activity at Russell Vale is provided in **Section 2.1.1**.

The existing and proposed workings are contained within Consolidated Coal Lease 745 (CCL745) and Mining Lease 1575 (ML1575) (refer to **Figure 1.3**). The Colliery Pit Top is located at the base of the Illawarra Escarpment above the suburb of Russell Vale (refer to **Figure 1.4**). The Pit Top facilities occupy an area of approximately 100 hectares (ha) at the eastern extent of the Colliery holdings. The site is accessed via a private driveway from the Princes Highway at a signalised intersection with Bellambi Lane. Coal has historically been hauled from Russell Vale Colliery to Port Kembla Coal Terminal (PKCT) by truck, via Bellambi Lane and Memorial Drive.

The Russell Vale Emplacement Area (RVEA) is located immediately north of the Colliery Pit Top and is largely located outside the Colliery Holding (lease area) (refer to **Figure 1.3**). The RVEA operates under a development consent issued by Wollongong City Council (WCC) on the 11 April 1990. The area was used as part of earlier mining operations and was used to store oversize material during 2015-2016. The Department of Planning and Environment (DPE), now the Department of Planning, Industry and Environment (DPIE), issued WCL with a Development Control Order to remove approximately 200,000 tonnes of material stockpiled at the RVEA and transport it off site. Removal of this material commenced in early March 2019 and on completion of this process, the area will be subject to final rehabilitation in accordance with the relevant conditions of the order.

In December 2004, after a period of care and maintenance, the mine was sold to NRE by the former owners Bellpac Pty Ltd and the assets transferred to a company called Gujarat NRE Coking Coal Ltd. Mining recommenced in 2005, however the mine produced very little coal between 2004 and 2012 when mining recommenced in the Wongawilli Seam. Jindal Steel and Power Limited acquired a majority stake in Gujarat NRE Coking Coal Ltd in October 2013. The name of the company, Gujarat NRE Coking Coal Ltd, was changed to WCL following the change in ownership.

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[1] An entrance into a mine for access or drainage.

The original UEP application submitted by Gujarat NRE Coking Coal Ltd in 2009 involved a substantial expansion of longwall mining in the Wongawilli Seam across the Wonga East area (a total of 11 longwall panels) and Wonga West area (a total of seven longwall panels) to extract 31 million tonnes (Mt) of run-of-mine (ROM) coal over a project life of 18 years (refer to **Figure 1.4**). In response to concerns from the public and government agencies, the original UEP application has been substantially revised over time to reduce the potential adverse impacts of the mine.

A summary of the UEP assessment process to date is provided in **Section 1.2**.

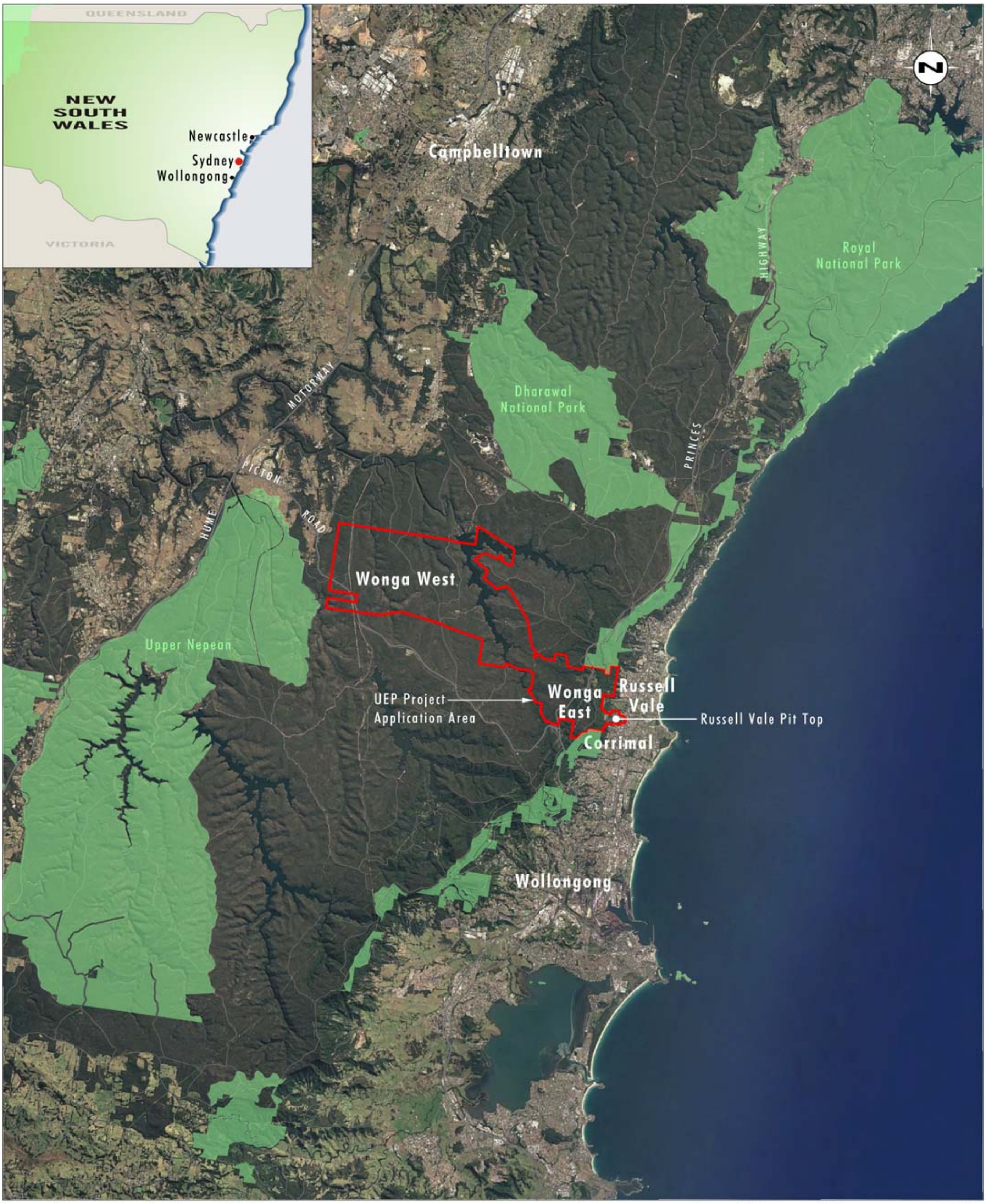


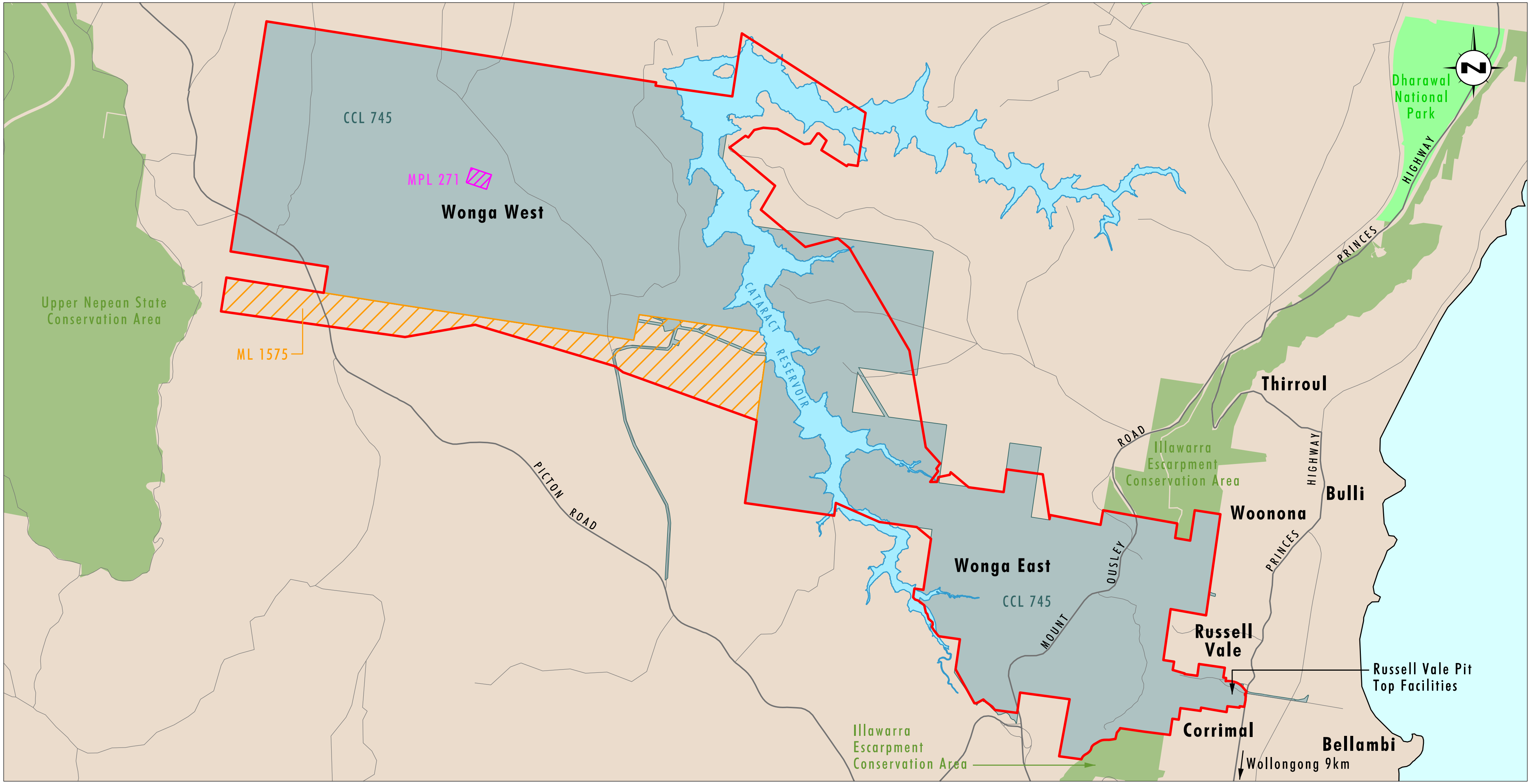
Image Source: Google Maps (2016)
Data Source: OEH (2016)

0 3.0 7.5 15.0km
1:300 000

Legend
UEP Project Application Area

FIGURE 1.1

Locality Plan



Data Source: Wollongong Coal (2016), OEH (2013)

Legend

- UEP Project Application Area
- CCL 745
- ML 1575
- MPL 271

FIGURE 1.2

Russell Vale Colliery Mining Leases and UEP Application Area

File Name (A4): 3687_026.dgn
20190621 14.28

umwelt

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

0 100 250 500m
1:10 000

Legend
UEP Project Application Area
Coal Truck Route

FIGURE 1.3

Existing Russell Vale Pit Top Facilities

File Name (A4): 3687_025.dgn
20190703 8.38

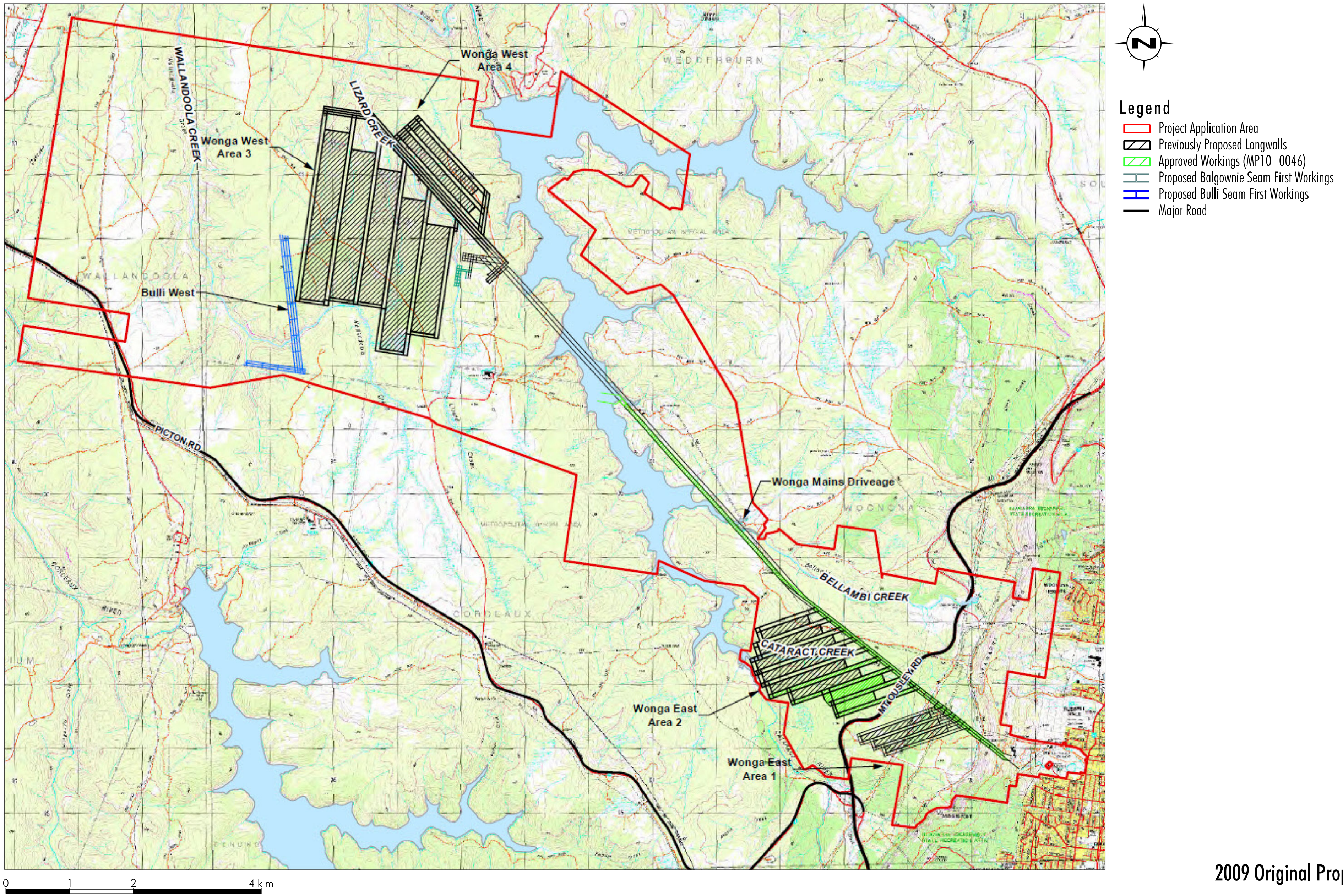


FIGURE 1.4

2009 Original Proposed UEP Mine Plan

Image Source: ERM (2013)

File Name (A4): R05/3687_063.dgn
20190703 14.23

1.2 Previous Assessment of the UEP

The original UEP application was submitted in 2009, with a supporting Environmental Assessment publicly exhibited in 2013 (ERM, 2013). A Preferred Project was exhibited in 2014 based on a reduced longwall mine plan of eight longwalls in the Wonga East area only (refer to **Figure 1.5**). The Preferred Project was referred to the Planning Assessment Commission (PAC) and the PAC released its first Review Report on the UEP Preferred Project in April 2015. The report recommended that further work and assessments was required before a determination could be made.

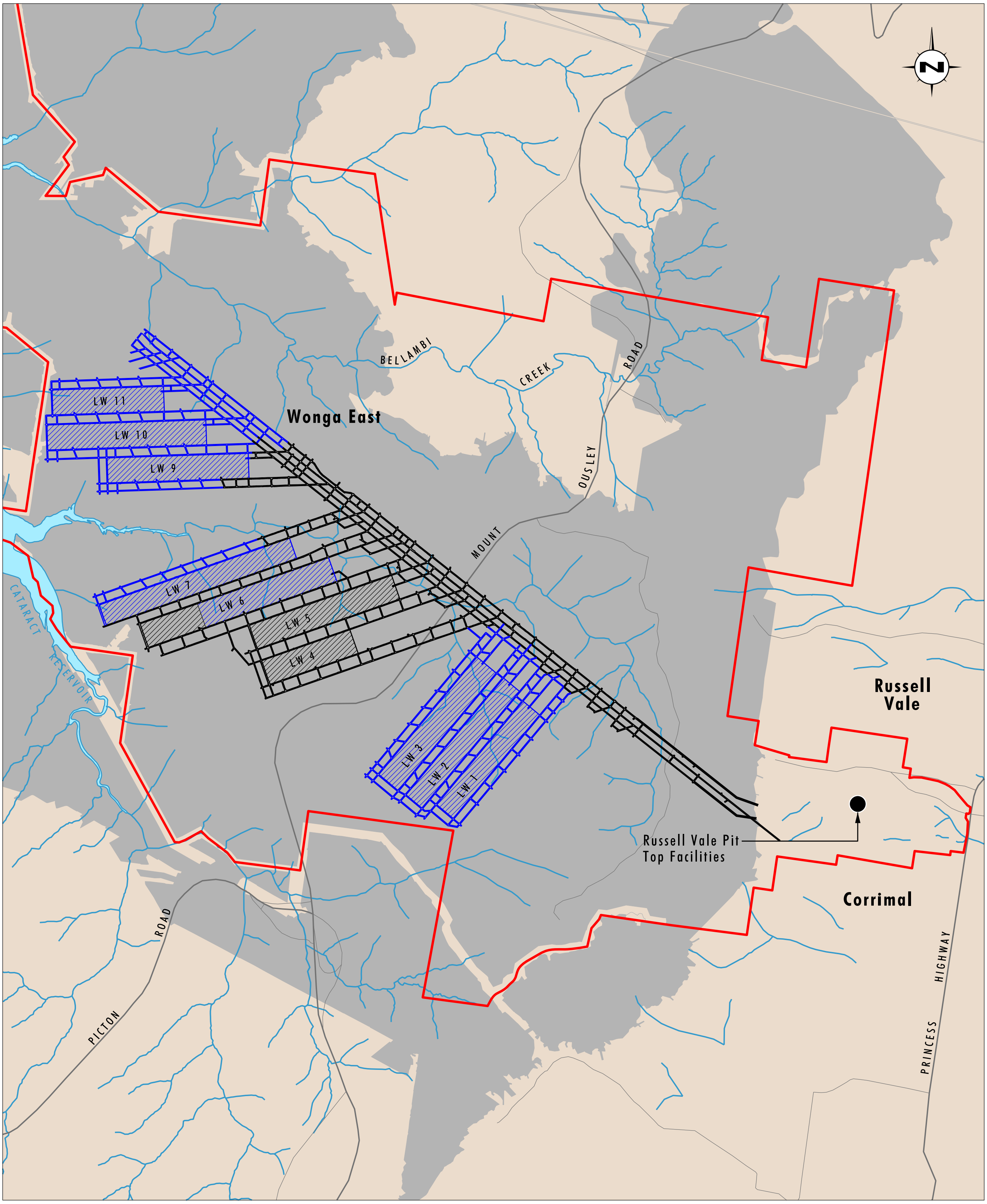
In July and September 2015 WCL submitted its responses to the first PAC Review Report following consultation with various agencies. In October 2015, the Minister referred the responses to the PAC for a second review.

The PAC's Second Review Report was released in March 2016 and required further consideration and assessment of water and subsidence, risks of water loss and impact to upland swamps, the estimated cost associated with water loss, and the noise assessment (PAC, 2016).

Through the course of the UEP application process the following reports and amendments of the UEP have been prepared on behalf of the proponent and submitted for review:

- Environmental Assessment (ERM, February 2013) to support the original UEP application;
- Preferred Project Report including Response to Submissions (Natural Resources Environment (NRE), undated) and the Residual Matters Report (Hansen Bailey, June 2014);
- Response to the PAC's First Review Report Part 1 (Hansen Bailey, July 2015) and Part 2 (Hansen Bailey, September 2015) including an Independent Risk Assessment (Broadleaf, 2015).

These reports have been made available on the DPIE website.



Data Source: Wollongong Coal (2016)

0 0.5 1.0 1.5km
1:30 000

Legend
- UEP Project Application Area
- Existing Wongawilli Seam Workings
- Previous Preferred Project Mine Plan
- Historic Workings (other mines)

FIGURE 1.5

2014 Preferred Project Mine Plan

1.3 Revised Preferred Project Overview

In order to address residual uncertainty regarding the impacts of longwall mining raised by the PAC Second Review Report, a revised mine design has been developed based on a non-caving first workings mining system. The revised mine plan has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

Changes to the Russell Vale Pit Top are also proposed to address concerns regarding potential amenity impacts to surrounding residential areas.

This revised plan is referred to in this document as the Revised Preferred Project. The Revised Preferred Project is outlined in detail in **Section 2.0** of this report.

Key elements of the Revised Preferred Project are:

- Mining by means of first working mining techniques only, with the workings designed to be long term stable with minimal subsidence impacts. No longwall mining is proposed;
- Extraction of approximately 3.7 Mt of ROM coal over 5 years at a production rate that will not exceed 1 Mt of product coal per year;
- Construction and use of a coal processing plant to improve the quality of product coal;
- Redesign of the Pit Top layout to strategically relocate infrastructure to more shielded locations;
- Reduced hours of operation for surface facilities relative to the Preferred Project mine plan; and
- Additional noise mitigation works at the Russell Vale Pit Top including a new noise barrier, extension to the height of existing bunds and acoustic treatment of coal processing infrastructure.

1.4 Revised Preferred Project Objectives and Key Design Considerations

The following key objectives have guided the refinement of the UEP mine plan subsequent to the PAC Second Review Report:

- develop a mine design that eliminates residual uncertainty regarding subsidence predictions, geotechnical constraints and potential impacts on groundwater, surface water and biodiversity associated with longwall mining
- gain access to sufficient resources to enable mining to recommence and occur over a sufficient time frame to undertake the necessary assessments to confirm a suitable mine plan in the Wonga West area that would extend the life of Russell Vale Colliery for a period similar to that sought in the initial UEP application
- develop comprehensive mitigation and management strategies to reduce environmental and social impacts associated with the Revised Preferred Project in order to meet relevant criteria where-ever practicable and feasible
- conduct mining in an environmentally responsible manner to minimise project specific and cumulative environmental and social impacts

- create additional employment opportunities within the local and regional community
- co-exist with the local community.

Furthermore, the mine design for the Revised Preferred Project has also taken account of:

- surface constraints (such as the Cataract Reservoir, ecological and Aboriginal Heritage constraints as well as built features),
- underground geological discontinuities (dykes, faults, roof strata sill and lease boundary) and
- existing workings above the targeted Wongawilli Seam, in the Balgownie and Bulli seams.

1.5 Consideration of Project Alternatives

The Revised Preferred Project represents the culmination of an exhaustive process of reviewing project alternatives to address issues raised in agency and public submissions and by the PAC Second Review Report. This included consideration of options to:

- Undertake further investigation and assessment work on the UEP Preferred Project mine plan design to reduce uncertainty in impact predictions and address issues raised by the PAC.
- Amend the UEP Preferred Project mine plan by redesigning second workings to address impact issues raised by the PAC. This would be supported by additional research and assessment of subsidence impacts to remove uncertainty in subsidence impact predictions. This scenario was likely to result in reduced resource recovery.
- Amend the UEP Preferred Project mine plan to be first workings only with workings designed to be long term stable. This scenario was likely to result in significantly reduced production rates and resource recovery.
- Withdraw the UEP application and close Russell Vale Colliery. The option was not considered a feasible alternative due to the significant investment in the UEP from WCL to date and the extent of valuable coal resources remaining in the colliery holding.

1.5.1 Rationale for Moving to First Workings Mine Plan

A key issue for the PAC in its consideration and review of the UEP Preferred Project was the uncertainty associated with subsidence and groundwater impacts as a result of the proposed longwall mining in the multi-seam mining environment present at Russell Vale, and in particular the Wonga East area. In assessing the constraints and opportunities associated with each of the potential project alternatives outlined above, the need to reduce this uncertainty was considered a priority.

During the WCL and Umwelt review process, it was considered unlikely that the options to amend the previous second workings mine plan would sufficiently resolve the uncertainty to a level that was acceptable to the PAC. Therefore, a mine plan option for long term stable first workings was considered the only feasible alternative, despite the lower production rates and resource recovery volumes that would result from this option.

Section 1.5.2 provides a discussion of the difference between longwall mining and first workings mining methods and typical subsidence behaviour associated with these methods.

1.5.2 Underground mining methods: First workings vs Longwall mining

First workings comprise a series of self-supporting roadways or 'tunnels' driven into the coal seam by a continuous miner. Left behind is a grid of pillars (blocks of coal) between the roadways that are designed to provide stability to the seam void in the long term and support the roof strata above the seam (refer to **Figure 1.6**). This method is commonly undertaken where surface subsidence has to be limited (IESC, 2014).

The width of the roadways is limited to reduce the likelihood of roof falls and minimise the load on the pillars. As the depth of cover above the coal seam increases, the width of the pillars also increases to carry the extra weight of the overburden.

Some low-level subsidence of the ground surface above first workings will occur as a result of compression of the coal pillars and the strata above and below the seam from the weight of overburden, however where pillars have been designed to be long-term stable (low probability of pillar failure), vertical subsidence will be very small. These movements are typically comparable to surface and ground variations that occur from natural and seasonal processes with the wetting and drying of soils and is at the limit of general surveying accuracies (IESC, 2014).

Longwall mining involves the secondary extraction of large panels of coal between parallel first workings roadways, these panels can typically be 150 - 400 m wide and 1 - 4 km long (IESC, 2014). A longwall shearer is used to progressively remove all the coal within the panel, creating a void into which the roof material and overlying rock collapses. This triggers a subsidence process in the overburden strata. The strata layers above bend and shear, with the amount of strata sagging, fracturing and bed-separation reducing towards the surface (IESC, 2014). The fracture zone commonly forms an arch over the extracted panel (as illustrated in **Figure 1.6**).

This method of mining typically results in vertical and horizontal subsidence movement at the land surface, which can extend beyond the edge of the longwall panel and can impact on natural and built features on the surface.

The conceptual illustration in **Figure 1.7** depicts the situation at Russell Vale Colliery where historical longwall mining has been undertaken in over lying seams (with existing subsidence effects as a result of this activity) and first workings is proposed in an underlying seam. Subsidence monitoring data available from previous mining indicates that while there are some significant differences in behaviour compared to single seam mining, the multi-seam subsidence behaviour is reasonably predictable (SCT, 2019). The assessment of potential subsidence impacts of the proposed first workings mine plan has considered potential interactions with overlying historical workings and concludes that it is not expected to cause perceptible surface subsidence, significant interaction with the overlying seams or significant interaction with existing ground water systems (SCT, 2019) (refer to **Section 5.2**).

umwelt

Proposed mining (First Workings Method)

Typical Subsidence Associated with First Workings Mining

Not proposed mining (Longwall Mining Method)

Typical Subsidence Associated with Longwall Mining

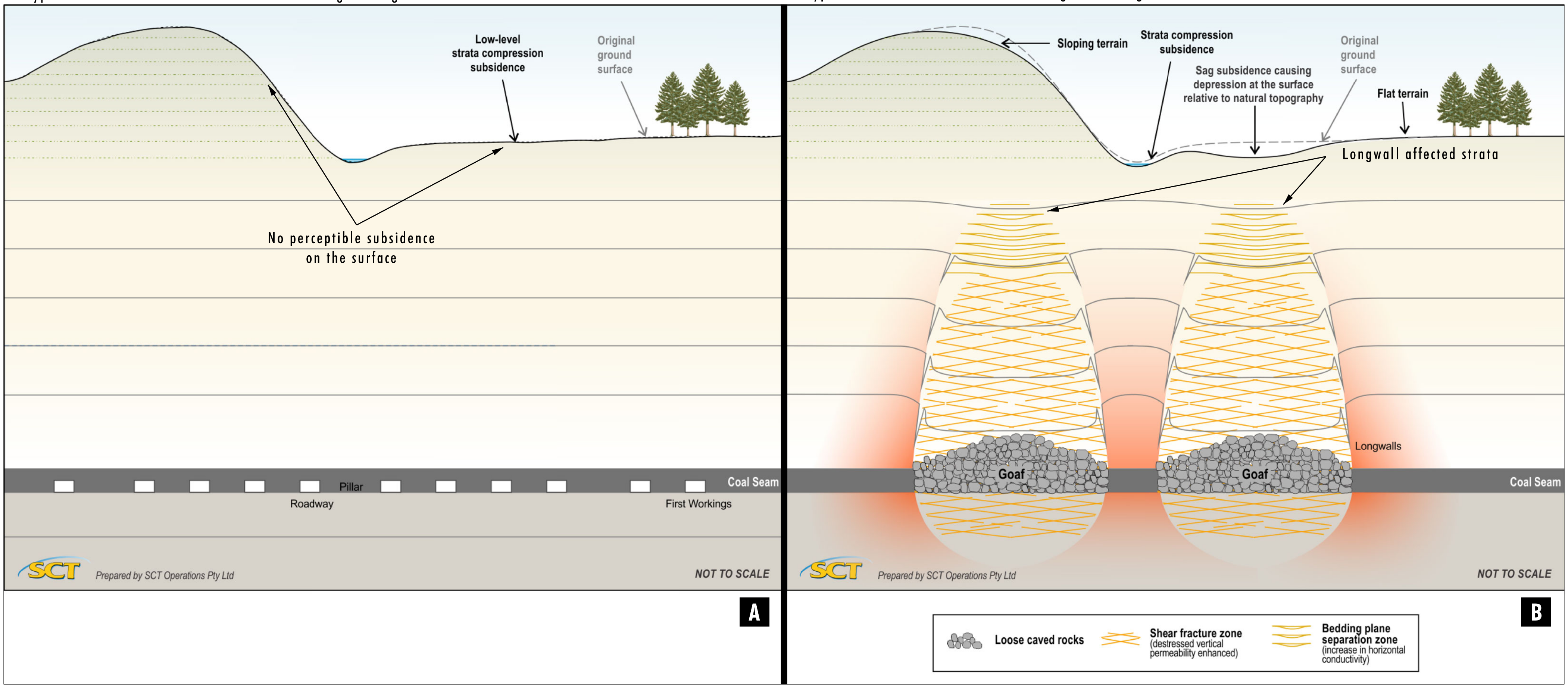


FIGURE 1.6

General Subsidence behaviour associated with First Workings (A) Vs Longwall Mining (B).

Image Source: SCT Operations (Pty Ltd (2019)

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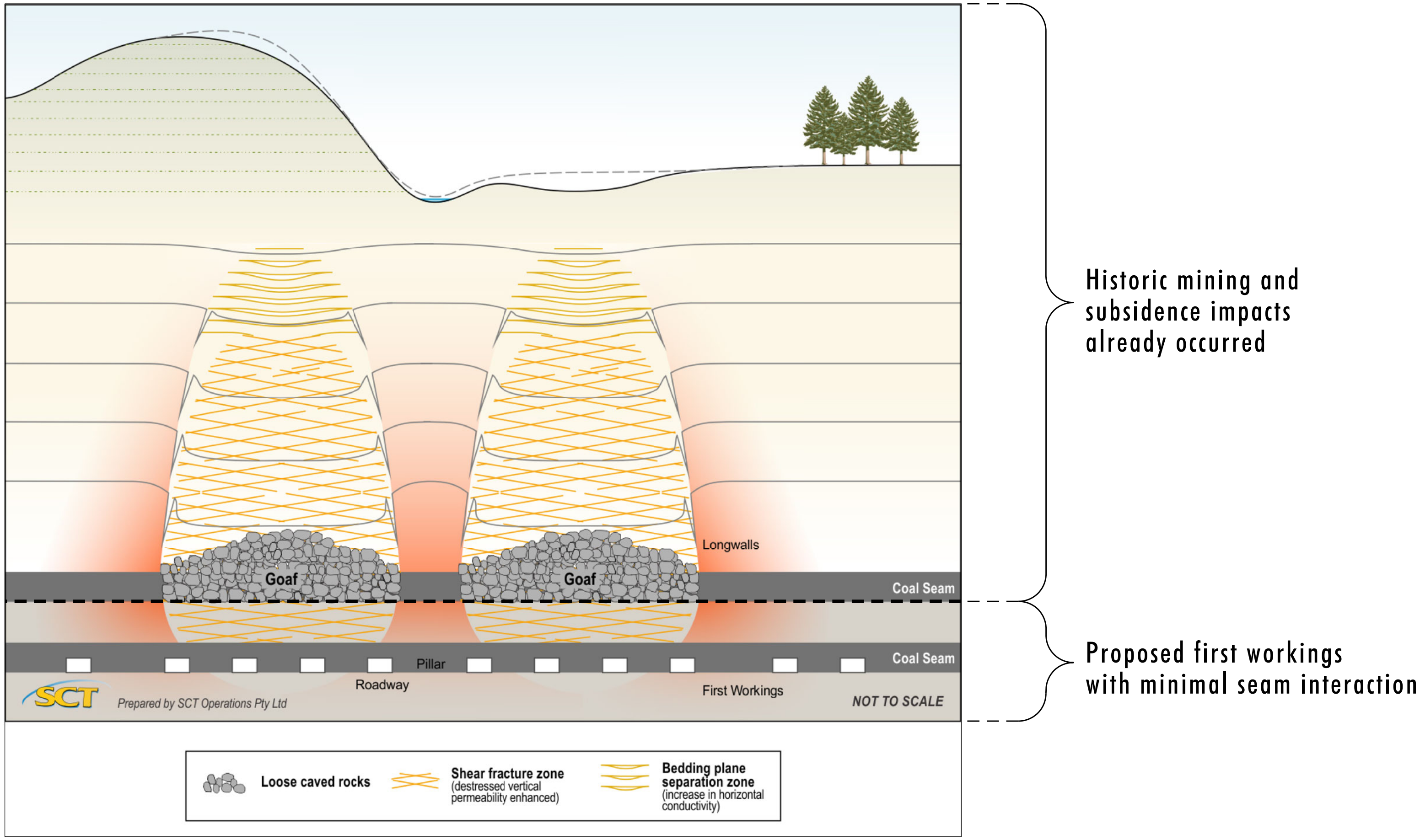

FIGURE 1.7

General layout of Two Seams with Proposed First Workings Below Historical Longwall Mining

Image Source: SCT Operations (Pty Ltd (2019)

1.6 Future Mine Planning

Large volumes of economically viable coal remain un-extracted within the central and western portions of the Russell Vale lease holding. The UEP in its original form sought to recover a substantial portion of this resource, however due to major concerns raised in submissions on the original project, the project was modified to remove the Wonga West mining domain from the application. WCL remains committed to undertaking further detailed environmental and social impact studies to enable the recovery of this resource in an environmentally and socially acceptable manner and has commissioned studies that are ongoing for this purpose.

WCL has committed that all future mine planning within the Russell Vale Colliery lease holding will be based on non-caving first workings mining methods in order to limit the potential for subsidence related impacts to surface features or water resources. WCL will not be seeking future approval for longwall mining within the Russell Vale Colliery lease holding. Existing longwall equipment will be extracted and sold should the UEP be approved.

Works toward a long-term consolidated approval for Russell Vale Colliery are in progress. WCL commenced an exploration program in August 2018 consisting of 11 boreholes covering the central and western areas of the lease. These holes will improve the resource definition and will also provide base line data. The exploration program is ongoing. In parallel, a conceptual life of mine plan is being developed. As the exploration data becomes available the mine plan will be further refined to provide Joint Ore Reserves Committee (JORC) Code compliant reserves. The JORC Code sets minimum standards for the classification of minerals Exploration Results, Mineral Resources and Ore Reserves.

Subject to completion of further detailed environmental studies and development of a suitable non-caving first workings mine plan for Wonga West, WCL intends to seek development consent for the continued operation of the Russell Vale Colliery to recover the portions of this resource that can be extracted in an environmentally acceptable manner.

1.7 Structure and Purpose of this Report

This report details the Revised Preferred Project and provides a response to the issues raised in the PAC Second Review Report.

This report is divided into two parts:

- Part A – Revised Preferred Project Report, and
- Part B – Response to PAC Second Review Report.

Part A contains a description of the Revised Preferred Project, outlining the key changes to the UEP in response to issues raised in the PAC Second Review Report. It contains further evaluation of the statutory context for the Revised Preferred Project, with changes to key planning legislation that have occurred since the last submission. Part A also contains a description of the stakeholder engagement process undertaken for the Revised Preferred Project and an updated assessment of the key environmental, social and economic issues including a review of subsidence, groundwater, ecology (particularly upland swamps), noise, air quality, traffic, surface water and water balance assessments as well as a greenhouse gas assessment. Part A concludes with an updated Statement of Commitments.

Part B of this report provides responses to the issues raised in the PAC Second Review Report.

PART A – Revised Preferred Project Report

2.0 Description of Revised Preferred Project

In order to address residual uncertainty regarding potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir water catchment, WCL has redesigned the UEP. Longwall mining is no longer proposed as part of the UEP and the revised mine design is based on a non-caving first workings mining system that will result in imperceptible subsidence.

Key elements of the Revised Preferred Project are:

- Mining using first working mining techniques only, with the workings designed to be long-term stable with minimal subsidence impacts. No longwall mining is proposed. Further, WCL have resolved that all future mine designs will be based on first working mine designs only to eliminate subsidence from mining activities affecting significant levels of strata stability and integrity towards the surface.
- Current longwall equipment will be retrieved from underground and sold.
- Extraction of approximately 3.7 Mt of ROM coal over a period of 5 years at a reduced production rate that will not exceed 1 Mt of product coal per year.
- Mining within the Wonga East area only, with no mining proposed within the Wonga West area or underneath the full supply level of Cataract Reservoir.
- Construction and use of a coal processing plant to improve the quality of product coal.
- Substantial redesign of the Pit Top layout to reduce amenity impacts.
- Operation of surface facilities and product transport typically limited to daytime hours only (7.00 am to 6.00 pm Mondays to Friday, 8.00 am to 6.00 pm Saturday, no Sundays and Public Holidays); with provision for occasional operation until 10.00 pm Monday to Friday to cater for unexpected Port closures or interruption.
- Reduced product trucking rates relative to the Revised Preferred Project.
- Additional noise mitigation works surrounding the Pit Top including a new noise barrier, extension to the height of existing bunds and acoustic treatment of coal processing infrastructure.

The key features of the Revised Preferred Project are summarised in **Table 2.1** along with a comparison of the Revised Preferred Project with the Preferred Project.

Table 2.1 Revised Preferred Project Key Features and Comparison with Preferred Project

Project Component	Preferred Project (2014)	Revised Preferred Project (2019)
Project Life	5 years	No change
Project Application Area	As per the historical Colliery Holdings/lease boundary, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575.	No change
Mine design and method	Extraction of 8 longwalls in three blocks within the Wonga East area, as illustrated in **Figure 1.5**.	Non-caving first workings within the Wonga East area, as shown in **Figure 2.1**. No longwall mining proposed. Longwall equipment will be recovered from underground and sold.
Target seam	Wongawilli seam	No change
Total Reserves Recovered	Approximately 4.7 Mt of ROM coal	Approximately 3.7 Mt of ROM coal
Extraction Rate	Up to 3 Mtpa	Up to 1.2 Mtpa ROM coal
Production Rate	Up to 3 Mtpa	Up to 1 Mtpa of product coal
Hours of Operation	**Underground Operations:** 24 hours, 7 days a week **Surface Facilities:** 24 hours, 7 days a week. **Product Transport:** 7.00am - 10.00pm, Mondays to Fridays; and 8.00am - 6.00pm Saturdays, Sundays and Public Holidays	**Underground Operations and delivery of ROM coal to the surface:** 24 hours, 7 days a week **Surface Facilities and Product Transport:** 7.00am - 6.00pm, Mondays to Friday, 8.00am - 6.00pm Saturday. No Sundays or Public Holidays. Provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions. Operation until 10.00pm Monday to Friday has been considered in this assessment.
Pit Top Facilities	• Upgraded and continued operation of the Pit Top area, support facilities and utilities; • Construction and use of two new stockpiles of 140,000 t capacity each with associated reclaim facilities. • Construction and use of a new Sizing Plant • Construction and use of new truck loading facilities. • Upgrading of existing surface conveyers.	• Upgraded and continued operation of the Pit Top area, support facilities and utilities; • Establishment of new product stockpile (approx. 14,000 t capacity) and rejects stockpile (approx. 1,500 t capacity) within Pit Top disturbance area. • Construction and use of new enclosed Coal Processing Plant to improve coal quality. • Construction and use of a new Secondary Sizing Plant. • Construction and use of new Surge Bin in more shielded location.

Project Component	Preferred Project (2014)	Revised Preferred Project (2019)
		• Construction and use of enclosed conveyors for transfer of ROM coal to Secondary Sizer, Processing Plant and truck loading facility. • Construction of new truck loading facility. • Construction of noise barrier along access road and extension to height of existing bunds. • Establishment of a designated truck parking area.
Management of Mining Waste	Waste rock used onsite, or if the need arises, disposed of at an appropriately licensed facility.	Coarse rejects from the processing plant will be trucked off site as fill if it meets requirements for Virgin Excavated Natural Material (VENM), stockpiled for emplacement underground or used in the rehabilitation of the site.
Coal Transport	Transport by road to the PKCT for export.	No change.
Transport Hours and Rates	• An average rate of 17 coal truck loads per hour with a peak of 22 coal truck loads per hour, leaving the site between 7.00am - 10.00pm on Mondays to Fridays. • An average rate of 19 coal truck loads per hour with a peak of 26 coal truck loads per hour, leaving the site between 8.00am and 6.00pm Saturdays. • An average rate of 10.5 coal truck loads per hour with a peak of 14 coal truck loads per hour, leaving the site between 8.00 am and 6.00 pm Sundays and Public Holidays.	• An average rate of 16 laden outbound trucks per hour leaving the site between 7.00 am - 6.00 pm Monday to Friday and 8.00 am - 6.00 pm Saturday. • No coal transport Sundays or Public Holidays. • If coal transport is required during the evening to cater for unexpected Port closures or interruptions, these movements would be limited to an average of 12 trucks per hour leaving the site between 6.00 pm - 10.00 pm Mondays to Fridays only. • Trucks arriving at the site between 6:00 am - 7.00 am Monday to Friday or between 7.00 am - 8.00 am Saturday will be required to proceed to the truck parking area on site and turn off engine until loading commences at 7.00 am Monday to Friday or 8.00 am Saturday.
Employment	• Operational workforce of 300 employees and contractors. • Short-term construction workforce of up to 100 employees at various stages of the project	• Operational workforce of approximately 205 employees and contractors. • Short-term construction workforce of approximately 22 employees over a 12 - 24 month period.
Ongoing activities within mining tenements	• Exploration activities, environmental monitoring and maintenance of access to the	No change

Project Component	Preferred Project (2014)	Revised Preferred Project (2019)
	existing underground workings and surface infrastructure within exploration and mining tenements in the Wonga West domain. • Ongoing maintenance and refurbishment of ventilation shafts, water and electrical facilities	
Rehabilitation	Progressive rehabilitation over project life, with rehabilitation of all surface facilities following the completion of mining.	No change
Capital Investment Value	$85 million	$35.3 million

2.1 Proposed Mining Operations

2.1.1 Mining Areas and Methods

The Illawarra Coal Measures[2] include the Bulli, Balgownie and Wongawilli seams. The uppermost Bulli seam has been extensively mined dating back to 1880, while the Balgownie seam was subject to mining between 1970 and 1982. The target resource for the Revised Preferred Project is within the Wongawilli seam, which lies approximately 27 m below the Bulli seam within the eastern portion of the UEP Application Area. The Wongawilli seam is approximately 8 - 11 m thick across the UEP Application Area with the basal part of the seam containing the highest proportion of coal. The depth of cover to the Wongawilli seam ranges from 200 - 320 m within the East of the UEP Application Area, increasing to 400 - 450 m in the western portion of the UEP Application Area.

The mine plan for the Revised Preferred Project (**Figure 2.1**) has been designed as a non-caving first workings mining system using continuous miners to limit potential for interaction with existing overlying workings or subsidence-related impacts to natural or built surface features or groundwater. The pillars remaining are designed to be long-term stable with a large width to height ratio. The proposed mining is not expected to cause perceptible subsidence at the surface, significant interaction with the overlying seams or significant interaction with existing groundwater systems.

The revised mine plan includes the construction of development mains into the Wonga Central Area (refer to **Figure 2.1**). These development mains were previously approved under Project Approval PA 10_0046 (Preliminary Works Project) granted by the PAC on 13 October 2011 under Section 75(J) of the EP&A Act. With the exception of the previously approved development mains into the Wonga Central area, the revised mine plan has been restricted to the Wonga East area. No mining is proposed beneath the full supply level of Cataract Reservoir.

[2] A group of sedimentary rocks up to 150 m thick occurring in the Sydney Basin in eastern Australia.

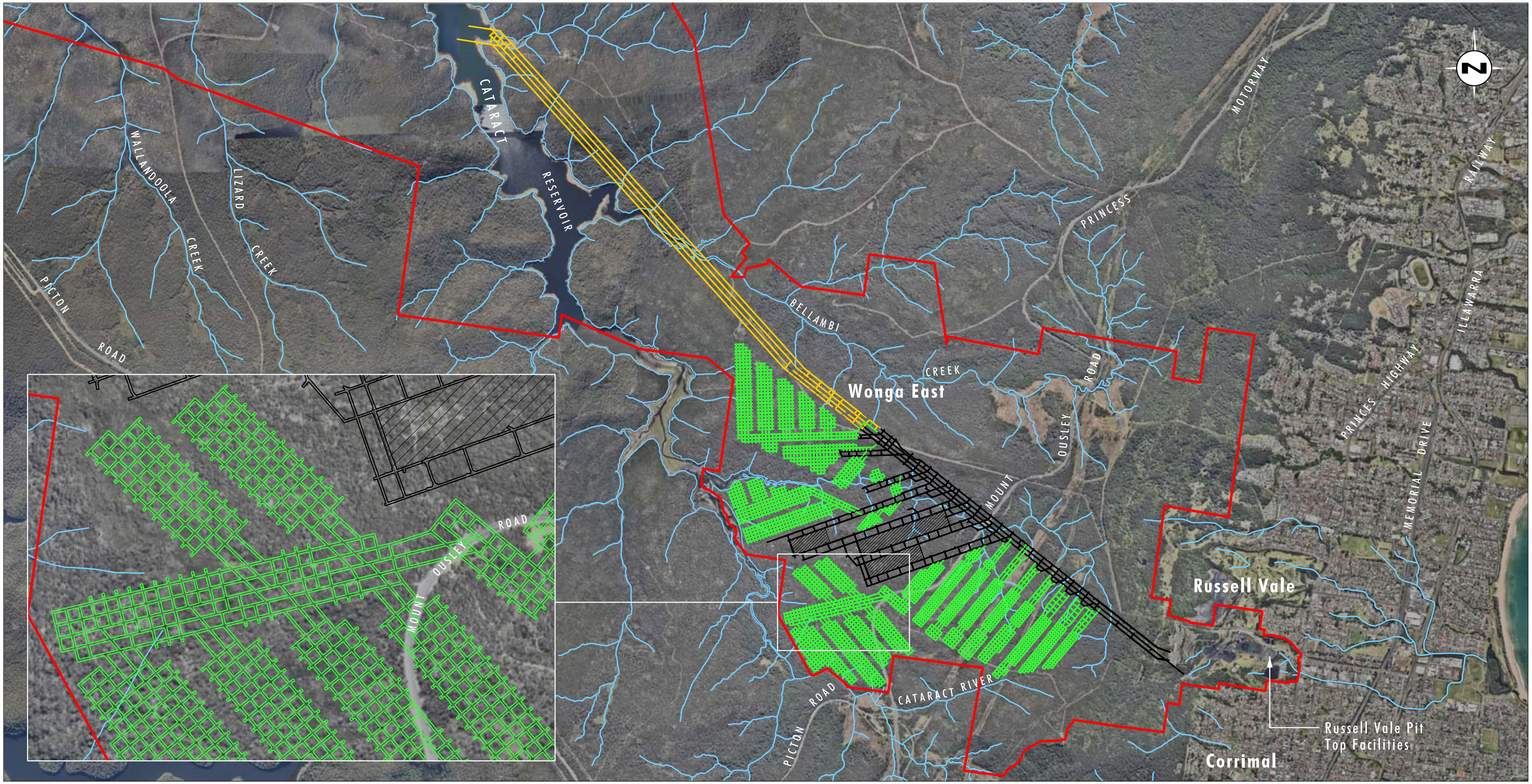

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

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Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line

FIGURE 2.1

Revised Preferred Project Mine Plan

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The proposed mine plan aims to minimise potential subsidence-related mining impacts while maximising the extraction of available resources. The mine design and pillar size are based on the provision of permanently stable pillars to reduce the potential for subsidence. The mine plan utilises existing roadways and avoids underground constraints such as faults and dykes where possible. The revised mine plan also restricts mining to the south of the existing development mains due to the presence of a sill in the northern parts of the Wongawilli Seam in the Wonga East area.

The mining panels are generally designed as 5 headings of 5.5 m width with a separately ventilated conveyor located within the centre of one roadway. Underground mining operations will be undertaken 24 hours per day, 7 days per week.

2.1.2 Retrieval of Longwall Equipment

As discussed in **Section 1.6**, WCL will not be seeking future approval for longwall mining within the Russell Vale Colliery lease holding. To confirm this commitment, the existing longwall mining equipment that is currently located within LW6 will be retrieved and sold. The longwall face equipment is currently located approximately 25 m short of the next gate road access point that would allow for its safe removal. Recovery will therefore require the mining of this 25 m section of LW6 to facilitate removal. This mining has been previously assessed and approved under the existing *Russell Vale East - LW6 (365m) Extraction Plan* (Hanson Bailey, 2015c) and represents the panel retreat between 340 - 365 m of LW6.

2.1.3 Coal Handling and Processing

New coal handling facilities and surface infrastructure upgrades are proposed as part of the Revised Preferred Project to improve the quality of ROM coal in order to meet market demands and to minimise impacts on the environment and local community. The proposed coal handling facilities and surface infrastructure upgrades are illustrated in **Figure 2.2** and described further in **Section 2.2**.

The construction of the new coal handling facilities will be completed and phased in over a 12 - 24 month period. During this period, ROM coal will be transported from the underground workings via the existing underground conveyor system to the primary sizer building where it will be crushed. Coal will then be transferred to the ROM stockpile (refer to **Figure 2.2**) from where a front-end loader will load ROM coal onto trucks to be transported to PKCT.

Once the new Coal Processing Plant and associated infrastructure is fully operational, ROM coal processing will commence. From the ROM stockpile, coal will be fed into an existing underground coal reclaim using a dozer, then conveyed to a new screening and sizing station where oversize material is removed. From the screening and sizing station, coal will be transferred to the new surge bin by conveyor and on to the new Processing Plant (refer to **Figure 2.2**).

The Coal Processing Plant will comprise a coal sizing plant that will remove rock material using crushing and heavy media cyclone methods. No washing of coal will occur on site. Product coal will then be transferred to a new Truck Loading Bin from where it will be either loaded onto road trucks for transportation to PKCT or transferred to the product stockpile area for temporary stockpiling (refer to **Figure 2.2**). The capacity of the product stockpile will be limited to approximately 14,000 t. This is sufficient capacity to ensure continuity of operations during periods when the PKCT is closed or there are restrictions on transferring coal to the stockpiles at the Port.

Rocky material that is separated by the Processing Plant will be transferred to a rejects stockpile by the rejects conveyor (refer to **Figure 2.2**) from where it will be either loaded onto road trucks to be sold as VENM fill material, transferred to the mine portal and emplaced underground or used in site rehabilitation.

ROM coal may also be transferred from the site as a ROM coal product. Where this occurs, road trucks will be loaded using a front-end loader from the ROM stockpile area.

2.1.4 Coal Production Rates

ROM coal production will commence in conjunction with the construction of the new Coal Processing Plant and associated infrastructure. During this construction and phase-in period for the Coal Processing Plant, approximately 500,000 tpa of ROM coal will be produced.

The production schedule will vary from year to year as a result of geological and geotechnical conditions, coal market fluctuations or logistical reasons. At full operation, the Revised Preferred Project will produce up to a maximum of 1 Mtpa product coal.

2.1.5 Coal Transport

Product coal will be transported by truck to PKCT utilising road registered 19 m articulated vehicles such as semi-trailer or truck and dog trailers. WCL may in the future use B-double vehicles which would reduce the average number of trucks per hour. Consistent with previously approved operations, the transport route will be via Bellambi Lane and Memorial Drive, which is the route that has historically been used for the transport of coal from the Russell Vale site.

Outbound laden truck movements will be limited to an average of 16 per hour between the hours of 7.00 am - 6.00 pm (Monday - Friday) and 8.00 am - 6.00 pm (Saturdays). Coal transport may occasionally be required until 10.00 pm Monday to Friday as a result of unexpected Port closures or interruptions. If this is the case, outbound laden truck movements will be further limited to an average of 12 trucks per hour between 6.00 pm - 10.00 pm, Monday to Friday. No evening truck movements are proposed on Saturday, and no truck movements will occur on Sunday's or Public Holidays.

The signposted speed limit for vehicles using Bellambi Lane is 60 km/h. Under the Preliminary Works Project (PA 10_0046), coal truck movements along Bellambi Lane were subject to a voluntary speed limit of 50km/hr. This voluntary speed limit for trucks has been monitored using Geographical Positioning Systems (GPS) equipment fitted to the trucks and monitored centrally by the trucking company. There has been an extremely high compliance with this limit (99.9986% from 2,162 truck movements), with only three minor exceedances registered, all of which were below the signposted 60km/hr limit. The voluntary speed limit for coal trucks of 50 km/hr along Bellambi Lane will be maintained for the Revised Preferred Project with WCL aiming to achieve 95% compliance with the voluntary speed limit and 100% compliance with the sign posted 60km/h speed limit. All haul trucks will be subject to GPS monitoring to monitor compliance with this speed limit.

Early Morning Truck Arrivals

Based on historical operations at the site, it is recognised that inbound trucks may arrive on site prior to the commencement of coal loading operations at 7.00 am (Monday - Friday) and 8.00 am (Saturdays). In order to avoid trucks parking in residential streets prior to 7.00 am (Monday - Friday) and 8.00 am (Saturdays), a designated truck parking area will be established on site (refer to **Figure 2.2**). Trucks entering the site between 6.00 am – 7.00 am, Monday to Friday and between 7.00 am - 8.00 am Saturday, prior to the commencement of loading operations will be required to turn off their engines while parked. Adequate parking will be available on site to avoid trucks queuing on the road outside of the Colliery.

2.1.6 Reject Material Handling

Following commissioning of the Coal Processing Plant, it is anticipated that approximately 0.2 Mtpa of reject material will be produced at full production.

Reject material from the Coal Processing Plant and sizing and screening plant will be transferred via the rejects conveyor to the reject stockpile (refer to **Figure 2.2**). Reject material will consist of rock material. Reject material that meets the specifications for Virgin Excavated Natural Material (VENM) may be sold for use as fill material, alternatively rejects will be used in site rehabilitation or hauled back to the mine portal via the internal haul road shown on **Figure 2.2** for emplacement underground.

Haulage of reject material from the reject stockpile to the portal will be limited to between 7.00 am - 6.00 pm Monday to Friday. Reject material transferred offsite will be subject to the same transport restrictions as ROM and product coal. The transport route for reject transferred offsite will depend on the destination of the material but will generally be transported via Bellambi Lane and Memorial Drive.

2.1.7 Coal Stockpiling

Three main coal stockpiles will operate within the Pit Top area, these being the main ROM stockpile, product stockpile and proposed temporary rejects stockpile (refer to **Figure 2.2**). The approximate maximum capacity and maximum height of these stockpiles is provided in **Table 2.2**.

Table 2.2 Coal Stockpile Capacities and Height

Stockpile	Approximate maximum Capacity	Approximate Maximum Height
ROM stockpile	30,000 tonnes	7 metres
Product stockpile	14,000 tonnes	6 metres
Temporary reject stockpile	1,500 tonnes	4 metres

2.1.8 Operational Hours

Underground Operations

Underground activities will occur 24 hours per day, 7 days per week. This will involve bringing ROM coal from the underground workings to the surface via the underground conveyor system to the ROM stockpile.

Surface Operations

Given the close proximity to neighbouring residential properties, coal beneficiation, truck loading and coal transport will typically be limited to daytime hours only between 7.00 am - 6.00 pm Monday to Friday and 8.00 am - 6.00 pm Saturday. No coal beneficiation, truck loading and coal transport will occur on Sundays or Public Holidays.

Coal beneficiation, truck loading and coal transport may occasionally be required until 10.00 pm Monday to Friday in exceptional circumstances such as Port closure or supply interruption, however such circumstances would be rare and as a result of unexpected events. The relevant technical assessments (noise, air quality and traffic impact assessments) have considered surface operations in the evening period as part of the Revised Preferred Project's updated environmental assessment (refer to **Section 5.0**).

ROM coal will be delivered from the underground to the ROM stockpile 24 hours a day.

2.2 Construction

Construction of the proposed Pit Top upgrades will commence at the same time as operations and the use of new and upgraded facilities will be phased in over approximately 12 - 24 months as construction is completed. The following fixed plant and infrastructure will be constructed as part of the Revised Preferred Project (refer to **Figure 2.2**):

- New 4 m high noise barrier along the site access road and extension/raising of existing bunds around the Pit Top, as described in **Section 2.2.1**.
- A new conveyor system for transferring coal from the underground reclaim bin to the processing plant.
- A new Secondary sizer.
- A new Surge bin.
- A new enclosed Coal Processing Plant and clean coal belt.
- New truck loading bin.
- Establishment of product stockpile area.
- New rejects conveyor and establishment of temporary reject stockpile area.

A Construction Environmental Management Plan (CEMP) will be developed to manage the construction works at the site. This plan will address:

- Environmental management including erosion, water, air and noise.
- Traffic management.
- Waste management.
- Management of construction works with the commencing of operation of the site.

2.2.1 Noise barrier and bunds

In order to minimise the potential noise impacts associated with trucks accessing the site, a 4 m high noise barrier will be installed along the northern side of the site access road between the site entrance and the turn off to the truck parking area prior to phase-in operations commencing.

In order to improve noise mitigation from site operations, bunds surrounding the Pit Top will also be raised and/or extended using material won onsite or imported clean fill material. Bunds shown on **Figure 2.2** will be modified as follows:

- Bund 1 will be raised by an additional 5 m throughout its length and extended to the west to the edge of the access road turn-off.
- Bund 2 will be raised and extended to reach Reduced Level (RL) of 56 m throughout its length.
- Bund 3 will be raised and extended to reach an RL of 47 m throughout its length.
- Bund 4 will be raised by 4-5 m to reach an RL of 44 m throughout its length.

- Bund 5 will be raised by additional 3 m throughout its length, and extended to the south to the access road.

The extension of the main bund to the north of the Pit Top (Bund 1) will be prioritised and commenced prior to phase-in operations and construction of other infrastructure commencing in order to minimise the noise impacts associated with these activities. The construction of Bund 1 will be completed over as short a timeframe as possible, indicatively 6 - 8 weeks to achieve planned height. If phase-in operations or infrastructure construction commence prior to Bund 1 achieving its planned height, phase-in operations and infrastructure construction will be managed to meet the operational project noise trigger levels outlined in **Section 5.6.3** until such time as Bund 1 achieves its planned height.

Bund construction will be managed in accordance with a Construction Noise Management Plan (CNMP) to be prepared and approved prior to commencement of construction.

The remaining bunds shown on **Figure 2.2** will be completed prior to full operation commencing. Bund construction will be undertaken using a dump truck, front end loader, compactor roller and occasional use of a grader.

2.2.2 Coal Processing Plant and associated infrastructure

Construction of the new Coal Processing Plant and associated infrastructure will be staged over an anticipated 12 - 24 month construction period, subject to delays such as weather and logistical issues.

2.2.3 Construction hours and workforce

All construction works will be undertaken during standard working hours as defined in the Interim Construction Noise Guidelines (ICNG) (DECCW, 2009):

- Monday to Friday: 7.00 am - 6.00 pm
- Saturday: 8.00 am - 1.00 pm
- Sunday and public holidays: No work.

It is anticipated that the Revised Preferred Project will require a construction workforce of approximately 22 full time staff for the duration of the construction period (12 - 24 months).

2.3 Operations Maintenance and Management

2.3.1 Mine Workforce

The operation of the Revised Preferred Project will require approximately 205 staff. Underground mining operations will be undertaken 24 hours a day, 7 days per week.

For environmental impact assessment purposes, the following shift details are indicatively proposed, noting that these may be refined or updated as part of ongoing operations.

Office management and support staff will generally work Mondays to Fridays typically from 6.00 am to 4.00 pm and will total approximately 30 staff.

The operations shift workforce will indicatively comprise 35 staff currently proposed to work on the following shift rotations, noting this may change from time to time:

- Mondays to Thursdays – 3 shifts per day (each 9 hours) overlapping – change at face:
  - 7.00 am – 4.00 pm
  - 3.00 pm – 12.00 am
  - 11.00 pm – 8.00 am
- Fridays to Sundays – 2 shifts per day (each 12 hours) back to back – change at surface:
  - 6.00 am – 6.00 pm
  - 6.00 pm – 6.00 am

2.3.2 Environmental Management

Mining operations undertaken at the Russell Vale Colliery under the Preliminary Works Project (PA 10_0046) have been subject to the following updated management plans and strategies:

- Air Quality and Greenhouse Management Plans
- Biodiversity Management Plan
- Conservation Management Plan
- Environmental Management Strategy
- Heritage Management Plan
- Noise Management Plan
- Rehabilitation Management Plan
- Mining Operations Plan
- Surface Facilities Water Management Plan
- Traffic Management Plan
- Water Management Plan.

Longwall mining previously undertaken pursuant to the Preliminary Works Project has been subject to approved Subsidence Management Plans and Extraction Plans. Monitoring and remediation works associated with this previous mining will continue to be undertaken in accordance with these approved plans.

Monitoring undertaken on site includes groundwater, surface water (flow rates and quality), air quality, noise and meteorological data. Biodiversity monitoring is also undertaken in areas above past longwall mining operations.

It is intended that the existing Management Plans and monitoring networks will be reviewed and revised (where necessary) to reflect the Revised Preferred Project approval requirements and continue to be applied, should the project be approved.

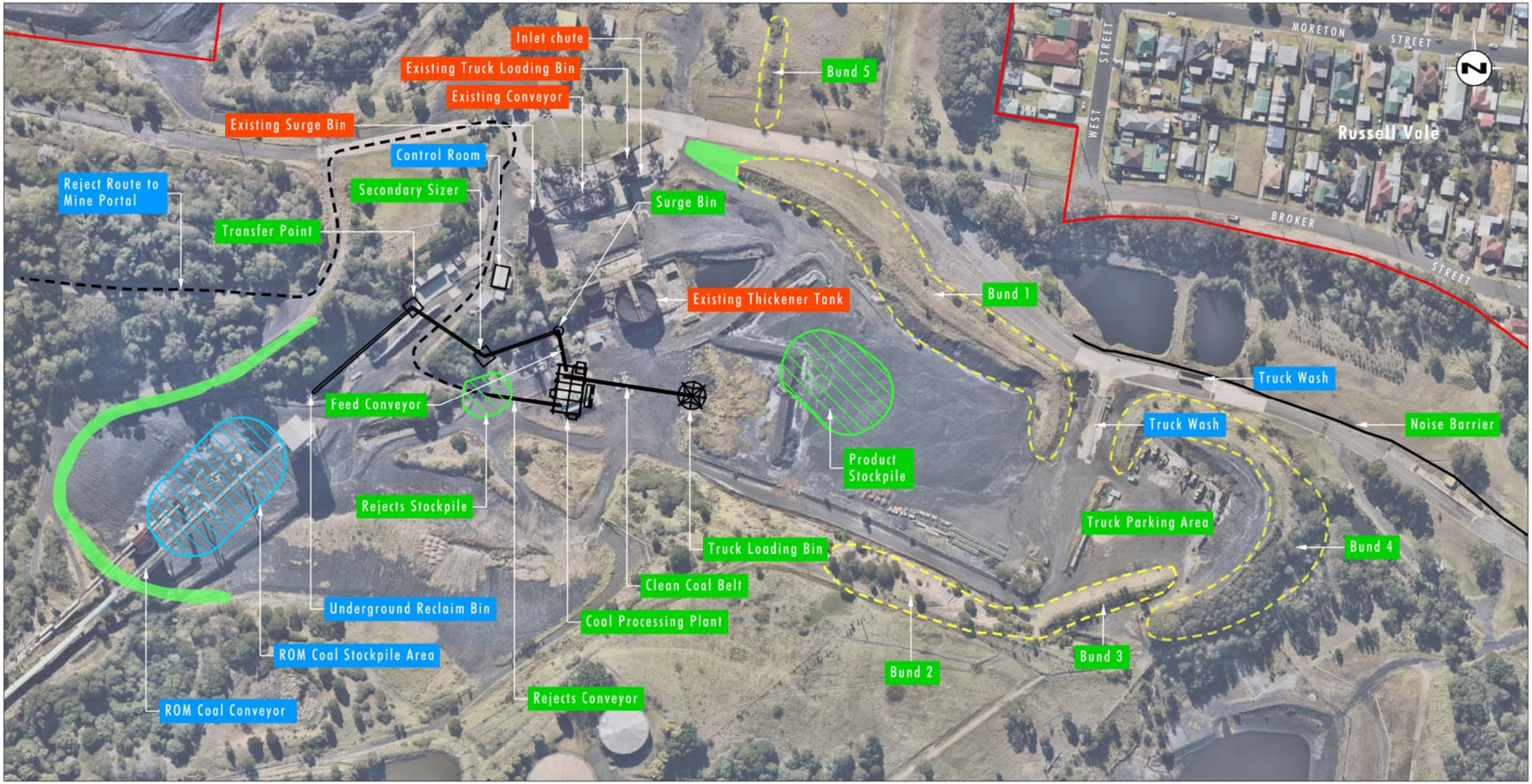

Image Source: Nearmap (Aug 2018)
Data Source: Wollongong Coal (2016)

Legend

- UEP Project Application Area
- Existing Disused Infrastructure
- Existing Infrastructure to be used by UEP
- Infrastructure to be Constructed
- Proposed Flood Levee to be constructed under Mod 4
- Existing bund to be raised/extended

FIGURE 2.2

Current and Proposed Plant and Infrastructure

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2.4 Rehabilitation and Closure

As discussed in **Section 1.6** large volumes of economically viable coal remain un-extracted within the central and Western portions of the Russell Vale mining leases. WCL remains committed to undertaking further detailed environmental studies to enable the environmentally responsible recovery of this resource. To this end, following completion of further detailed environmental studies, WCL intends to seek development consent for the continued operation of the Russell Vale Colliery to recover the portions of this resource that can be done in an environmentally acceptable manner via non-caving first workings mining methods.

Given the intended continuing use of the site (subject to future planning approval), decommissioning and closure of the Russell Vale Colliery Pit Top facilities are not proposed immediately following the completion of the UEP. Rather, it is intended that the site would be maintained in care and maintenance until such time as the planning assessment process is completed. If consent for continuing use of the site is not forthcoming, WCL will prepare and implement a detailed mine closure and rehabilitation plan in consultation with the Resources Regulator and other relevant government agencies and stakeholders.

Until that time, the existing rehabilitation and mine closure strategy outlined in the current Russell Vale Colliery Rehabilitation Management Plan, Preliminary Works Project Environmental Assessment (ERM 2011) and Rehabilitation Objectives established under Schedule 3 Condition 42 the Preliminary Works Project Approval (PA 10_0046) continue to remain valid.

WCL will continue to progressively rehabilitate and decommission non-critical infrastructure as they are phased out of operations or become non-critical to potential future land use options at the colliery. Rehabilitation within the site will continue to be managed in accordance with the existing approved Russell Vale Colliery Rehabilitation Management Plan. WLC will review and update the existing Rehabilitation Management Plan to reflect approval requirements and commitments associated with the Revised Preferred Project and refinements to the site water management system proposed as part of MOD4.

3.0 Statutory Context

This section details the statutory context for the Revised Preferred Project and discusses the application of these planning provisions to the project.

3.1 Commonwealth Legislation

A summary of the Commonwealth legislation potentially relevant to the Revised Preferred Project is provided in **Table 3.1**.

Table 3.1 Commonwealth Statutory Context

Regulatory Instrument	Application to Revised Preferred Project	Approval Required?
Commonwealth Legislation		
Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act)	Under the EPBC Act the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on a matter of national environmental significance. In 2014 the original UEP project was referred to the Commonwealth Department of Environment (DoE), now the Department of Environment and Energy (DoEE) under section 68 of the EPBC Act for the proposed action of extraction of eight longwall panels from the Wongawilli Seam (EPBC 2014/7628). On 14 November 2014 it was determined that the proposal constituted a controlled action subject to controlling provisions for listed threatened species and ecological communities (sections 18 and 18A) and protection of water resources from coal seam gas development or large coal mining development (sections 24D and 24E). The changes in mining method proposed by the Revised Preferred Project has resulted in a substantial reduction in the predicted impacts of the referred action on listed threatened species and ecological communities and water resources. As discussed in **Sections 5.1** and **5.2**, negligible impacts on listed threatened species and ecological communities and insignificant impacts on water resources are now predicted as a result of the Revised Preferred Project. As previously requested, a copy of this document will be provided to DoEE to confirm any further requirements in in relation to the completion of the referral process.	Yes
Native Title Act 1993	The *Native Title Act 1993* is not directly relevant to the approval process for the Revised Preferred Project; however, it does have implications for the grant of mining leases under the *Mining Act 1992* where there is potentially land in respect of which native title has not been extinguished within the lease application area. No additional mining lease applications are required for the Revised Preferred Project; therefore, consideration of the *Native Title Act 1993* will not be required.	No
National Greenhouse and Energy Reporting Act, 2007 (NGER Act)	The NGER Act provides a single national framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds. WCL is a registered corporation under the NGER Act and is therefore required to report air emissions. If approved, the UEP will be required to be considered in WCL corporate NGER Act reporting.	No

3.2 NSW Legislation and Policies

There are a substantial number of legislative instruments in NSW which regulate the environmental impact of development. The primary instrument is the EP&A Act which regulates the planning and environmental assessment and approval process for development in NSW. The application of the EP&A Act and relevant planning and environmental legislation to the Revised Preferred Project is discussed in **Section 3.2.1** and **Section 3.2.2**. The operation of other environmental legislation in regard to the Revised Preferred Project is discussed in **Section 3.2.3** and in **Section 5.0** in relation to specific Project impacts where relevant.

Section 3.2.4 discusses the key strategic policies that have relevance to the design and operation of the Revised Preferred Project and which have been considered in the environmental assessment. In addition to the policies discussed in **Section 3.2.4** there are a large number of impact specific guidance documents and policies that have been considered as part of the environmental assessment of the Revised Preferred Project, these are identified and discussed in the relevant impact assessment sections in **Section 5.0**.

3.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the primary legislation governing environmental planning and assessment for NSW. The EP&A Act prescribes a number of approval and assessment pathways for new development and modifications to existing development. These pathways are determined by environmental planning instruments such as local environmental plans and State Environmental Planning Policies (SEPPs).

The objects of the EP&A Act are outlined in **Table 3.2**, including a discussion of how the Revised Preferred Project seeks to achieve consistency with these objectives.

Table 3.2 Consideration of EP&A Act Objectives

EP&A Act Object	Consistency of Revised Preferred Project
(a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources	The Revised Preferred Project represents a continuation of a long-standing historical land use that is permissible under existing environmental planning instruments (refer to **Section 3.2.2.1**). Substantial changes have been made to the Revised Preferred Project to minimise the potential adverse impacts of the project on the environment and local community (as discussed in **Section 1.5**, **Section 2.0** and **Section 5.0**).
(b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment	The environmental assessment completed for the Revised Preferred Project presents an integrated assessment of relevant economic (refer to **Section 5.13**), environmental (refer to Section 5.0) and social (refer to **Section 4.1** and **Section 5.12**) considerations. Consideration of the principles of ecologically sustainable development has also been provided in **Section 16.3**).
(c) to promote the orderly and economic use and development of land	The Revised Preferred Project represents a continuation of a long-standing historical land use. Consideration of the compatibility of project with surrounding land uses has been provided in **Section 5.9.3** and a cost benefit analysis of the project is provided in **Section 5.13**.

EP&A Act Object	Consistency of Revised Preferred Project
(d) to promote the delivery and maintenance of affordable housing	While not specifically relevant due to the nature of the proposed development, the Russell Vale Colliery produces high quality hard coking coal, a product that can help meet the expanding demand for metallurgical coal globally, where it is used for the production of steel – a product that is used in housing construction.
(e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats	The Revised Preferred Project has been specifically redesigned to limit potential subsidence related impacts. As discussed in **Section 5.5**, the project is not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. As a result, impacts to the biodiversity values of the UEP Application Area are predicted to be negligible.
(f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)	The Revised Preferred Project has been specifically redesigned to limit potential subsidence related impacts. As discussed in **Table 5.1**, the proposed first workings are predicted to result in imperceptible subsidence and are not expected to cause perceptible impacts to any natural surface features, including Aboriginal or cultural heritage sites. Further, no additional disturbance at the Pit Top is proposed, beyond that currently disturbed and approved for development. The Revised Preferred Project is therefore unlikely to result in any impacts to cultural heritage.
(g) to promote good design and amenity of the built environment	As discussed in **Section 2.0**, in response to concerns from the PAC and community regarding amenity impacts associated with the Russell Vale Pit Top, substantial improvements to the Pit Top layout and adoption of a range of additional feasible and reasonable noise control measures, including restricting hours of operation, have been proposed to reduce the amenity impact of the Pit Top and trucks accessing the site.
(h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants	As discussed in **Section 5.6.1** and **Section 5.7.7**, a range of control measures have been included in the design of Pit Top infrastructure including enclosure of conveyors and material transfer points, and enclosure of the coal processing plant in order to reduce noise and air emission from these facilities.
(i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State	The UEP (amended here as the Revised Preferred Project) is classified as a 'transitional Part 3A project ' under the savings and transitional provisions established under Schedule 2 Clause 3 of the *Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017* (formerly Schedule 6A of the EP&A Act).
(j) to provide increased opportunity for community participation in environmental planning and assessment	Details of community and stakeholder consultation undertaken during the project redesign and environmental assessment process for the Revised Preferred Project is summarised in **Section 4.0**. Further opportunity for community participation will be provided following submission of this documentation to the DPIE and the public exhibition process.

Approval Pathway

The UEP (amended here as the Revised Preferred Project) is classified as a 'transitional Part 3A project ' under the savings and transitional provisions established under Schedule 2 Clause 3 of the *Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017* (formerly Schedule 6A of the EP&A Act).

As a ‘transitional Part 3A project’, the provisions of Part 3A of the EP&A Act (as in force immediately before the repeal of that Part and as modified under this Schedule after that repeal) continues to apply to and in respect of the Revised Preferred Project.

Permissibility

The UEP Application Area is located within the Wollongong and Wollondilly local government areas (LGA). Hence, the *Wollongong Local Environment Plan 2009* (LEP) and *Wollondilly LEP 2011* are relevant to the permissibility of the Revised Preferred Project. Relevant land zonings under each of the LEPs are shown in **Figure 3.1**.

Under these LEPs, mining is prohibited within parts of the Revised Preferred Project area, however the permissibility provisions of *SEPP (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) provide that ‘underground mining carried out on any land’ is permissible with development consent. Consequently, the Revised Preferred Project is permissible with development consent under the Mining SEPP (refer to **Section 3.2.2.1**).

3.2.2 Environmental Planning Instruments

Section 75R(3) of Part 3A of the EP&A Act states that environmental planning instruments, other than SEPPs, do not apply to part 3A projects. However, section 75J(3) provides the consent authority with a broad discretion to consider the provisions of any relevant environmental planning instrument, notwithstanding section 75R.

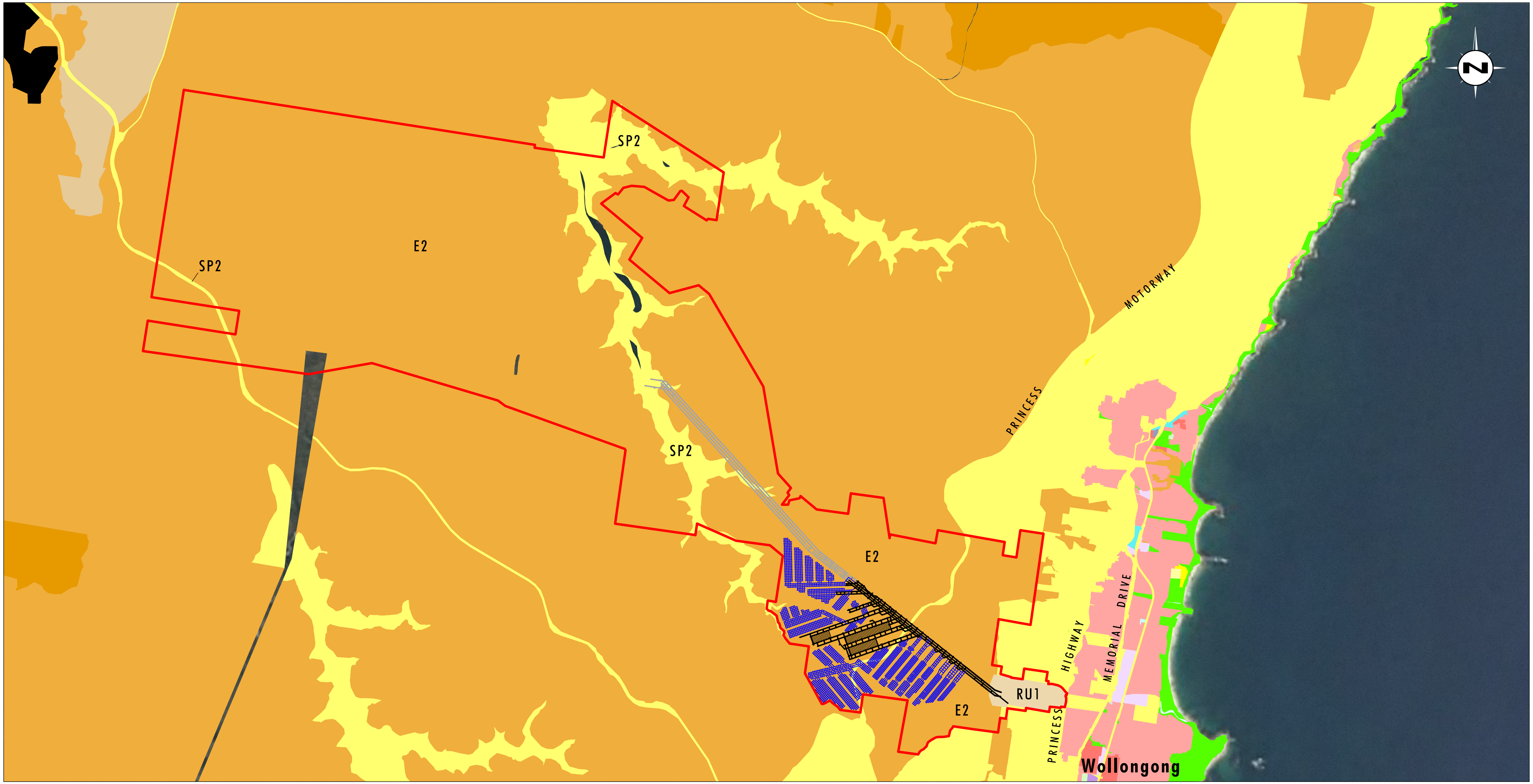

Image Source: Google maps (2016)
Data Source: Wollongong Coal (2016), NSW Environment Planning Industry (2018), Wollongong LEP (2009), Wollondilly LEP (2011), Wingecarribee LEP (2010)

Legend

- UEP Project Application Area
- Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- B1 Neighbourhood Centre
- B2 Local Centre
- B4 Mixed Use
- B6 Enterprise Corridor
- E1 National Parks / Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- E4 Environmental Living
- IN2 Light Industrial
- IN3 Heavy Industrial
- R2 Low Density Residential
- R3 Medium Density Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU1 Primary Production
- RU2 Rural Landscape
- RU4 Primary Production Small Lots
- SP1 Special Activities
- SP2 Infrastructure
- SP3 Tourist
- W1 Natural Waterways

FIGURE 3.1

LEP Zoning

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20190717 15.17

The following SEPPs are relevant to the consideration of the development application for the Revised Preferred Project.

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

The Mining SEPP regulates the permissibility and assessment requirements for mining, petroleum production and extractive industries and related development. As set out in **Section 3.2.1**, the permissibility provisions of Mining SEPP provide that 'underground mining carried out on any land' is permissible with development consent. Consequently, the Revised Preferred Project is permissible with development consent under the Mining SEPP.

Part 3 of the Mining SEPP includes specific matters for consideration. in relation to development applications made under Part 4 of the EP&A Act. While these matters do not strictly apply to the Revised Preferred Project as it is a 'transitional Part 3A project', consideration of these matters has been provided in **Table 3.3** to inform the assessment of the project.

Table 3.3 Part 3 Matters for Consideration

Matters for Consideration	Relevance to Revised Preferred Project
Non-discretionary development standards for mining (Clause 12AB)	Clause 12AB establishes non-discretionary development standards relating to cumulative noise, cumulative air quality, airblast overpressure, ground vibration and aquifer interference. The Revised Preferred Project has been assessed against the cumulative noise and air quality standards set out in Clause 12AB and found to comply (refer to **Sections 5.6** and **5.7**). A range of reasonable and feasible noise and air quality mitigation measures are proposed to be implemented as part of the project. No blasting is proposed therefore no significant adverse impacts associated with airblast overpressure or ground vibration are anticipated. Predicted groundwater impacts associated with the Revised Preferred Project have been assessed against the Aquifer Interference Policy. This assessment concludes that the project adequately satisfies the minimal impact considerations for less productive porous rock water sources and perched, ephemeral aquifers defined by the NSW Aquifer Interference Policy (refer to **Section 5.3.7**).
Compatibility of proposed mine, petroleum production or extractive industry with other land uses (Clause 12)	Clause 12 requires the consent authority to consider the compatibility of proposed mining developments with existing land uses in the area. Mining at Russell Vale has been undertaken since 1887. Over time, urban development has encroached on the pit-top facilities at Russell Vale and these facilities are now bordered by residential land uses. Russell Vale Colliery has coexisted with these neighbouring land uses over an extended period with a degree of impact on the amenity of these residential land uses. Key elements of the Revised Preferred Project have been designed to minimise these amenity impacts on surrounding residential land uses. Given the existing and historical use of the site for mining purposes, the Revised Preferred Project is considered to be compatible with the existing land use within the UEP Application Area. With regard to surrounding land uses, the assessment in **Section 5.0** identifies that with the implementation of existing and proposed monitoring, management and mitigation measures, the Revised Preferred Project is predicted to operate within acceptable environmental standards. The project also represents a continuation of an existing local land use (i.e. mining). Post mining, the opportunity exists for the rehabilitated Pit Top to be transferred to an alternate land use compatible with surrounding residential and commercial land uses.

Matters for Consideration	Relevance to Revised Preferred Project
Consideration of voluntary land acquisition and mitigation policy (Clause 12A)	Clause 12A requires the consent authority to consider any applicable provisions of the Voluntary Land Acquisition and Mitigation Policy. Compliance with relevant noise and air quality criteria has been assessed in **Sections 5.6** and **5.7** and a range of reasonable and feasible noise and air quality mitigation measures are proposed to be implemented as part of the project. The results of the noise and air quality impact assessments described in **Sections 5.6** and **5.7** do not trigger voluntary mitigation or acquisition rights established under the Voluntary Land Acquisition and Mitigation Policy.
Compatibility of proposed development with mining, petroleum production or extractive industry (Clause 13)	Clause 13 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. The Revised Preferred Project mine plan has been designed to be long term stable and is not expected to result in perceptible surface subsidence, significant interaction with overlying seams or significant interaction with existing groundwater systems. The proposed mine plan will not limit access or impede assessment of current of future resources. Therefore, the Revised Preferred Project will not have a significant impact on current or future extraction or recovery of resources in the vicinity of the development, nor is it considered incompatible with current or future mining-related activities in the vicinity.
Natural resource management and environmental management (Clause 14)	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 Revised Preferred Project's potential impact on natural resources is assessed in detail in **Section 5.0** and specific commitments regarding the management of potential environmental impacts are contained in **Section 6.0**. As discussed in **Section 5.0**, potential impacts to surface water and groundwater resources, threatened species and biodiversity have been minimised to the greatest extent practicable through the change in mine design to a stable first workings mine plan. The revised mine plan significantly reduces the potential for subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment, and is not expected to result in perceptible surface subsidence, significant interaction with overlying seams or significant interaction with existing groundwater systems. Importantly, the revised mine plan is not considered to have any potential to perceptibly impact natural surface features including upland swamps, cliffs including the Illawarra Escarpment, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.
Resource recovery (Clause 15)	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. In response to community and agency concerns regarding the potential adverse impacts of mining associated with the original UEP proposal, the Revised Preferred Project proposes the use of non-caving first working techniques to significantly limit the potential adverse impacts of mining. The Revised Preferred Project is considered to strike an appropriate balance between maximising resource recovery within the environmental and community constraints of the site.
Transport (Clause 16)	Clause 16 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. Consistent with historical operations at the site, coal from the Revised Preferred Project will be transported by truck to PKCT. An assessment of the road traffic impacts of the Revised Preferred Project are presented in **Section 5.8**.

Matters for Consideration	Relevance to Revised Preferred Project
Rehabilitation (Clause 17)	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 Revised Preferred Project will utilise non-caving first workings mining techniques, therefore remediation or rehabilitation of subsidence-related impacts is unlikely to be required. Given the intended continuing use of the site, decommissioning and closure of the Russell Vale Colliery pit top facilities are not proposed immediately following the completion of the UEP. Rather, it is intended that the site will be maintained in a care and maintenance mode until such time as any future planning assessment process is completed. If consent for continuing use of the site is not forthcoming, WCL will prepare a detailed mine closure and rehabilitation plan in consultation with the Resources Regulator.

3.2.2.2 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The UEP Application Area is located within the boundary of the Sydney Drinking Water Catchment (refer to **Figure 3.1**). The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* requires all proposed development in the Greater Sydney drinking water catchment to have a neutral or beneficial effect on water quality (NorBE). The 'Neutral or Beneficial Effect on Water Quality Assessment Guideline 2015' supports the implementation of the SEPP by providing clear direction on what a neutral or beneficial effect means, how to achieve it, and how to assess an application against the neutral or beneficial effect on water quality test using the 'Neutral or Beneficial Effect on Water Quality Assessment Tool' (the NorBE Tool).

While SEPP (Sydney Drinking Water Catchment) 2011 does not strictly apply to the Revised Preferred Project as the project application was lodged on 13 August 2009, prior to the introduction of the Drinking Water SEPP (see Clause 13), the potential impact of the Revised Preferred Project on water quality within the Sydney Drinking Water Catchment has been considered as part of the Groundwater Impact Assessment and Surface Water Assessment presented in **Appendix 2** and **3**. A review of these potential impacts is provided in **Sections 5.3** and **5.4** respectively. The Revised Preferred Project is considered to satisfy the NorBE Test as applied under clause 11A of the Drinking Water SEPP (refer to **Section 5.3.7**).

3.2.2.3 State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33)

SEPP 33 requires the consent authority to consider whether an industrial proposal is a potentially hazardous industry or a potentially offensive industry. A hazard assessment is completed for potentially hazardous development to assist the consent authority to determine acceptability.

A preliminary risk screening has been completed for the Revised Preferred Project. The preliminary risk screening demonstrates that hazardous materials to be stored at the site are below the SEPP 33 screening threshold, therefore the Revised Preferred Project is not considered potentially hazardous and a preliminary hazard analysis is not required under SEPP 33 (refer to **Section 5.10.1**).

3.2.2.4 State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44)

SEPP 44 was introduced in 1995 to encourage local councils to conserve and manage koala habitat to ensure populations remain stable and population decline is reversed.

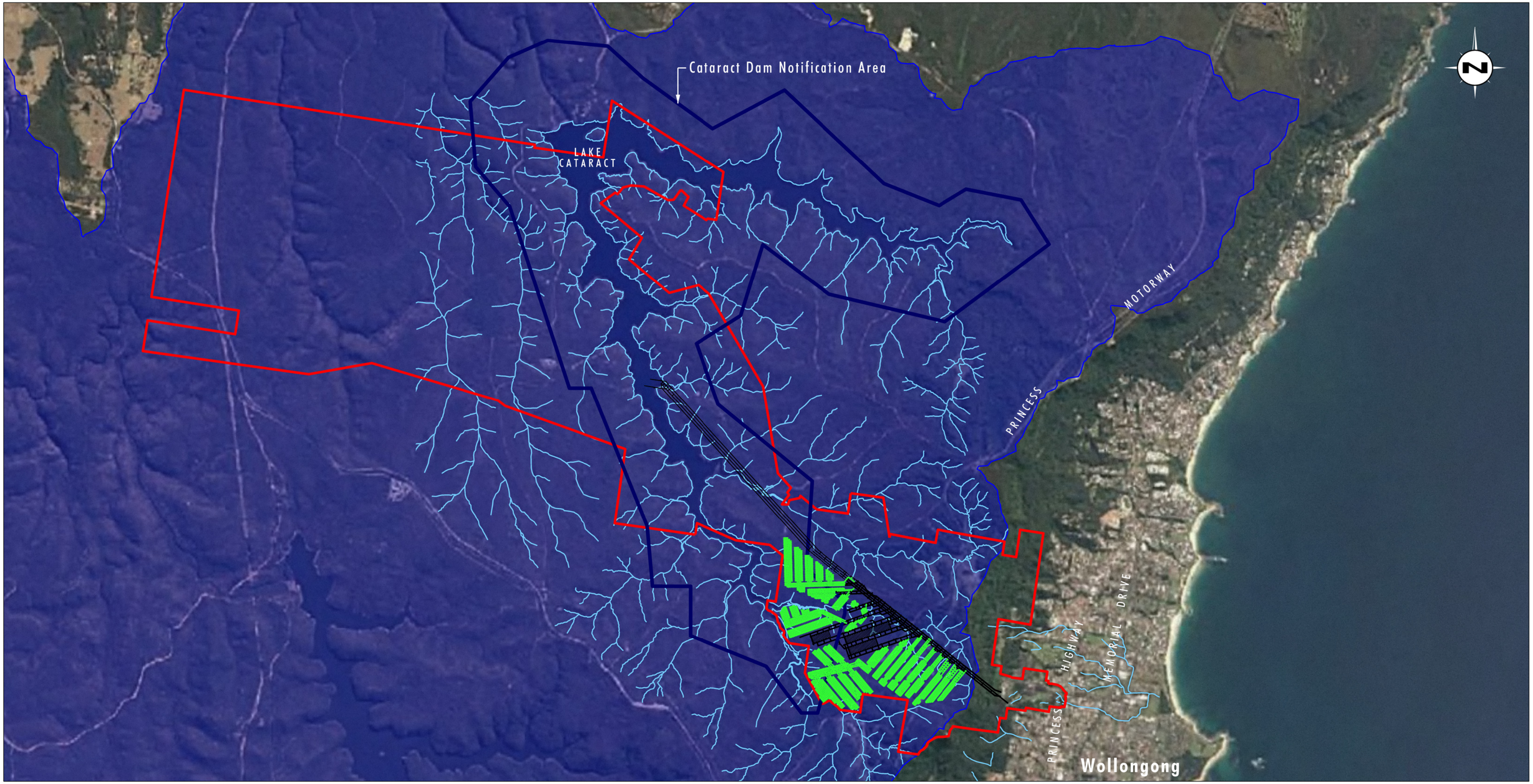

Image Source: Nearmap (Sept 2018)
Data Source: Wollongong Coal (2016), NSW Environment Planning Industry (2018)

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Legend

- UEP Project Application Area
- Cataract Dam Notification Area
- Sydney Drinking Water Catchment Area
- Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line

FIGURE 3.2

Cataract Dam Notification Area and Sydney Drinking Water Catchment Area

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Wollongong and Wollondilly local government areas are listed in Schedule 1 as areas where koalas are known to occur and accordingly where the provisions of SEPP 44 apply. However, only applications under Part 4 of the EP&A Act are subject to this SEPP. As the Revised Preferred Project is being assessed under Part 3A of the EP&A Act this SEPP does not apply. Regardless, the subsidence impact assessment and ecological impact assessment prepared for the Revised Preferred Project (included as **Appendix 1** and **4** respectively), conclude that the revised mine plan will not result in any perceptible surface subsidence and is not considered to have any potential to perceptibly impact on natural surface features, therefore the Revised Preferred Project is considered to have negligible risk of impacting any potential Koala habitat.

3.2.2.5 State Environmental Planning Policy No. 55 Remediation of Land (SEPP 55)

SEPP No. 55 – Remediation of Land 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 the SEPP, a consent authority must not consent to the carrying out of development on land unless it has considered potential contamination issues.

There are no contaminated sites currently recorded within the UEP Application Area. The Revised Preferred Project is within existing mining tenements and will not result in a change of land use, therefore no preliminary land contamination investigation has been undertaken. Further site investigation will be undertaken as part of the mine closure and rehabilitation process, or if a potential contamination issue is identified as part of ongoing operations.

3.2.3 Other State Legislation

A summary of the other State environmental and planning legislation potentially relevant to the Revised Preferred Project is provided in **Table 3.4**.

Table 3.4 Summary of Other State Legislation and Relevance to Revised Preferred Project

Regulatory Instrument	Application to Revised Preferred Project	Approval Required?
***Protection of the Environment Operations Act, 1997* (POEO Act)**	The POEO Act provides an integrated system of licensing for polluting industries. Schedule 1 of the POEO Act identifies types of development that require an Environment Protection Licence (EPL). Mining for coal is included in Schedule 1. WCL currently holds EPL number 12040 issued under the POEO Act for current operations. The licence regulates water quality and the volume of water discharges and requires dust and meteorological monitoring at the site. It is expected that modification to this licence would be required should approval for the Revised Preferred Project be granted. Under section 75V in Part 3A (as it applied immediately prior to its repeal), any modification to the EPL must be approved in a manner that is substantially consistent with any Part 3A approval for the Revised Preferred Project.	Yes

Regulatory Instrument	Application to Revised Preferred Project	Approval Required?
***Mining Act 1992* (Mining Act)**	Under this Act a mining lease is required before any mining or specified mining purpose can be carried out on the land. The site currently has an approved Consolidated Coal Lease (CCL 745), Mining Purpose Lease (MPL 271) and Mining Lease (ML 1575) over the UEP Application Area, which provides WCL with the mining rights to the target seam for the project. All mining operations must be subject to a Mining Operations Plan (MOP) and approved Extraction Plan (where the operation may cause subsidence). A Care and Maintenance MOP for the Colliery has been prepared and accepted by the Resources Regulator. A new MOP would be required to reflect changes resulting from the Revised Preferred Project, if approved.	No, however a new MOP will be required
***Biodiversity Conservation Act 2016* (BC Act)**	The purpose of the BC Act is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development. Under the BC Act it is an offence to harm or pick a threatened species, threatened ecological community or a protected plant or animal, or to damage habitat of a threatened species or ecological community, except under a range of circumstances set out in Division 2, including where the activity has appropriate planning approval under the EP&A Act or where the activity is authorised by a biodiversity conservation licence. A licence under this Act is not required for any activity undertaken in accordance with a development consent granted under the EP&A Act and therefore no separate approvals are required under the BC Act for the Revised Preferred Project.	No
***National Parks and Wildlife Act 1974* (NPW Act)**	The object of the NPW Act relate to conserving their State's natural and cultural heritage; fostering public appreciation, understanding and enjoyment of their State's natural and cultural heritage; and managing any lands reserved for the purposes of conserving and fostering public appreciation and enjoyment of the State's natural and/or cultural heritage. Under section 86 of the NPW Act, it is an offence to harm an Aboriginal object, except where authorised by an Aboriginal heritage impact permit issues under section 90 of the Act. Under section 75U(d) in Part 3A (as it applied immediately prior to its repeal), an Aboriginal heritage impact permit under section 90 of the NPW Act would not be required for the Revised Preferred Project.	No

Regulatory Instrument	Application to Revised Preferred Project	Approval Required?
Heritage Act 1977 (Heritage Act)	The Heritage Act provides for the identification, registration and protection of items of State heritage significance. Under Part 4 of the Heritage Act, approval is required to undertake a range of activities relating to a listed an item listed on the State Heritage Register. Under Part 6, an excavation permit is required for any activity that is likely to disturb a relic of State or local heritage significance. Undersection 75U(c) in Part 3A (as it applied immediately prior to its repeal), an approval under Part 4, or an excavation permit under Part 6 section 139 of the Heritage Act would not be required for the Revised Preferred Project.	No
Crown Land Management Act 2016 (CLM Act)	The CLM Act provides for the ownership, use and management of Crown land in NSW. Crown land may not be occupied, used, sold, leased, licensed, dedicated, reserved or otherwise dealt with unless authorised by this Act. The Minister may grant a 'relevant interest' such as a lease, licence or permit, over Crown land for the purpose of any infrastructure, activity or other purpose that the Minister thinks fit. The Revised Preferred Project does not propose any works within Crown Land therefore approval under this Act is not required.	No
Roads Act 1993 (Roads Act)	Consent is required under section 138 of the Roads Act to work on or above a road or to connect a road to a classified road. The Revised Preferred Project will not require any works on or above a road or connection to a classified road. As discussed in **Section 5.2**, some ongoing low-level ground movement, mainly horizontal movement associated with previous mining, including the Wongawilli Seam longwalls, may still be ongoing. This low-level movement has potential to continue to cause perceptible cracking on Mount Ousley Road at the top of the ridge to the south of Cataract Creek and some compression on the road at Cataract Creek that may also be perceptible. This movement is a legacy of previous mining and is not expected to be influenced by the proposed mining. Movement is expected to continue irrespective of any further first workings that are developed in the Wongawilli Seam. Should any perceptible cracking requiring repair of the road surface occur, these impacts will continue to be managed in accordance with the existing Built Features Management Plan for Mount Ousley Road in consultation with RMS.	No

Regulatory Instrument	Application to Revised Preferred Project	Approval Required?
***Water Management Act 2000* (WM Act)**	Under section 75U(h) Part 3A (as it applied immediately prior to its repeal), a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the WM Act would not be required for the Revised Preferred Project. The *Aquifer Interference Policy* (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 take water from a source covered by a water sharing plan (WSP), a water access licence is required under the WM Act to account for this loss of water. WCL holds water access licence (WAL) WAL36488 for 515 ML (units)/year under the WM Act for the extraction of water under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources, 2011.* Based on the predicted maximum groundwater inflow make into the WCL workings, including all previous mining impacts, of 288ML/year, WCL currently hold a sufficient quantity of units in their existing Water Access Licence (refer to **Section 5.3.5**). WCL will require a WAL under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* for the annual cumulative take of up to 10.04 ML/yr of stream baseflow (estimated at 9.91ML/year) and leakage from Cataract Reservoir (estimated at 0.13 ML/year) resulting from depressurisation of deeper aquifers.	Yes, in respect of WALs only.
Dams Safety Act 1978 and 2015	Cataract Dam, South Bulli Basin 1 and South Bulli Stormwater Dam are listed as prescribed dams under Schedule 1 of the *Dams Safety Act 1978*. Notification Areas are defined by the Dams Safety Committee (DSC) under Section 369 of the *Mining Act 1992*. Notification Areas are 'investigation areas' for technical review and regulation of mining and related impacts. The DSC recognises that the Cataract Dam wall may be sensitive to far-field horizontal movements and has set a 1.5 km radius around the dam wall where the assessment of potential mining impacts should be focussed (refer to **Figure 3.1**). There is no Notification Area listed for South Bulli Basin 1 or South Bulli Stormwater Dam. The Revised Preferred Project involves first workings within the DSC Notification Area for Cataract Storage Reservoir. The consent authority must therefore consult with Dam Safety NSW prior to issuing consent for mining within the notification area.	No, however the consent authority must consult with Dam Safety NSW prior to issuing consent for mining within the Cataract Dam Notification Area.

3.2.4 Relevant Strategic Policies

3.2.4.1 Aquifer Interference Policy

The Aquifer Interference Policy requires mining activities to consider ‘Minimal Impact Considerations’ with respect to groundwater sources.

Predicted groundwater impacts associated with Revised Preferred Project have been assessed against the Aquifer Interference Policy. This assessment concludes that the Revised Preferred Project adequately satisfies the minimal impact considerations for less productive porous rock water sources and for the perched, ephemeral aquifers defined by the NSW Aquifer Interference Policy (refer to **Section 5.3.7**).

3.2.4.2 WaterNSW Principles for Managing Mining and Coal Seam Gas Impacts in Declared Catchment Areas

WaterNSW was established to provide a safe and reliable supply of raw water suitable for treatment to drinking water standards. To meet this objective WaterNSW manages its land, the Sydney drinking water catchments and infrastructure including water storages, to protect water quality and quantity.

WaterNSW has formulated a number of principles that establish the outcomes WaterNSW considers essential to protect the drinking water supplies from the impacts of mining and coal seam gas activities. These principles have been addressed in **Section 5.3.7.**

3.2.4.3 Voluntary Land Acquisition and Mitigation Policy

The NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) provides guidance on voluntary mitigation and land acquisition to address noise and dust (particulate matter) impacts from state significant mining, petroleum and extractive industry developments. As a transitional Part 3A project, the VLAMP does not apply to the Revised Preferred Project; however, based on the results of the noise and air quality impact assessments described in **Sections 5.6** and **5.7**, the Revised Preferred Project does not trigger voluntary mitigation or acquisition rights established under the Voluntary Land Acquisition and Mitigation Policy.

3.2.4.4 Independent Expert Panel for Mining in the Catchment

In November 2017 the NSW Government established the Independent Expert Panel for Mining in the Catchment (the Panel) to provide expert advice to DPIE on the impact of underground mining activities in the Greater Sydney Water Catchment Special Areas.

Advice from the Panel will include, but not be limited to, risks to the total water quantity and holding capacity of surface and groundwater systems, including swamps and reservoirs, and the types and reliabilities and methodologies used to predict, monitor, assess and report on mining effects, impacts and consequences. The Panel will also provide, as required, expert advice to the DPIE on mining applications, including monitoring and management plans.

The full Terms of Reference (TOR) established for the Panel are:

1. ***Undertake an initial review and report on specific coal mining activities at the Metropolitan and Dendrobium coal mines in the Greater Sydney Water Catchment Special Areas**, including*:
   a) A review of the findings and recommendations of studies and reports deemed appropriate by the Panel, including but not confined to the reports:
      i. *Height of Cracking*—Area 38, prepared by PSM, dated 16 March 2017

ii. *2016 Audit of the Sydney Drinking Water Catchment,* prepared by Alluvium, dated June 2017.

b) A review of the types and reliability of prediction, monitoring and response methodologies (including mitigation, remediation and rehabilitation) currently used for assessing and managing the effects, impacts and consequences of mining activities at the Metropolitan and Dendrobium coal mines as they relate to water quantity, including having regard to historical data and performance.

c) Provide advice and recommendations on measures required to improve approaches to prediction, monitoring, responses and reporting at the Metropolitan and Dendrobium coal mines, including having regard to cumulative risks posed to the quantity of drinking water available in the Greater Sydney Water Catchment Special Areas.

d) Based on the outcomes TOR 1(a) to 1(c), provide advice to Government on how' to respond to the findings and recommendations of reports reviewed as part of TOR la.

e) In developing its advice, the Panel will meet, undertake site visits, seek information and data, and consult as needed.

f) In delivering its report, the Panel will provide comment on and make observations or recommendations about any information or factors the Panel believes relevant; or further work that should be undertaken.

g) A progress update on the report is to be delivered no later than 30 April 2018 and the report is to be delivered no later than 31 July 2018.

2. Undertake a review of current coal mining in the Greater Sydney Water Catchment Special Areas with a particular focus on risks to the quantity of water available, the environmental consequences for swamps and the issue of cumulative impacts*, including:*

a) A review and update of the findings of the 2008 Southern Coalfield Inquiry (impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review) for mining operations at the Dendrobium, Metropolitan, Russell Vale and Wongawilli mines, including recommending measures to improve the way mining effects, impacts and consequences in relation to water quantity are assessed and managed.

b) In developing its advice, the Panel will meet, undertake site visits, seek information and data, and consult as needed.

c) Establish a process for and invite public submissions, including from public authorities and special interest groups.

d) In delivering its report, the Panel will provide comment on and make observations or recommendations about any information or factors the Panel believes relevant, including requirements to strengthen monitoring networks or undertaking further scientific research.

e) The report is to be delivered no later than 31 December 2018.

3. ***Provide advice as required to the Department of Planning and Environment on mining activities in the Greater Sydney Water Catchment Special Areas***, which may include but is not confined to:

a) A Subsidence Management Plan application for Longwall 16 at the Dendrobium mine.

b) An Extraction Plan application for Longwall 303 at the Metropolitan mine.

c) An Environmental Impact Statement for the Dendrobium Extension Project.

d) A Preferred Project Report for the Russell Vale Underground Expansion Project.

e) A modification application for the Wongawilli mine.

The Initial Report from the Panel, addressing the above TOR 1, was issued in draft status in November 2018 to allow consultation and to seek submissions on the observations made in the report before reaching the final conclusions which will be reflected in the final report. The initial report draws a wide range of conclusions and makes a number of recommendations in relation to future investigations and monitoring to better inform groundwater modelling and surface water modelling to quantify mining impacts on water quantity in the Catchment Special Areas.

It is noted that although the review and findings of the Initial Report focus on longwall mining activities at the Metropolitan and Dendrobium coal mines, the Revised Preferred Project has sought to take into consideration the Panel's draft recommendations, as outlined in **Table 3.5**.

Table 3.5 Consideration of Independent Expert Panel Draft Recommendations

Draft Recommendation	Consideration of Revised Preferred Project
Mine design methodologies and procedures that underpin critical aspects of future mining proposals should be supported by robust, independent peer review and/or a demonstrated history of reliability when applications are submitted for approval.	The proposed change in mine design methodology to a stable first workings mine plan is proposed to increase certainty regarding potential subsidence related impacts and is based on a method with a demonstrated history of reliability. Importantly, due to the small magnitude of subsidence effects expected from the proposed mining layout, there is a high level of confidence in the reliability of the subsidence impacts forecast.
All future applications to extract coal within Catchment Special Areas should be supported by independently facilitated and robust risk assessments that conform to ISO 31000 (the international standard for risk management subscribed to by Australia).	As discussed in **Section 5.1.1**, given that the proposed change to the mine design has effectively addressed all of the identified pathways for impacts on water quantity, water quality and environmental effects assessed by the previous independent risk assessment completed for the Preferred Project, and has significantly increased certainty regarding impact predictions, an updated risk assessment is not considered warranted.
Field investigations and data collection, analysis and reporting need to be based on a standard agreed to by key stakeholders.	As noted in **Sections 5.0** and **6.0**, all existing management plans and monitoring programs will be reviewed in consultation with key stakeholders following approval of the Revised Preferred Project, and regularly thereafter as required under contemporary consent conditions. This process of review and consultation will enable ongoing stakeholder input to the standards of field investigations, data collection, analysis and reporting.

4.0 Stakeholder Engagement and Identification of Environment and Community Issues

A comprehensive stakeholder engagement program has been designed as part of the updated assessment process for the Revised Preferred Project.

The stakeholder engagement program was aimed to:

- inform and seek feedback from stakeholders during the design and development of the proposed revised mine plan,
- identify key issues to inform the environmental assessment of the Revised Preferred Project
- seek feedback from stakeholders to identify and refine proposed mitigation measures to seek to minimise environment and community impacts.

The engagement program was implemented in two phases, with the initial round of engagement during May/June 2017 (refer to **Section 4.1.2**) and a second round during May/June 2019 (refer to **Section 4.1.3**).

This allowed for community consultation to be undertaken during two key stages of the assessment process; during the project design phase to allow for scoping of key issues related to the Revised Preferred Project issues and impacts, and on completion of the draft environmental assessment to inform the finalisation of studies and appropriate strategies to seek to further minimise the environment and community impacts.

The outcomes of the engagement program have been used to inform various aspects of the Revised Preferred Project and assessment including the comprehensive Social Impacts and Opportunities Assessment (SIOA) (refer to **Section 5.13** and **Appendix 9**). A summary of the process of stakeholder engagement is outlined below, and further discussion of the key issues raised during the stakeholder engagement program is provided in **Section 5.13**.

4.1 Community Consultation

4.1.1 Stakeholder Identification and Engagement

As part of the SIOA program for the Revised Preferred Project, stakeholders were identified and grouped as follows:

- Local landholders and residents residing in proximity to the Revised Preferred Project operations.
- Local community groups and organisations.
- Regional environment and recreational groups.
- State and Commonwealth government agencies.
- Local government representatives.

- State and Federal Elected Representatives.
- Local business and business chambers/groups.
- Service providers, including education and emergency services.

A range of mechanisms were used to engage with local landholders, key stakeholders and the wider community during the consultation program, as set out in **Table 4.1** below.

Table 4.1 Consultation and Communication Methods

Method	Description
Engagement	
Near neighbour and landholder interviews	Personal interviews with near neighbours and landholders to outline Project aspects and document project issues and opportunities, during Phase 1 of the engagement program.
Regional stakeholder consultation	Personal meetings with key regional stakeholders drawn from across key community service sectors (including education, local businesses and community groups) in Russell Vale and Corrimal.
Regional and State Environment/Interest Groups	Project briefings provided to group members of the Illawarra Residents for Responsible Mining (IRRM) on 26 June 2017 and 22 May 2019, and the Knitting Nannas Against Greed (KNAG) on 22 May 2019.
Government briefings and consultation	Briefings and personal meetings with relevant government representatives (local, state and federal) to present the Project and obtain feedback on Project aspects (refer to **Section 4.2** for further details in this regard).
Community Information Session	Facilitation of a community information drop in session at the Thirroul Community Centre held on 25 May 2019, to present the Revised Preferred Project, key outcomes of the updated environmental assessment, proposed mitigation strategies, and to document community issues and opportunities. Approximately 67 individuals attended.
Community Consultative Committee (CCC) presentations	Presentations on the revised Preferred Project and assessment to CCC meetings on 6 June 2017 and 21 May 2019. An update on the progress of the UEP was provided at the regular CCC meetings held on 21 March 2018, 18 June 2018, 27 August 2018 and 26 November 2018.
Information Provision	
Project Information Sheets	Development of a Project Information Sheet No. 1 summarising key aspects of the Revised Preferred Project and progress/outcomes of the environmental and social assessment program. Approximately 1200 information sheets were distributed to neighbouring community residents and relevant stakeholders. Development of a Project Information Sheet No. 2 summarising the key outcomes of the updated environmental assessment and technical studies. Approximately 1,500 sheets were distributed to neighbouring community residents and relevant stakeholders.

4.1.2 Phase 1 Community Engagement

The purpose of this phase of community engagement was to:

- Understand the community's perceptions of WCL
- Measure community knowledge regarding the Revised Preferred Project specifically
- Seek feedback regarding potential impacts on the community (both positive and negative) and suggested mitigations.

A total of 158 stakeholders were contacted, as part of the SIOA engagement process via phone calls, interviews, personal letters, briefings and discussions. This was in addition to broader project briefings delivered to relevant local and State government agencies. A summary of the contact by stakeholder group is provided in **Table 4.2**.

Table 4.2 Phase 1 - Engagement Status by stakeholder group

Stakeholder	Direct contact made	Contact attempted but unsuccessful	Total
Landholders	63	57	120
Local Businesses	16	5	21
Community Groups	4	1	5
Education	3	5	8
Environmental Groups	1	1	2
Recreational Groups	2	0	2
Total	**89**	**69**	**158**

Doorknocking of approximately 50 households and landholders in the area proximal to the Russell Vale Colliery (noting more than one person may have been consulted per household) was undertaken to provide these residents with project information and to offer the opportunity for a personal meeting. Twelve individuals (24%) agreed to a meeting and these have been included in the landholder count in **Table 4.2** above.

Figure 4.1 shows that of the 158 stakeholders where contact was attempted, direct contact was made with 89 stakeholders (56%), while the remainder could not be contacted for reasons including disconnected phone numbers or no reply to phone calls.

Figure 4.2 outlines the reasons that were given for people declining to be part of the consultation process.

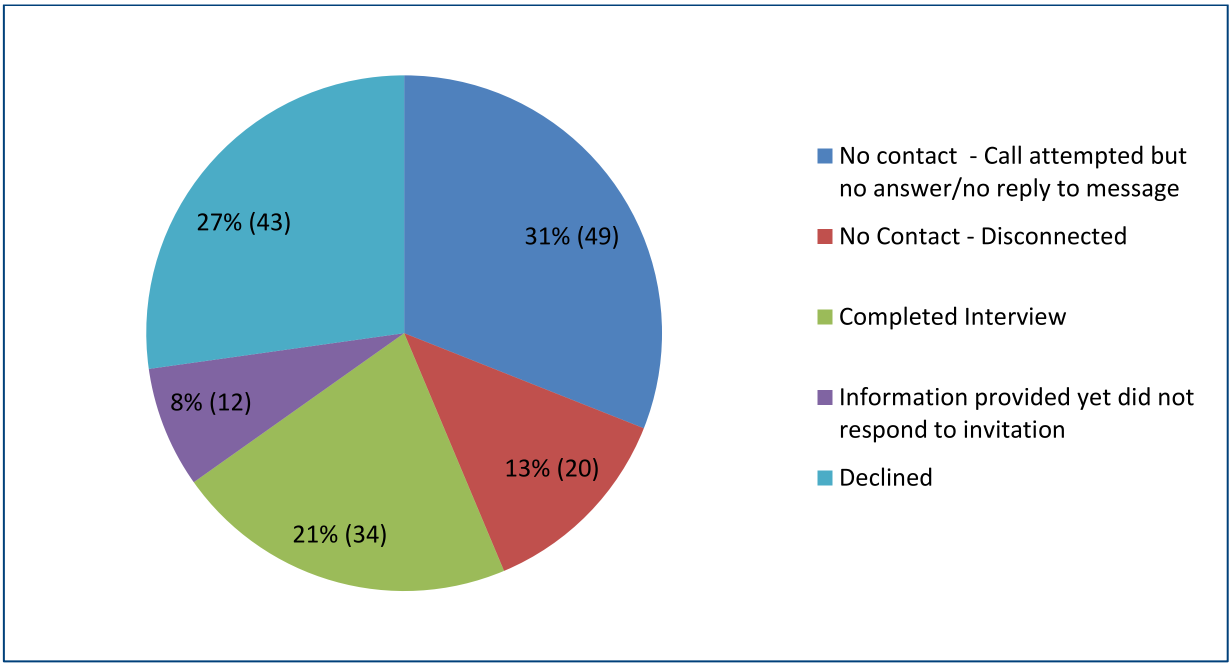


Figure 4.1 Engagement Status, n=158

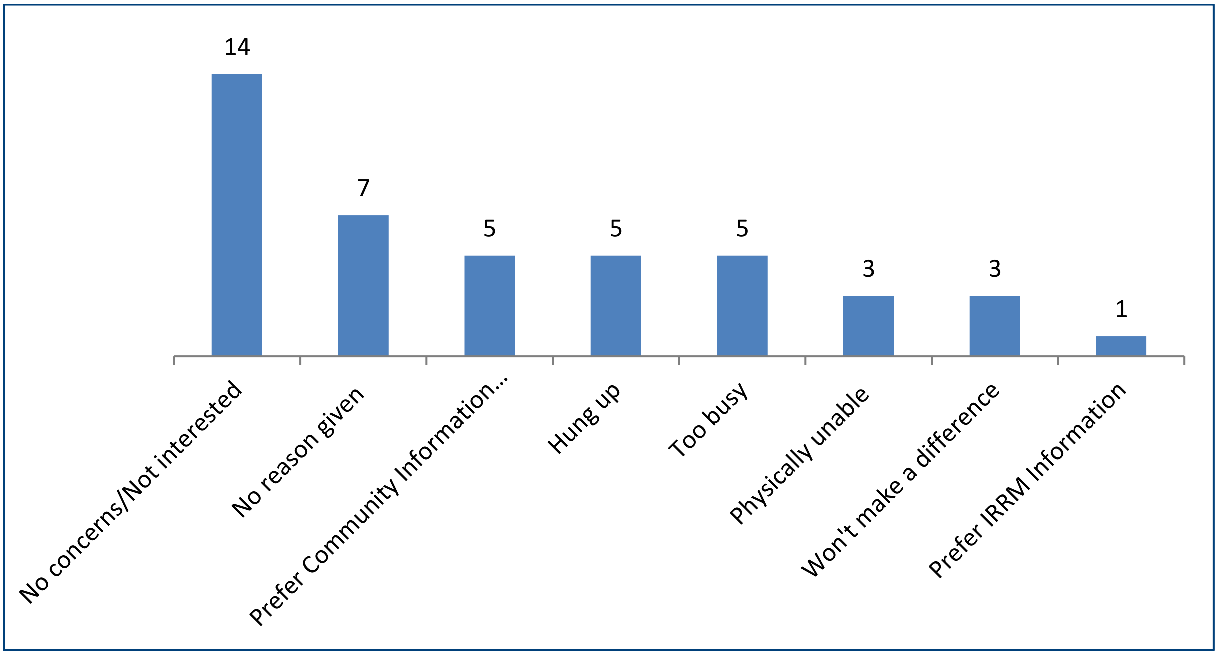


Figure 4.2 Declined Interview Reasons, n=43

In total, 44 individuals were consulted via 34 meetings or interviewed. These included:

- 27 with neighbouring and nearby landholders
- 7 with local businesses and special interest groups (i.e. education and community).

Table 4.3 provides an overview of the number of stakeholders consulted across each stakeholder group category.

Table 4.3 Meeting Summary

Stakeholder Category	Meetings (total number of participants)
Local Landholders and Residents	27 (37 participants)
Local Businesses	4 (4 Participants)
Community Groups	1 (1 participant)
Education	1 (1 participant)
Recreation Groups	1 (1 participant)
Total	**34 (44 participants)**

Feedback from the Phase 1 community engagement are documented in **Section 5.13.**

4.1.3 Phase 2 Community Engagement

The focus of the Phase 2 community engagement was to:

- provide previously engaged stakeholders with feedback from the first round of consultation
- consult with potential new and additional stakeholders that had not yet had an opportunity to be engaged
- provide the community with information regarding changes to the Revised Preferred Project
- provide the community with information regarding the outcomes of the updated environmental and social studies as a result of the project changes.

Phase 2 community engagement activities involved:

- Community Information Session held at Thirroul Community Centre on 25 May 2019. In order to inform the community, approximately 1,500 invitations were sent to residents of Russell Vale and Corrimal, including homes along Rixons Pass Road via letter box drop one week prior to the event. The session was attended by approximately 67 people (refer to **Table 4.4** for an overview of attendees). Attendees were provided with a copy of the Project Information Sheet 2.
- A notice was placed in the Illawarra Mercury on 16 May 2019 to inform the broader community of the session, and details of the information session were placed on the WCL website.
- Face to face discussions with key community-based organisations including the Illawarra Residents for Responsible Mining (IRRM) and the Knitting Nannas Against Greed (KNAG) on 22 May 2019.

- Additional organisations within the immediate surrounds were contacted via telephone to provide opportunity for a meeting or further information, including Russell Vale Pre-School, Aspect School South Coast and Russell Vale Golf Course.
- A letterbox drop of Project Information Sheet No.2 to approximately 1,500 residences in Russell Vale (including Rixons Pass Road) and Corrimal.
- Additional consultation has been undertaken with relevant stakeholders, such as local and state government agencies, to support the preparation of other specific technical studies included within the updated environmental assessment, as detailed in **Section 4.2**.

Table 4.4 Community Information Session Attendees

Stakeholder Category	Participants
Local Residents (Russell Vale, Corrimal, Bellambi and Woonona)	22
Illawarra Residents	16
WCL employees and contractors (including family members)	17
Members of the CCC	2
Members of the KNAG	3
No information supplied by attendee	7
Total	**67**

4.2 Government and Agency Consultation

WCL has undertaken ongoing consultation with local and State government preventatives in regard to the site's ongoing compliance programme for the 'care and maintenance' regime and throughout the planning and environmental assessment process for the Revised Preferred Project for the UEP. A summary of ongoing government consultation undertaken is provided in **Table 4.5** below.

Table 4.5 Summary of Ongoing Government Agency Consultation

Agency name	Date	Purpose
Department of Planning, Industry and Environment (DPIE)	6 December 2016	A meeting was held with DPIE regarding approach to UEP application.
	21 May 2017	Presentation to DPIE regarding the proposed revised mine plan.
	22 August 2018	A meeting was held with DPIE to discuss the assessment approach and progress of the Mod 4 Response to Submissions (RTS) Report and the UEP Revised Preferred Project and Response to Submissions (RPPRTS) Report.
	17 December 2018	Briefing meeting and presentation to provide an update on the progress of the Mod 4 RTS and UEP RPPRTS Reports and discuss indicative lodgement dates.
	21 December 2018	Working draft document of the UEP RPPRTS Report was submitted to DPIE for preliminary feedback. This version was still awaiting final technical study outcomes and the final round of consultation to be completed.
	31 January 2019	Preliminary feedback was received from DPIE on the working draft document.

Agency name	Date	Purpose
	12 April 2019	A meeting was held with DPIE to provide a further update on the progress of the UEP and Mod 4 applications.
Department of Resources and Geosciences (DRG)	May 2017	Background briefing and presentation on the proposed revised mine plan.
	5 June 2017	Conceptual Project Development Plans (CDPD) Presentation regarding the proposed revised mine plan.
	5 June 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Preferred Project and to request a meeting with DRG.
Department of Environment and Energy (DoEE)	27 June 2017	Presentation to DoEE regarding the proposed revised mine plan.
Environment Protection Authority (EPA)	March 2018	WCL discussed with EPA regarding variation of the EPL to satisfy further requirements from EPA.
	July 2018	WCL met with EPA and WCC's floodplain manager regarding the overall storm water management plan for the entire Bellambi Gully creek and to discuss the Mod 4 application and proposed revised water management system at the site.
	2 May 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Preferred Project and to request a meeting with EPA.
	22 May 2019	Briefing meeting and presentation outlining the outcomes of the updated environmental assessment and associated technical studies.
Wollongong City Council (WCC)	20 June 2017	Briefing meeting and presentation regarding the proposed revised mine plan.
	March 2018	WCL met with EPA and WCC to discuss variation of the EPL to satisfy further requirements from EPA.
	July 2018	WCL met with EPA and WCC's floodplain manager regarding the overall storm water management plan for the entire Bellambi Gully creek and to discuss the Mod 4 application and proposed revised water management system at the site.
	2 May 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Preferred Project and to request a meeting with WCC.
	21 May 2019	Briefing meeting and presentation regarding the Revised Preferred Project and outcomes of the updated environmental assessment and associated technical studies.
WaterNSW	21 April 2017	Presentation to WaterNSW regarding the proposed revised mine plan.
	20 May 2019	Executive Steering Group Meeting with a brief update on the Mod 4 and UEP applications provided by WCL.
	5 July 2019	Briefing meeting and presentation regarding the Revised Preferred Project and outcomes of the updated

Agency name	Date	Purpose
		environmental assessment and associated technical studies.
OEH	2 May 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Preferred Project and to request a meeting with OEH.
	22 May 2019	Briefing meeting and presentation regarding the Revised Preferred Project and outcomes of the updated environmental assessment and associated technical studies.
RMS	5 June 2019	Written correspondence to RMS to provide a brief overview of the Revised Preferred Project, update on the progress of the environmental assessment and technical studies as well as to seek feedback from RMS.
TransGrid	5 June 2019	Written correspondence to TransGrid to provide a brief overview of the Revised Preferred Project, update on the progress of the environmental assessment and technical studies as well as to seek feedback from TransGrid.
Endeavour Energy	5 June 2019	Written correspondence to Endeavour Energy to provide a brief overview of the Revised Preferred Project, update on the progress of the environmental assessment and technical studies as well as to seek feedback from Endeavour Energy.
Independent Expert Panel for Mining in the Catchment	28 February 2019	WCL hosted the Independent Expert Panel for Mining in the Catchment at Russell Vale Colliery for a site inspection and high level briefing on current site operations, the Revised Preferred Project and future mine planning at the site.

5.0 Revised Preferred Project Environmental Assessment

5.1 Preliminary Environmental Risk Analysis

A preliminary environmental risk analysis was undertaken for the Revised Preferred Project to identify the key issues requiring detailed assessment as part of the environmental assessment process.

The Revised Preferred Project proposes mining by means of first working mining techniques, to address residual uncertainty regarding the impacts of longwall mining raised by the PAC Second Review Report. The proposed mine plan has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related impacts on biodiversity and water resources within the Cataract Reservoir catchment. The Revised Preferred Project also proposes changes to the Russell Vale Colliery Pit Top, to improve water quality and minimise potential noise impacts from coal handling and transport activities. The key issues requiring further assessment therefore relate to the reduction in potential subsidence –related impacts associated with the first workings mine plan and amenity related impacts associated with changes to the Pit Top.

The identification of key environmental issues that require assessment was based on consideration of:

- the scale and potential impact of the Revised Preferred Project
- outcomes of the previous and current stakeholder consultation
- the planning and environmental context of the project
- the findings of the previous environmental impact assessments for the previous UEP mine plans (ERM 2013, Natural Resources Environment undated, Hansen Bailey 2014) and ongoing environmental monitoring of the Russell Vale Colliery operations.

The outcomes of the preliminary environmental risk analysis are provided in **Table 5.1**. The following sections provide a detailed assessment of the key issues associated with the Revised Preferred Project.

Table 5.1 Preliminary Environmental Risk Analysis

Aspect	Preliminary Environmental Assessment	Further Assessment Required?
Subsidence	The Revised Preferred Project mine plan proposes first working mining techniques only and has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related impacts within the Cataract Reservoir catchment. Imperceptible subsidence is therefore anticipated as a result of the Revised Preferred Project. There is however a low risk of the proposed mining destabilising remnant pillars in historical Bulli Seam workings above the proposed workings. A detailed subsidence impact assessment has therefore been undertaken to confirm predicted impacts to built and natural features and inform proposed subsidence management. The subsidence assessment is included as **Appendix 1** and a summary of the findings of the subsidence assessment is provided in **Section 5.2**.	Yes, refer to **Section 5.2**.

Aspect	Preliminary Environmental Assessment	Further Assessment Required?
Groundwater Resources	The Revised Preferred Project first workings mine plan will minimise potential groundwater impacts by limiting depressurisation to within and immediately above the coal seam. An assessment of potential groundwater impacts of the Revised Preferred Project has been undertaken, including assessment of interactions of the project with historical multi-seam mining within the UEP application area. The assessment is included as **Appendix 2** and a summary of the findings is provided in **Section 5.3.**	Yes, refer to **Section 5.3**
Surface Water Resources	The Revised Preferred Project mine plan proposes first working mining techniques only and is expected to result in imperceptible subsidence movements and negligible subsidence-related surface impacts. The proposed first workings mine plan has been specifically re-designed to avoid any secondary extraction beneath Cataract and Bellambi Creeks or Cataract River and their associated swamps, as well as Cataract reservoir. Due to the proposed mining method, impacts on the local flooding and drainage regime as a result of subsidence are expected to be negligible. Additional depressurisation of coal seams associated with the extraction of coal proposed by the Revised Preferred Project has potential to induce some additional reductions in base flow in creeks in the area. These impacts have been assessed as part of the Groundwater Assessment prepared for the Revised Preferred Project included in **Appendix 2** and a summary of the findings is provided in **Section 5.3**. Surface water impacts associated with the existing Pit Top have been a key concern to the local community. An assessment of the potential impacts on surface water resources has therefore been undertaken, taking into consideration proposed improvements to existing surface management associated with the Bellambi Gully Diversion Pipeline proposed by MP 10_0046 MOD 4. The assessment is included as **Appendix 3** and a summary of the results is provided in **Section 5.4**.	Yes, refer to **Section 5.3**
Ecology	The Revised Preferred Project mine plan proposes first working mining techniques only and is expected to result in imperceptible subsidence movements that are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. . The potential ecological impacts of the UEP have been re-assessed based on the Revised Preferred Project. The ecological assessment is provided as **Appendix 4**, with the results summarised in **Section 5.5**.	Yes, refer to **Section 5.4**
Noise	The Revised Preferred Project proposes a number of changes to existing Pit Top, including construction of a Processing Plant, relocation of infrastructure to more shielded locations and extension to existing bunds to improve noise mitigation. An amended noise impact assessment has been completed for the Revised Preferred Project. The assessment is provided as **Appendix 5**, with the results summarised in **Section 5.6**.	Yes, refer to **Section 5.6**

Aspect	Preliminary Environmental Assessment	Further Assessment Required?
Air Quality	The Revised Preferred Project involves coal handling and construction activities that have the potential to impact the local air quality environment. An air quality impact assessment has therefore been completed for the Revised Preferred Project. The assessment is provided as **Appendix 6**, with the results summarised in **Section 5.7**.	Yes, refer to **Section 5.7**
Traffic	Consistent with previously approved operations, the Revised Preferred Project will transport coal to PKCT using trucks. The transport route will be via Bellambi Lane and Memorial Drive, which is the route that has historically been used for the transport of coal from the Russell Vale site. A traffic impact assessment has been completed for the Revised Preferred Project. The assessment is provided as **Appendix 7**, with the results summarised in **Section 5.8**.	Yes, refer to **Section 5.8**
Land Resources	The Revised Preferred Project will result in negligible subsidence-related surface impacts. The potential impacts of the project on land resources are limited to areas within the existing Pit Top where construction of additional infrastructure and bunds is proposed. This will all occur within the existing disturbance footprint of the Russell Vale Colliery Pit Top and therefore will not significantly impact land resources. A detailed assessment of impacts on land resources is not considered warranted, however a qualitative review of the potential impacts has been provided in **Section 5.9**.	Yes, refer to **Section 5.9**
Visual Amenity	The Revised Preferred Project will result in negligible subsidence-related surface impacts, therefore there is unlikely to be any visual impacts associated with subsidence or subsidence remediation works. Potential visual impacts will be limited to proposed changes to the Russell Vale Pit Top, including construction of a Processing Plant, relocation of site infrastructure and extending the height of existing bunds surrounding the Pit Top. An assessment of potential visual impacts of the proposed changes to the Pit Top has been undertaken and is included in **Section 5.10**.	Yes, refer to **Section 5.9**
Hazard/Risk	A preliminary risk screening has been completed for the Revised Preferred Project in accordance with SEPP 33 and is included in **Section 5.10**.	Yes, refer to **Section 5.10**
Greenhouse Gas	The Revised Preferred Project will result in the recovery of approximately 3.7 Mt of ROM coal over 5 years. The extraction of this coal will change the greenhouse gas and energy profile of the operation from that previously proposed, therefore a greenhouse gas and energy assessment has been undertaken to quantify the emissions associated with the Revised Preferred Project. The assessment is provided in **Appendix 8**, with the results summarised in **Section 5.12**.	Yes, refer to **Section 5.12**
Social Impact	The potential impacts of the Revised Preferred Project on the local community and economy have been assessed and methods used to engage the local community in the Revised Preferred Project planning and impact assessment processes have been documented. The assessment is provided as **Appendix 9**, with the results summarised in **Section 5.13**.	Yes, refer to **Section 5.13**

Aspect	Preliminary Environmental Assessment	Further Assessment Required?
Economic Impact	The potential impacts of the Revised Preferred Project on the local, regional and state economy have been assessed with the results summarised in **Section 5.14**. The full report is provided as **Appendix 10**.	Yes, refer to **Section 5.14**
Aboriginal Archaeology and Cultural Heritage	Several Aboriginal heritage sites have been previously identified within the UEP Application Area. These sites are mainly associated with rock shelters in sandstone cliff formations and grinding groove sites on upland sandstone outcrops. The proposed first workings are predicted to result in imperceptible subsidence and are not expected to cause perceptible impacts to any natural surface features, including Aboriginal heritage sites. Further, no additional disturbance at the Pit Top is proposed, beyond that currently disturbed and approved for development. The Revised Preferred Project is therefore unlikely to result in any impacts to cultural heritage and no further assessment has been undertaken.	No
Historic Heritage	There are no registered non-Aboriginal heritage items within the UEP Application Area. No direct or indirect impact to non-Aboriginal heritage is anticipated as a result of the Revised Preferred Project and therefore a detailed Heritage Assessment has not been undertaken.	No
Waste Management	The Revised Preferred Project will generate similar waste streams and waste volumes to that of previous operations on site. Waste will continue to be managed in accordance with existing site practices in accordance with relevant legislative requirements. No further detailed assessment has been undertaken. As discussed in **Section 2.1.6**, potential reuse opportunities for reject material will be prioritised, including for use in rehabilitation or, where reject material meets the definition of VENM, transfer offsite for sale as fill material. Excess reject material will be hauled back to the mine portal for emplacement underground. There is sufficient capacity within existing underground workings for the emplacement of all potential rejects generated by the Revised Preferred Project.	No
Rehabilitation and Closure	As discussed in **Section 2.4**, WCL intends to seek development consent for continuing use of the site beyond the period of approval sought by the Revised Preferred Project. Therefore, decommissioning and closure of the Russell Vale Colliery Pit Top is not proposed immediately following the completion of the Revised Preferred Project. Rather, it is intended that the site would be maintained in a care and maintenance mode until such time as any future planning assessment process is completed. If consent for continuing use of the site is not forthcoming, WCL will prepare a detailed mine closure and rehabilitation plan in consultation with the Resources Regulator. On this basis, no further detailed assessment of rehabilitation and closure has been undertaken.	No

5.1.1 Independent Risk Assessment (IRA)

A recommendation of the PAC in its first review of the UEP, was that WCL should undertake an Integrated Risk Assessment (IRA) with a particular focus on links between subsidence and water impacts. An IRA was undertaken as part of the Response to PAC Review Report (Hansen Bailey, 2015b) by Broadleaf Capital International Pty Ltd (Broadleaf), and assessed risks associated with the previously proposed Preferred Project.

The IRA identified a series of pathways from mining activities that could lead to impacts to water quantity, water quality and environmental effects. These pathways were used as the starting point for identifying risks, which were then analysed and evaluated under a formal risk assessment framework.

The pathways identified by the IRA as having the potential to lead to impacts to water quantity, water quality and environmental effects were all associated with subsidence caused by mining activities. Specifically, the identified risk pathways relate to subsidence movements that have the potential to result in surface fracturing, fracturing of deeper strata, changes to stream or swamp water regimes, changes to groundwater regimes or valley closure on Cataract Creek.

The proposed change to the mine design for the Revised Preferred Project to a stable first workings mine plan effectively addresses all of the identified pathways for impacts on water quantity, water quality and environmental effects assessed by the IRA. The subsidence assessment prepared for the Revised Preferred Project by SCT (2019) (refer to **Appendix 1**) concludes:

> *The small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.*
>
> *Proposed mining is not expected to increase interactions between the mine and surface water or impact surface water dependent ecosystems or groundwater at levels above those currently experienced.*
>
> *There is considered to be no significant potential for additional interaction between surface water, groundwater and the underground mining horizons. The deformations associated with strata compression are small in magnitude. There is very limited potential to create additional zones where hydraulic conductivity would be increased.*

It is noted that the Independent Expert Panel for Mining in the Catchment has recommended that all future applications to extract coal within Catchment Special Areas should be supported by independently facilitated and robust risk assessments that conform to ISO 31000. Given that the proposed change to the mine design has effectively addressed all of the identified pathways for impacts on water quantity, water quality and environmental effects assessed by the previous IRA, and has significantly increased certainty regarding impact predictions, an updated risk assessment is not considered warranted.

5.2 Subsidence

A summary of the key findings of the subsidence assessment for the proposed first workings prepared by SCT Operations (SCT, 2019) is presented in this section. The full report is provided in **Appendix 1**.

5.2.1 Existing Environment

5.2.1.1 Natural Features

Major natural features in the vicinity of the proposed first workings include the Illawarra Escarpment and the upper parts of Lake Cataract that forms part of the Sydney's water supply catchment. The Illawarra Escarpment is located 400 m east of the nearest proposed first workings. The Cataract Dam is located within the UEP Application Area however the proposed first workings do not extend under the fully supply level of the Dam. The proposed first workings are located partially within the Dam Safety Committee Cataract Notification Area for Cataract Dam (refer to **Figure 5.1**).

There are numerous natural swamps and sandstone cliff formations located within the Hawkesbury Sandstone outcrop, most of which are less than 5 m high. There is one semi-permanent waterfall on a first order watercourse and several locations where drainage lines and first order creeks flow over sandstone outcrops to form waterfalls following periods of heavy rain. Two of these features are approximately 7 m high.

5.2.1.2 Surface Infrastructure

Major infrastructure within the vicinity of the proposed first workings includes Mount Ousley Road (now M1 Princes Motorway), which runs in a north easterly direction and is administered by Roads and Maritime Services (RMS). The interchange with Picton Road is located at the southern boundary and includes a concrete bridge and several drainage culverts.

There are four power transmission lines traversing the surface of the proposed first workings. Located to the east of Mount Ousley Road is a 330Kv transmission line, a 132kV transmission line and two single pole 33kV transmission lines. Two further 33kV transmission lines are located at the north east corner of the proposed first workings, one of which services mine owned infrastructure.

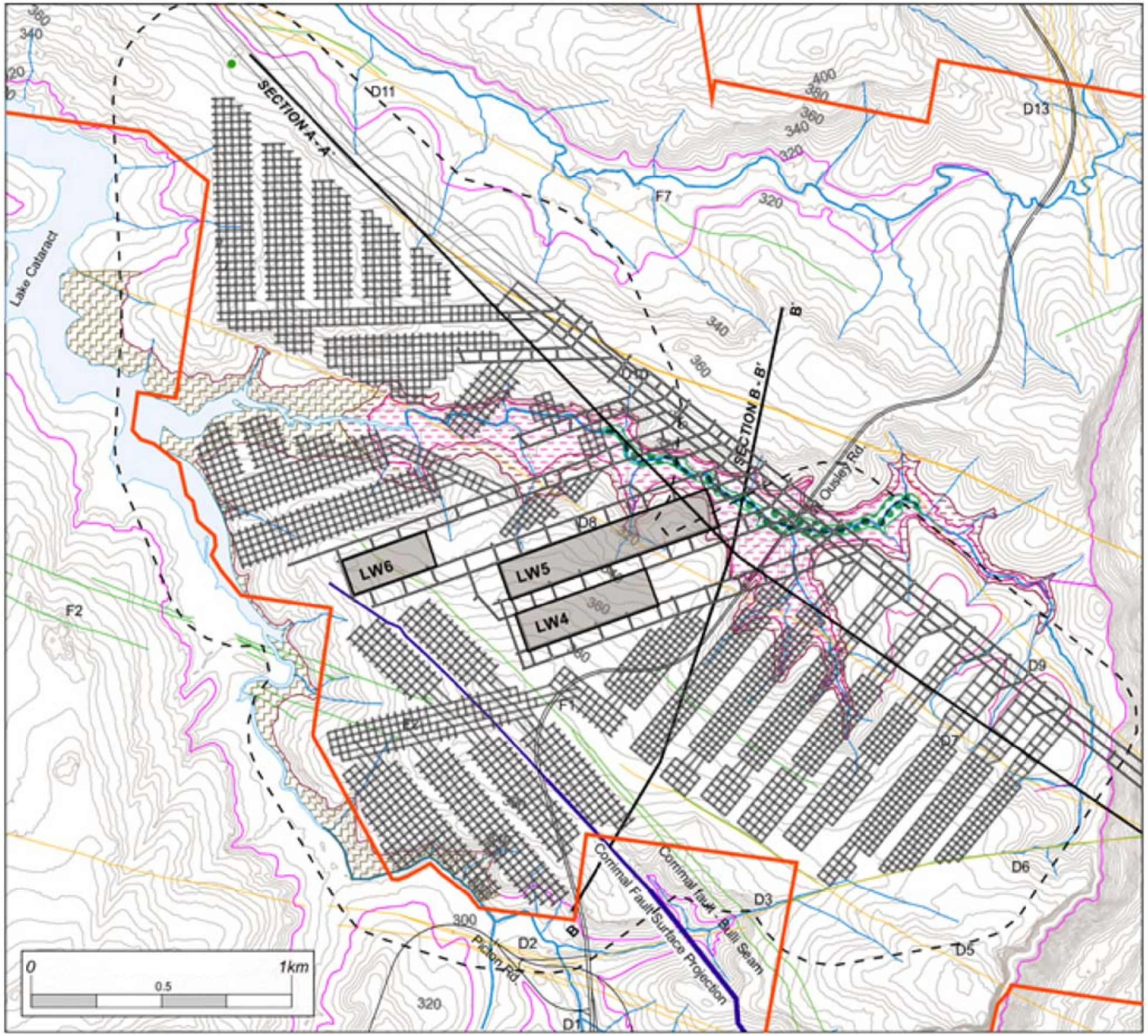
A telecommunications installation is located adjacent the Illawarra Escarpment at Brokers Nose, approximately 600 m from the nearest proposed first workings.

5.2.1.3 Geology

The target coal resource, the Wongawilli Seam, is part of the Illawarra Coal Measures and ranges in thickness from about 8 to 12 m. The lower section contains the best quality coal and the bottom 2.4 m of the seam section is the target of the proposed mining.

Within the vicinity of the proposed first workings, the strata dips at between 1 in 25 and 1 in 30 to the west-north-west from its outcrop on the Illawarra Escarpment. Hawkesbury Sandstone is present on the surface over most of the proposed first workings (refer to **Figure 5.1**).

The major geological structures of interest in the area are the Corrimal Fault, several other minor faults, an igneous sill intrusion to the north of the main headings and several dykes. Further information on the main geological structures in the three coal seams mined at Russell Vale Colliery is provided in **Appendix 1** and **2**.



Legend

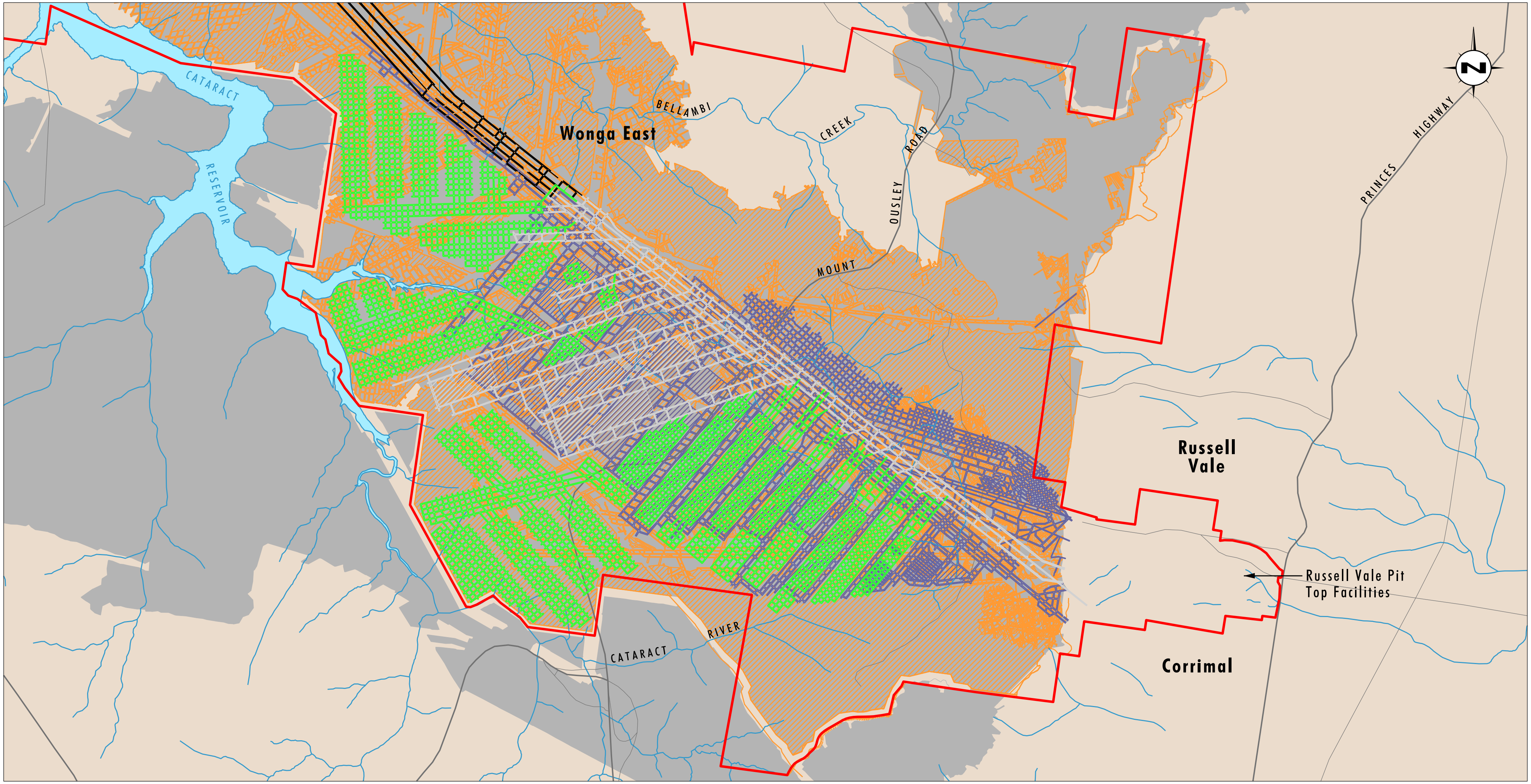
- Surface Contours 5M intervals
- Application Area
- Dyke Intrusion
- Extracted Longwalls Wongawilli Seam
- Existing Wongawilli Workings
- Russel Vale Colliery UEP Project Application Area
- Bald Hill Claystone Outcrop
- Proposed Wongawilli Workings
- Hawkesbury Sandstone Outcrop
- Colluvial / Talus Deposits
- Gosford Formation Outcrop
- Fault
- Bulgo Sandstone Outcrop
- Mt Ousley Rd.
- Surface Creeks

FIGURE 5.1

Major Geological Features

Data Source: SCT Operations Pty Ltd (2018)

File Name (A4): R05/3687_042.dgn
20190416 11.44



Data Source: Wollongong Coal (2016)

0 0.5 1.0 1.5km
1:30 000

Legend

- UEP Project Application Area
- Existing Wongawilli Seam Workings
- Existing Balgownie Seam Workings
- Existing Bulli Seam Workings
- Historic Workings (other mines)
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings

FIGURE 5.2

Existing and Proposed Underground Workings at Russell Vale Colliery (UEP)

5.2.2 Previous Mining and Subsidence

The target seam for the UEP is the Wongawilli Seam which underlies historical workings in the Balgownie and Bulli seams (refer to **Figure 5.2**). The presence of previous mining activity and the potential for multi-seam interactions as a result of proposed further mining in the Wongawilli Seam have been investigated and assessed as part of the subsidence and groundwater assessments prepared for the Revised Preferred Project.

Previous mining in the Bulli, Balgownie and Wongawilli Seams provided a baseline of impact experience and recovery for the assessment of subsidence in the vicinity of the proposed first workings, allowing an opportunity to examine the impacts over timeframes of 50 to 100 years for the Bulli Seam and 30 to 40 years for the Balgownie Seam mining. This past mining also provides greater certainty in understanding the location and nature of geological structures in the areas and their behaviour in response to local mining impacts.

For the purpose of the assessment, this past mining has allowed better understanding of the nature of the potential interactions between seams and the potential for pillar instability, particularly in the Bulli seam, to cause unexpected additional subsidence. The ongoing nature of the mining operation at Russell Vale Colliery provided SCT the opportunity to inspect the mine workings in the Bulli Seam and the Balgownie Seam to better understand the nature of the potential interactions between seams and the potential for pillar instability, particularly in the Bulli Seam, to cause unexpected additional subsidence.

Subsidence monitoring data available from mining in the Balgownie Seam and more recently from three longwall panels in the Wongawilli Seam is available and this provides a basis for confirming overburden behaviour and estimating the potential for further subsidence. This data indicates that while there are some significant differences in behaviour compared to single seam mining, the multi-seam behaviour is reasonably predictable and occurs predominantly within the bounds of the individual panels that were mined. This data and observations of previous ground movements indicate that the ground movements expected to result from the proposed mining are likely to be insignificant for all practical purposes.

5.2.3 Subsidence Assessment Findings

Predicted Ground Movements

The proposed first workings pillars have been designed to provide long term stability under the range of loading conditions anticipated within the Wongawilli seam, with width to height ratios of 8 and 10. These pillars would remain stable as they have constrained cores, preventing potential for sudden collapse or loading shedding at failure, that can occur with small pillars.

Irrespective of the strength, load and behaviour of the proposed first workings pillars, some low level deformation of the pillars is expected with elastic compression of the strata above and below these pillars. This strata compression has potential to result in some very low-level subsidence movements (less than 100 mm and generally less than 30 mm) with corresponding very low levels of tilt and strain. Any such subsidence is likely to occur gradually. Due to both the scale and the gradual nature of these movements, the subsidence is expected to be generally at or below survey monitoring tolerance. These subsidence movements are expected to be generally imperceptible and insignificant for all practical purposes.

The mine design has been developed with regard to the past mining in the seams located above the Revised Preferred Project mine plan. The proposed mine plan is not expected to contribute to significantly increased loading in the overlying seams, therefore in general there is very limited potential for the proposed mining to lead to additional pillar instability in the overlying seams. It is noted that there are some areas of marginally stable pillars in the Bulli Seam overlying the proposed workings. If these areas of marginally stable pillars are destabilised for any reason there is some potential for additional subsidence movements, however this potential generally exists irrespective of the proposed mining, and as noted above, there is very limited potential for the proposed mining to lead to additional pillar instability in the overlying seams.

A number of areas within the UEP Application Area are currently in limiting equilibrium (on the verge of moving) because of previous mining, including Longwalls 4-6 in the Wongawilli Seam. Some ongoing low-level ground movement, mainly horizontal movement associated with previous mining including the Wongawilli Seam longwalls, may not yet have ceased completely. This low-level movement related to previous longwall mining operations has potential to continue to cause low-level impacts to Mount Ousley Road and valley closure across Cataract Creek that may be perceptible. This movement is a legacy of previous mining and is not expected to be influenced by the proposed mining. Movement may continue irrespective of any further mining in the Wongawilli Seam.

Overall, the subsidence movements forecast for the proposed mine plan are not expected to result in any perceptible subsidence at the surface or cause any significant impacts to natural surface features within the UEP Application Area.

Natural Features

The proposed workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs (including the Illawarra Escarpment), steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

The Illawarra Escarpment, in particular the section of Hawkesbury Sandstone outcrop at Brokers Nose, is not expected to be impacted by the proposed mining. It should be recognised that there is always potential for cliff falls to occur naturally as part of the ongoing erosion processes, but the proposed mining is not expected to increase this potential.

Proposed mining is not expected to increase interactions between the mine and surface water or impact surface water dependent ecosystems or groundwater at levels above those currently experienced.

There is considered to be no significant potential for additional interaction between surface water, groundwater and the underground mining horizons. Due to the small magnitude of the deformations associated with strata compression, there is very limited potential to create additional zones where hydraulic conductivity would be increased. Potential impacts on groundwater and surface are discussed further in **Sections 5.3** and **5.4**.

Surface Infrastructure

Based on the outcomes of the subsidence assessment, the Revised Preferred Project is not expected to increase or cause additional perceptible subsidence-related impacts on Mount Ousley Road and Picton Road interchange.

It is noted that large areas of the surface within the UEP Application Area are currently on the verge of moving as a result of previous mining. Further narrow tension cracks and minor compression impacts to the Mount Ousley Road pavement are considered possible because of ongoing subsidence associated with this previous mining. These impacts from previous longwall mining will continue to be monitored and managed in accordance with the Built Features Management Plan for Mount Ousley Road (and Picton Road interchange).

The 330kV and 132kV powerlines located east of Mount Ousley Road are both supported on steel truss pylons which are very sensitive to differential ground movements from subsidence. The ground movements associated with the proposed mining are so low as to be well within the tolerance of these steel truss pylon structures.

The assessment identifies that the only potential for impacts on the steel truss pylons would be from subsidence movements resulting from destabilisation of remnant pillars in the historically mined Bulli seam above the proposed workings. The potential for additional subsidence from destabilised pillars in the upper seams is considered low, however cannot be eliminated. Therefore, a suitable engineered solution or alternative method of reducing uncertainty regarding the Bulli seam layout will be outlined in a Built Features Management Plan for the powerlines to be prepared in consultation with the asset owners prior to undermining of the lines.

The two 33kV powerlines located further to the east are not expected to be impacted by the low levels of subsidence movements forecast for proposed first workings mining. These powerlines are supported on single and double pole structures that are generally tolerant of subsidence movements.

Telecommunications infrastructure at Brokers Nose and the bridge at the Picton Road Interchange are remote from the proposed mining. There is considered to be no potential for mining induced ground movements or impacts associated with the proposed mining.

Interactions with Geological Structures (Corrimal Fault and Dyke D8)

The proposed workings avoid interaction with major geological structures where possible. Detailed assessment of the potential impacts or environmental consequences of mining through or in the vicinity of the major geological structures within the mine plan area, including the Corrimal Fault and Dyke D8, has been completed. No significant subsidence impacts or environmental consequences are expected from mining through or in the vicinity of the Corrimal Fault and Dyke D8 by the proposed first workings layout. The likelihood of impacts to the Corrimal Fault is considered to be very low. The consequences of any impacts to the Corrimal fault are expected to be negligible.

5.2.4 Subsidence Management and Monitoring

WCL will review and update existing Built Features Management Plans for all surface infrastructure within the vicinity of the proposed first workings to manage any potential subsidence-related impacts on surface infrastructure. The Built Features Management Plans will be reviewed in consultation with the asset owner prior to undermining of the surface infrastructure.

The existing subsidence monitoring program will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The monitoring program will be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mining below subsidence sensitive infrastructure.

5.3 Groundwater

GeoTerra Pty Ltd (GeoTerra) and Groundwater Exploration Services Pty Ltd (GES) were commissioned by WCL to undertake a revised groundwater modelling-based assessment and updated reporting of the regional groundwater system in the proposed first workings mining area prior to, during and after the proposed first workings extraction within the Wongawilli Seam. Desktop assessments, field monitoring, laboratory analysis and computer modelling studies were used to prepare a baseline assessment of the groundwater system, groundwater quality and aquifer hydraulic parameters within the proposed first workings mining area.

A summary of the key findings from the Groundwater Assessment prepared by GeoTerra Pty Ltd (2019) is presented in this section. The full report is provided in **Appendix 2**.

5.3.1 Existing Hydrogeological Environment

Six general hydrogeological domains are present in the Wonga East area:

- Hydraulically disconnected (perched) upland swamps
- Hydraulically disconnected (perched) ephemeral weathered Hawkesbury Sandstone
- Deeper Hawkesbury Sandstone, which is hydraulically separated from the underlying Bulgo Sandstone and deeper lithologies by the Bald Hill Claystone, except where the claystone is fractured by subsidence or eroded away in the channel of Cataract Creek
- Narrabeen Group sedimentary lithologies, the lower portions of which have already been locally fractured and depressurised above the existing Wongawilli, Bulli and Balgownie seam workings and are interpreted to be fractured and/or depressurised over areas of triple seam mining up to the shallow surficial strata, whilst areas only mined in the overlapping Bulli and Balgownie secondary extraction areas are interpreted to extend to the upper Bulgo Sandstone
- Illawarra Coal Measures, which contains the Bulli, Balgownie and Wongawilli Seam aquifers that have also been fractured and depressurised to varying degrees by the existing workings and will be locally fractured and depressurised by the proposed workings, and
- Sedimentary sequence underneath the Wongawilli Seam.

Due to the steep topography and limited alluvium within the Cataract Reservoir storage, there is no notable groundwater bearing stream-based alluvium within the Wonga East area.

5.3.1.1 Hawkesbury Sandstone

Apart from aquifers in the coal seams, the main aquifer in the Wonga East area is the Hawkesbury Sandstone which, although having generally low permeability, can provide relatively higher groundwater yields compared to other lithologies in the area. The Hawkesbury Sandstone outcrops over most of the lease area although it has been partially eroded in the central valley of Cataract Creek where the upper Bulgo Sandstone is exposed.

Regional water levels within the sandstone result from rainfall recharge through the shallow weathered zone into the underlying clastic rocks and with topography over geologic time. The low groundwater flow rates within the Hawkesbury Sandstone are primarily horizontal with minor vertical leakage due to the dominant horizontal bedding planes and bedding discontinuities interspersed with generally poorly connected vertical joints.

Ephemeral perched water tables within the upper 20m of the Hawkesbury Sandstone that are hydraulically disconnected from the underlying regional aquifer, can occur following extended rainfall recharge periods.

Measured standing water levels in the Hawkesbury Sandstone range from to 12 to 39 m below surface. Water quality in the Hawkesbury Sandstone generally has low salinity (81 - 420µS/cm) with relatively acidic pH (3.22-5.45) and can contain high iron levels up to 12.0 mg/L in the proposed first workings mining area.

5.3.1.2 Narrabeen Group

The Narrabeen Group lithologies have significantly lower yielding aquifers compared to the Hawkesbury Sandstone, with very minor productive supplies obtained in the Southern Coalfields due to its generally deeper elevation below surface and its very low permeability. The Narrabeen Group is generally low yielding (<1.0L/sec), with its highest yields obtained from the coarser grained or fractured units.

5.3.1.3 Illawarra Coal Measures

Water quality varies regionally both within and between coal seams and interburden in the Illawarra Coal Measures due to the complexity of groundwater flow, with the water being mostly brackish to saline.

The Balgownie, Bulli or Wongawilli Seams do not outcrop within the assessment area for the Revised Preferred Project, although they outcrop along the lower section to the base of the Illawarra Escarpment. They would be recharged by vertical infiltration from overlying lithologies, and there is no direct connection between the seams and the surface creeks.

5.3.1.4 Registered Bores and Piezometers

There are no private bores or wells within the Russell Vale East area. The nearest registered bore on the Woronora Plateau is a test bore at Appin Colliery, which is located approximately 4.9 km to the north of the proposed workings.

5.3.2 Groundwater Model Setup

Numerical modelling was undertaken to assess the existing groundwater system status and predict the potential effects from extraction of the proposed workings. The key objective of the model was to simulate the current and proposed first workings mining within the Wongawilli Seam in the Wonga East area, and to understand the effects to the groundwater and surface water environment in a local and regional context.

The model start date is 1 January 1993, whilst the calibration period is from 1 January 1993 to 28 February 2014. This includes the 500 series longwalls in Wonga West within the Bulli seam in 1993 and the initial mine development in the Wongawilli Seam at Wonga East, which began in early 2011. The interim period included a long period where no significant mining activities occurred. The period of predictive analysis occurs from 1 April 2017 to 1 January 2023 with the completion of the proposed first workings extraction in the Wongawilli Seam. The recovery period modelled includes the subsequent 200 years to 31 December 2223.

Detailed time stepping was been used to simulate the Wongawilli Seam development and mining progression in the Russell Vale East area.

The modelling of groundwater impacts associated with previous mine plans considered as part of the UEP Project included considerable uncertainties associated with subsidence impacts and potential interactions with previous mining. Due to the change in mining method and the considerations in the mine plan layout, subsidence impacts associated with the proposed mining are considered to be negligible and this removes much of the previous uncertainty associated with the modelling of previously considered mine plans.

Full details of model set-up, calibration and uncertainty analysis, including peer review processes, are detailed in **Appendix 2**.

5.3.3 Groundwater Model Results

Groundwater modelling indicates that the influence of the proposed first workings can be broken down into the depressurisation of two separate regimes:

- within the Wongawilli Seam, and
- overburden above the Wongawilli Seam.

The Wongawilli Seam and overburden immediately overhead would be depressurised to atmospheric pressure in the immediate footprint of the proposed workings; however there would be minimal transgression of depressurisation above the Bulli Seam at the end of the mining period due to the lack of goaf development and associated subsidence cracking and strata delamination associated with the first workings extraction. The overlying Balgownie and Bulli seams have previously been mined and therefore significant depressurisation has occurred historically. The shallower surficial strata groundwater levels/pressures will be unaffected by the proposed first workings.

Stream Bed Alluvium and Plateau Colluvium

There are no anticipated subsidence effects on stream bed alluvium or plateau colluvium as there is minimal predicted subsidence or transmitted overburden depressurisation over and due to the proposed first workings extraction. Additionally, there is no significant accumulation of Quaternary sediments within the Russell Vale lease area.

Upland swamps

The proposed workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps.

The Revised Preferred Project impacts on upland swamps is therefore limited to induced depressurisation impacts associated with the depressurisation of sub-cropping strata below the swamps. Due to limitations of modelling software and the regional scale model set up, the effect of subsidence on the thin (<2m) perched groundwater in upland swamps with their limited and variable spatial extent was not assessed in the simulation. It is noted however that the nature of these perched groundwater systems indicates the likely presence of very low permeability layer(s) at the base of the swamps. In the absence of any mechanism for the cracking of this layer, the Revised Preferred Project impacts on swamps due to depressurisation impacts is expected to be negligible.

Perched Ephemeral Hawkesbury Sandstone

Perched, ephemeral, shallow groundwater within the upper Hawkesbury Sandstone could undergo a water level reduction over the proposed workings after subsidence, but as a consequence of transmitted depressurisation from the triple seam mined areas, and not due to the proposed first workings.

The minimal predicted subsidence of the shallow upper layer of the Hawkesbury Sandstone due to the proposed first workings is not anticipated to have an observable effect on stream baseflow or stream water quality where the temporary aquifers seep into local catchments.

Upper Hawkesbury Sandstone Regolith

Modelling of Layer 1 (including the Hawkesbury Sandstone, Newport/Garie Formation, Bald Hill Claystone and upper Bulgo Sandstone in eroded creek bed locations) after the end of mining in Wonga East indicates up to 10 m of drawdown in comparison to pre-Wongawilli Seam development.

Results indicate that groundwater levels in Layer 1 initially continue to fall after extraction of the Wongawilli Seam longwalls and proposed first workings. At 40 years up to a 5 m drawdown is evident over LW4, however, 10 m of recovery occurs after 200 years. It should be noted that the Layer 1 drawdown effects at both 40 and 100 years are linked to historic workings and, in particular, LW4, 5 and 6.

There is no observable Layer 1 drawdown effect associated with the proposed first workings mine plan.

Hawkesbury Sandstone to Wombarra Claystone

There is no predicted influence on these layers from the proposed first workings extraction.

Bulli Seam

The Bulli Seam has been mined over a very long period of time over a large regional area. Within the Russell Vale area where there is over 100 years of historical mining activity, unsaturated voids still exist and continue to be drained. As such the Bulli seam is generally dry at Wonga East. The escarpment adits associated with the mining of the lower Balgownie and Wongawilli seams means that groundwater levels are unlikely to recover in the Bulli Seam in the area immediately above the former Balgownie Seam workings and existing and proposed Wongawilli seam workings due to the mining of LW4, 5 and 6 and the associated fracturing of strata between the seams.

The Revised Preferred Project will have a negligible impact on these long-term recovery outcomes.

Balgownie Seam

Mining in the Balgownie Seam at Wonga East occurred prior to the model start in 1990. Therefore, enhanced hydraulic properties were included from the start of the model, which are further impacted by fracturing occurring in the Wongawilli Seam over LW4 and 5 and to a lesser degree the limited longwall extraction in LW6 and is drained via connection with the Wongawilli Seam. Results show drawdown over the proposed first workings mine plan is limited to a maximum of approximately 5 m.

As with the Bulli Seam, the escarpment adits associated with the mining of the lower Wongawilli seams means that groundwater levels are unlikely to recover in the Balgownie Seam in the area immediately above the and existing and proposed Wongawilli seam workings due to the mining of LW4, 5 and 6 and the associated fracturing of strata between the seams.

The Revised Preferred Project will have a negligible impact on these long-term recovery outcomes.

Wongawilli Seam

Drawdown occurs in the Wongawilli Seam at the end of the proposed first workings. The areal extent of the 2 m drawdown contour at the end of the proposed mining extends a maximum of 0.5 km to the north of the main headings. Maximum drawdown of up to 50m above the Wongawilli Seam occurs just to the north of the Mains out to a distance of approximately 0.5 km from the proposed workings. As the depressurisation only progresses up to 50 m above the Wongawilli Seam, there is no connective strata depressurisation up to surface as a result of the proposed workings.

At 40 years after completion of mining, the Wongawilli Seam is predicted to recover by up to 45 m in comparison to initial conditions over Russell Vale East, which is essentially close to a full recovery. Recovery is ultimately limited by the elevation of the lowest adit entry level at 117m AHD.

Stream and Groundwater System Connectivity

As the Revised Preferred Project will have no perceptible subsidence impacts, stream and groundwater system connectivity impacts associated with the proposed mining are largely limited to induced drawdown impacts. The Revised Preferred Project is not considered to result in any strata deformation or cracking impacts which will affect surface flow and groundwater interactions.

Although groundwater level reductions are predicted over the Wonga East workings, the majority of the groundwater related impacts on surface drainage features are limited to minor reductions in baseflows in Cataract Creek. Impacts on baseflows associated with the Project and historical mining are discussed below.

<u>Cataract Creek</u>

Where only Bulli seam first workings have been extracted, the proposed workings are not predicted to destabilise the Bulli seam pillars (SCT, 2019) sufficiently to cause fracturing or displacement that will extend into the upper Bulgo Sandstone.

This means there will be no predicted free drainage connection from surface to seam in these areas.

Beneath the plateau over the Bulli and Balgownie workings in the vicinity of Cataract Creek, extraction of the proposed first workings is modelled to not generate any observable depressurisation in Layer 1 at the end of the proposed first workings extraction. As a result, there is no anticipated observable change in stream baseflow and seepage flow volumes to Cataract Reservoir.

It is anticipated that no additional incremental effect will be caused due to extraction of the proposed first workings, and it will not cause an observable change in overall stream discharge into Cataract Reservoir (in addition to any prior longwall related effects).

The maximum stream flow loss as a consequence of only the proposed first workings is modelled to be 0.0006ML/day (0.22ML/yr) in Cataract Creek during 2073, which will be, for practical purposes, unobservable. Cumulative impacts on baseflow in Cataract Creek associated with all mining at Russell Vale (combined impact of previous longwall mining and the proposed first workings) are predicted to peak at 0.024ML/day (8.76 ML/year). Put in perspective, the average daily stream flow from Cataract Creek to Cataract Reservoir is 13ML/d of which 4.1ML/day is baseflow, with a median baseflow of 2.9ML/d (WRM Water & Environment, 2015).

The predicted loss of base flow in Cataract Creek is unlikely to be observable.

Cataract River (Upstream of Cataract Reservoir) and Bellambi Creek

There is anticipated to be no observable change in stream flow or groundwater seepage in the Cataract River (upstream of Cataract Reservoir) and Bellambi Creek catchments due to the very low proportion of the two catchments that may be partially depressurised.

The modelling predicts a maximum reduction in stream flow, due only to the proposed first workings, of 0.0002ML/day (0.07ML/yr) in Cataract River (upstream of Cataract Reservoir) and 0.0005ML/day (0.18ML/yr) in Bellambi Creek occurring in the period 2072 to 2088. Cumulative predicted impacts associated with mining at Russell Vale (combined impact of previous longwall mining and the proposed first workings) are in the order of 1.09ML/yr and 0.051ML/yr for Cataract River and Bellambi Creek respectively. These modelled annual changes for the Cataract River and Bellambi Creek will be practically unobservable.

Cataract Reservoir

Stream Inflow

Due to the distance of the mined longwall panels (LW4, 5 and 6) and the proposed first workings from the Cataract Reservoir, and the lack of subsidence impacts from the proposed first workings, no adverse impacts on stored water quantity or quality have been observed, or are predicted to occur, as a result of the proposed first working extraction on, or in, Cataract Reservoir, based on the factors discussed in previous sections.

Modelling indicates that base flow losses due to the proposed mine plan peak in approximately 45 to 60 years post mining and are in the order of 0.0013 kL/day or 0.47 ML/year. Total predicted cumulative losses in base flow due to all mining at Russell Vale Colliery (proposed and historical) are in the order of 0.0027 ML/day or 9.91 ML/year.

Strata Depressurisation

The modelled transfer of stored water within Cataract Reservoir to the underlying groundwater system due to depressurisation of the regional groundwater system in the vicinity of the reservoir is not measurable at the end of the proposed mining, as shown in **Table 5.2** below.

Table 5.2 Cataract Reservoir Storage Changes

	Loss Due to ALL Mining (ML/day) / (ML/year)	Loss Due to Proposed First Workings (ML/day) / (ML/year)
End of LW 6	0.000065/0.024	-
End of proposed mining	0.000065/0.024	0.0/0.0

Maximum cumulative leakage from Cataract Reservoir associated with all historical mining at Russell Vale is predicted to peak at 0.024 ML/year.

The cumulative annual predicted impacts to Cataract Reservoir associated with reduced baseflows and leakage represent approximately 0.01% of the full operating storage of Cataract Reservoir of 97,190 ML.

Subsidence Interaction with Faults and Dykes

The Corrimal Fault is mapped as crossing to the south of LW4 and 5 and fades out within LW6 and is not anticipated to generate a hydraulic connection to the surface water system or Cataract Reservoir. The fault has been identified as a “hinge fault” with a varying throw of approximately 25 m in the east, reducing to 1.8 m at Maingate 5, and is predicted to reduce to no displacement north of LW6.

Evidence indicates that the Corrimal Fault “zone” is diminishing to the north and is anticipated to fade out before it underlies the reservoir. This observation indicates that the potential re-activation or displacement of the Corrimal Fault due to subsidence and, therefore, it’s potential to cause a significant hydraulic connection between the workings and the mine, or significant drainage from the reservoir to the mine, is not considered likely (refer to **Section 5.2.3**).

The thin (<1m wide) highly weathered dyke D8 is located over the Wonga East workings, however, due to its highly weathered clay state and associated low intrinsic permeability, undermining this structure is not anticipated to enhance its permeability or potential hydraulic connection to the surface water systems (including Cataract Reservoir).

To date, mining in the Bulli seam on both sides of the Corrimal Fault (both first and second workings), has not resulted in observable increased flows to the mine workings (ERM, 2013).

Based on past mining experience and interpretation of the mine water balance monitoring (SCT, 2019), the faults in the Bulli/Balgownie workings are essentially dry and are not anticipated to provide enhanced permeability fluid pathways in the proposed mining area. No water inrush has been observed with mining through faults or dykes in the Bulli, Balgownie or Wongawilli Seam workings (S Wilson, pers comm).

As discussed in **Section 5.2.3**, the proposed workings avoid interaction with geological structures where possible and the limited interaction is not expected to extend beyond the immediate vicinity of individual roadways. The proposed mining system is not expected to mobilise ground movements on any of the geological structures present in the mining area or immediate surrounds.

The assessment indicates that the Corrimal Fault and Dyke D8 will not have a significant risk of causing hydraulic connection between Cataract Reservoir and the underground mine workings.

Groundwater Inflow to Workings

A background groundwater inflow of 0.2ML/day is currently measured from the Bulli Seam workings including the western side of Cataract Reservoir. These inflow rates are variable in the recorded flow data however the average rate for the period from 1 January 2013 to 31 December 2014 is 0.6ML/day (219ML/year). These rates decrease in Wonga East as groundwater makes its way vertically down to the Wongawilli Seam workings.

However, it should be noted that approximately 0.6ML/day is pumped out at Russell Vale portal which originates from the Bulli seam workings at Wonga West. It is assumed that this includes 0.2ML/day (73ML/year) of inflow that is thought to be generated in the up-gradient Cordeaux Colliery lease area as this area is partially flooded and there is a potential head gradient across the barrier which means that groundwater from the Corrimal workings flows south into the WCL workings, as the western Bulli Seam workings are in the order of 40m lower than the Corrimal workings. The groundwater taken by the upgradient Corrimal underground workings, which is thought to subsequently flow into the Russell Vale Colliery workings, should not be required to be licensed by WCL, as the Corrimal Lease holders are required to have a licence for groundwater inflows that are initially and primarily generated by their workings (GeoTerra, 2019).

In addition, 0.2ML/day (73ML/year) of groundwater seepage inflow from Wonga East is also thought to be generated from the up-gradient Bulli Colliery.

Existing and modelled groundwater inflows to the Russell Vale Colliery are shown in **Table 5.3**.

Table 5.3 Predicted Groundwater Mine Inflows

Stage	Bulli Seam Inflow (ML/day)/(ML/yr)	Predicted Russell Vale East Inflow (ML/day)/(ML/yr)	Total Mine Inflow (ML/day)/(ML/yr)	Total Licensable Inflow (ML/year)*
Pre-Longwall 4	0.22/80	-	0.22/80	80
End of Longwall 6	0.22/80	0.43/157	0.65/237	157
After Proposed First Workings	0.25/91	0.53/193.5	0.79/288	288

Note: * (excluding up gradient inflow of 146ML/year)

Mine Water Level Recovery

The groundwater inflow rate gradually increases during extraction of the proposed first workings as they are dewatered. After the proposed first working mining activities are completed, the model assumes the pumps are turned off and the mine gradually fills up and re-pressurises the overburden.

A simulated recovery hydrograph at the location of the mine entry adit for the Wongawilli Seam shows groundwater levels in the Wongawilli Seam recover to above the LW4, 5 and 6 and the proposed first workings pre-mining levels and that they reach the 117.5m AHD elevation of the escarpment adit at around 2057. Outflow rates from the adit are modelled as reaching a maximum of 0.3ML/day.

Groundwater Quality

Due to the very low level of predicted subsidence, and by association, the minimal overburden fracturing that could develop as a result of the proposed first workings, no observable pH or iron hydroxide changes are anticipated in the shallow strata layers.

Based on an extensive surface water and groundwater monitoring database, and on the observed and predicted impacts from historical and proposed subsidence, the proposal will not result in a reduction in the quality of surface and groundwater inflows to Cataract Reservoir.

The modelled flow rates from the adit are capable of being treated prior to discharge to downstream catchments or reuse for residential or industrial use.

Potential Loss of Bore Yield

There will be no loss of bore yield as there are no registered private bores or wells located within the Russell Vale lease area as a result of the proposed first workings.

5.3.4 Cumulative Groundwater Related Impacts

Cumulative impacts associated with historical mining at Russell Vale are discussed in **Section 5.3.3**.

Regionally, the closest mining operations include those utilised for the model boundaries. The Appin Mine is located 13 km to the north-west and operates within the Bulli Seam. Twelve kilometres to the south-west, Dendrobium Colliery is mining the Wongawilli Seam.

A review of the groundwater related studies undertaken for these projects indicates that regional drawdown at Appin extends approximately 2 to 3 km from the southern margins of the current operation (Heritage Computing, 2009) and similarly at Dendrobium Colliery (Coffey Geotechnics, 2012).

Modelling conducted for the Revised Preferred Project and previous studies in the Southern Coalfield indicates there will not be any superposition of drawdown cones between the Russell Vale and Appin/Dendrobium mining areas. Therefore, there is no cumulative depressurisation resulting from the proposed first workings and other adjoining mines.

Cumulative losses include the impacts from all of the adjoining historical, decommissioned mining areas as well as the depressurisation due to the proposed Wongawilli Seam first workings extraction. These impacts, however, do not expand into, or interact with, the current or proposed mining operations at Appin Mine and Dendrobium Colliery.

5.3.5 Groundwater Licensing

The Revised Preferred Project is covered by the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (Groundwater WSP), which applies to thirteen groundwater sources.

WCL holds a current Water Access Licence (WAL) under the *Water Management Act, 2000* for 515 ML (units)/year (Licence No. WAL36488), located within Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source.

Since the Groundwater WSP applies to all aquifers, WCL will require WALs for all groundwater taken in the course of mining. The total licensing entitlement required will be the maximum mine water make, which will include the water taken from each formation.

Based on the predicted maximum groundwater inflow make into the WCL workings of 288ML/year, WCL currently hold a sufficient quantity of units in their WAL.

5.3.6 Surface Water Licensing (Impacts on Baseflows)

The predicted reductions in baseflows associated with the Revised Preferred Project are considered to be negligible (less than 0.5 ML/year).

The Revised Preferred Project is within the area covered by the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* (Unregulated River WSP). The Unregulated River WSP includes six water sources, with the Revised Preferred Project situated entirely within the '*Upper Nepean and Upstream Warragamba Water Source*'.

Clause 4 of the Unregulated River WSP states that these water sources include all water:

- Occurring naturally on the surface of the ground shown on the Registered Map; and
- In rivers, lakes, estuaries and wetlands in these water sources.

Under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (Surface Water WSP), which encompasses the overall UEP Application Area and is contained within the Sydney Basin Nepean Groundwater Source Area, WCL will require a WAL for the annual (cumulative) take of up to 10.04 ML/yr of stream baseflow resulting from depressurisation of deeper aquifers. This relates to depressurisation from both historical mining operations and the Revised Preferred Project mine plan.

5.3.7 Policy Considerations

NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (AIP) (NSW Department of Primary Industries, 2012) prescribes minimal impact considerations which must be satisfied.

The minimal impact considerations for a water source vary depending on the nature of the water source (i.e. alluvial, coastal, fractured rock etc.) and whether it is 'highly productive groundwater' or 'less productive groundwater'. The aquifers are not considered to be 'highly' productive as although they contain total dissolved solids of less than 1,500mg/L in the Hawkesbury Sandstone, there are no water supply works that yield water at a rate greater than 5L/sec in the Wonga East area.

The minimal impact considerations for less productive porous rock water sources are presented in **Table 5.4** and for the perched, ephemeral aquifers in **Table 5.5**.

Table 5.4 NSW AIP Minimal Impact Considerations for Less Productive Porous Rock Water Sources

Minimal Impact Consideration	Proponent Response
Water Table – Level 1 Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.	There are no high priority groundwater dependent ecosystems, or high priority culturally significant sites listed under Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The swamps above the mine plan are not classified as Temperate Highland Peat Swamps on Sandstone (which is high priority GDE). There are no water supply works (i.e. groundwater bores) in the Wonga East area that will undergo more than a 2m decline.
Water Pressure – Level 1 A cumulative pressure head decline of not more than 40% of the "post-water sharing plan" pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.	There are no water supply works (i.e. groundwater bores) in the Wonga East area that will undergo a greater than 40% post water sharing plan pressure head decline above the base of the water source, and no water supply work will undergo greater than 2m decline.
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a "reliable water supply" is not an appropriate mitigation measure to meet considerations 1(a) and 1(b) above. No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a "reliable water supply".	The beneficial use category of the groundwater source will not be changed beyond 40m from the Wonga East area. There are no highly connected surface water sources (alluvial aquifers) in the Wonga East area. There are no highly connected alluvial surface water sources defined as a reliable water supply within the Wonga East area.

Table 5.5 NSW AIP Minimal Impact Considerations for Perched Ephemeral Aquifer Water Sources

Minimal Impact Consideration	Proponent Response
Water Table – Level 1 Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.	There are no high priority groundwater dependent ecosystems, or high priority culturally significant sites listed under Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The swamps above the mine plan are not classified as Temperate Highland Peat Swamps on Sandstone (which is high priority GDE). There are no water supply works (i.e. groundwater bores) in the Wonga East area that will undergo more than a 2m decline.
Water Pressure – Level 1 A cumulative pressure head decline of not more than 40% of the "post-water sharing plan" pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.	There are no water supply works (i.e. groundwater bores) in the Wonga East area that will undergo a greater than 40% post water sharing plan pressure head decline above the base of the water source, and no water supply work will undergo greater than 2m decline.
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity, and No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a "reliable water supply" is not an appropriate mitigation measure to meet considerations 1(a) and 1(b) above. No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a "reliable water supply".	The beneficial use category of the groundwater source will not be changed beyond 40m from the Wonga East area. There are no highly connected surface water sources (alluvial aquifers) in the Wonga East area. There are no highly connected alluvial surface water sources defined as a reliable water supply within the Wonga East area.

WaterNSW Principles for Managing Mining and Coal Seam Gas Impacts in Declared Catchment Areas

The WaterNSW principles prescribing minimal impact considerations which must be satisfied in declared catchment areas for mining and coal seam gas activities and the proponent's response are outlined in **Table 5.6**.

Table 5.6 WaterNSW Principles for Mining and Coal Seam Gas Activities in Declared Catchment Areas

WaterNSW Principle	Response regarding the Revised Preferred Project	Relevant section
In Declared Catchment Areas mining and coal seam gas activities must not result in a reduction in the quantity of surface and groundwater inflows to storages or loss of water from storages or their catchments.	The proposal will not result in an observable reduction in the quantity of surface or groundwater inflows to, or loss of water from, Cataract Reservoir. Modelling predicts less than 0.5 ML/year in reduced inflows to Cataract Reservoir as a result of the Revised Preferred Project. This level of impact is considered to be negligible. Cumulative losses due to all mining are predicted to be approximately 9.91 ML/year.	**Section 5.3**
In Declared Catchment Areas mining and coal seam gas activities must not result in a reduction in the quality of surface and ground water inflows to storages.	The proposal will not result in a reduction in the quality of surface and groundwater inflows to Cataract Reservoir.	**Section 5.3**
Mining and coal seam gas activities must not pose increased risks to human health as a result of using water from the drinking water catchments.	The proposal will not pose an increase in risk to human health as a result of using water from Cataract Reservoir.	**Sections 5.2 and 5.3**
The integrity of the WaterNSW's water supply infrastructure must not be compromised.	The proposal will not compromise the integrity of WaterNSW water supply infrastructure.	**Sections 5.2 and 5.3**
The ecological integrity of the Special Areas must be maintained and protected.	The proposal will maintain and protect the ecological integrity of the Cataract Reservoir Special Area.	**Section 5.5**
Information provided by proponents, including environmental impact assessments, must be detailed, thorough, scientifically robust and holistic. The potential cumulative impacts must be comprehensively addressed.	Information provided by WCL is detailed, thorough, scientifically robust and holistic and the potential cumulative impacts have been comprehensively addressed.	**Appendix 2**

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

Clause 10 of the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (Drinking Water SEPP)* provides that:

> *a consent authority must not grant consent to the carrying out of development under Part 4 of the Act on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on water quality.*

This is known as the Neutral or Beneficial Effect (NorBE) test.

Table 5.7 presents an assessment of the impact against the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*, in accordance with WaterNSW (2015).

Table 5.7 Neutral or Beneficial Effect Test Impact Assessment

Assessment Condition	Compliant?	Impact Assessment	Relevant section
"A neutral or beneficial effect on water quality is satisfied if the development: (a) has no identifiable potential impact on water quality, or	Yes	The Revised Preferred Project is predicted to have no (or neutral) impact on water quality in the Cataract Reservoir and its tributaries.	**Section 5.3.3**
(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or	Yes	The Revised Preferred Project will not result in any groundwater within the mine entering the Sydney Drinking Water Catchment. Outflows from the adit following depressurisation up to the elevation of the adit will be at a rate similar to currently approved operations. The predicted rate of outflows from the adit (approximately 0.3ML/day) are capable of being treated to an appropriate quality prior to any discharge to Bellambi Gully if reuse for industrial or other uses is not required.	**Section 5.3.3**
(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority."	Yes	Not applicable.	

Accordingly, the Revised Preferred Project is considered to satisfy the NorBE Test as applied under clause 11A of the Drinking Water SEPP.

5.3.8 Groundwater Management and Monitoring Measures

The existing Russell Vale East Water Management Plan will be reviewed and updated in consultation with DPI Water and DPIE and the updated plan will be implemented for the Revised Preferred Project.

The existing groundwater monitoring network will continue to be utilised to monitor impacts associated with the Revised Preferred Project. The existing groundwater monitoring program will be reviewed and updated to reflect the Revised Preferred Project as part of an update to the existing Russell Vale East Water Management Plan. The groundwater monitoring program will include monitoring of groundwater levels, water quality, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model as required.

Existing monitoring and management measures associated with the historical mining of longwalls 4 to 6 will remain in place with triggers updated to reflect the reduced groundwater and subsidence impacts for the Revised Preferred Project.

No changes to current groundwater management practices are considered to be warranted, however all monitoring results and management practices will be reviewed regularly to ensure they remain appropriate given the scale of observed impacts.

5.4 Surface Water Resources

A surface water impact assessment (SWIA) and water balance study was undertaken to investigate the potential impact of the Revised Preferred Project on surface water resources as a result of:

- upgrades to the Surface Water Management System (WMS) infrastructure;
- changes to the water balance associated with the Revised Preferred Project; and
- discharges to surface waters.

A summary of the key findings of the SWIA is presented in this section, with the full report provided in **Appendix 3.**

5.4.1 Overview of Existing Water Management System (WMS)

The existing Russell Vale Pit Top WMS catchment is approximately 45 ha in area and consists of the following sub catchments:

- Rehabilitated and undisturbed natural catchments;
- Disturbed catchments including the pit top area and coal handling infrastructure;
- Hardstand areas including the maintenance workshop area, administration offices, access roads and car parking.
- The existing WMS allows for two categories of water:
- Clean water, which comprises runoff from undisturbed and fully rehabilitated areas; and
- Dirty water, which comprises runoff from any area disturbed by mining operations, runoff from areas where coal is stockpiled and handled and groundwater extracted from the underground workings.

Key features of the WMS are shown on **Figure 5.3**.

5.4.1.1 Clean Water and Flood Management

Clean water upslope of the Pit Top facilities flows through the natural Bellambi Gully Creek water course and connects with a stormwater diversion pipe. The diversion pipe conveys stormwater under the Pit Top and it discharges into Bellambi Gully Creek at the eastern end of the site. Runoff from the centre of the site and northern access roads is directed to the diversion pipe immediately south of the ROM conveyor. Clean water runoff from the north western upslope catchment is directed to the north around the Pit Top.

Clean water management system blockages have in the past allowed runoff from upslope catchments to enter the Pit Top WMS resulting in flooding of the stockpile area and washout of coal into residential areas and Bellambi Gully Creek.

Three separate flood studies have been undertaken to identify and assess options to minimise the risk of coal washout events occurring in the future. The proposed improvements to the Pit Top WMS to address this issue are discussed in **Section 5.4.2**.

5.4.1.2 Dirty and Mine Water Management

Runoff from the stockpile and coal handling area drains to Dam 1, which functions as a primary sediment basin, before flowing into Dam 2 (**Figure 5.3**). Dam 2 also receives excess water from the truck wash system. Water from Dam 2 overflows to the Stormwater Control Dam (SWCD).

Runoff from the maintenance and laydown areas flows to a First Flush system to remove entrained sediments. Dirty water discharge from the First Flush system flows to Dam 1. For higher rainfall events where the volumetric flow of runoff exceeds the capacity of the First Flush, stormwater overflows the weir into the clean water system.

Surplus water from the underground mining operation (groundwater and excess process water transferred to the underground) is also transferred to Dam 1. In addition to water transfers from Dam 2, the SWCD collects runoff from approximately 7.5 ha of undisturbed upslope catchment and receives transfers from the Highway Dam (**Figure 5.3**). The Highway Dam collects runoff from a small catchment between Bellambi Lane and Bellambi Gully Creek that is primarily vegetated but also includes unsealed roadway.

Dam 5 and Dam 6, located to the south of the stockpile area (**Figure 5.3**), have minimal catchment areas and spill to the SWCD. Dam 5 is overgrown with vegetation and unlikely to be used as part of any future operation. Pumped water transfers between Dam 6 and the SWCD are still possible, however, are unlikely to be part of any future operation.

Seepage through the SWCD wall is collected in the Seepage Sump, along with any runoff from the small Seepage Sump catchment and returned via a submersible pump to the SWCD (**Figure 5.3**). During periods of high rainfall, the combined seepage and runoff inflows to the Seepage Sump may exceed the submersible pump capacity. During these rainfall events excess water will spill to Bellambi Gully Creek from the Seepage Sump, however, any discharge will be greatly diluted by the high flows from the broader catchment within Bellambi Gully Creek.

The site Supervisory Control and Data Acquisition (SCADA) system is programmed to cease discharges when the total flow on any given day reaches 2,450 kL ensuring that the discharge volume limit is not exceeded.

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

Legend

- UEP Project Application Area
- Ambient Monitoring Location
- Licensed Discharge Point
- Former Monitoring Location

FIGURE 5.3

Environment Protection Licence Monitoring Locations

20190715 17.3720190715 17.37
20190715 17.38

WCL continuously monitor the turbidity of the supernatant discharge from the thickener, Bellambi Gully Creek upstream (EPL point 12, **Figure 5.3**) of the Pit Top and the Bellambi Gully Diversion Pipeline outlet (EPL point 10, **Figure 5.3**) which is downstream of LDP 2. Should the discharge from the thickener exceed a turbidity of 60 Nephelometric Turbidity Units (NTU) discharge is ceased and the supernatant is diverted to the SWCD.

If the turbidity at the outlet of the Bellambi Gully Diversion Pipeline exceeds a turbidity of 100 NTU, WCL implement a Trigger Action Response Plan (TARP) to investigate the cause of the elevated turbidity and respond accordingly to mitigate any potential contributions from colliery operations.

5.4.1.3 Stormwater Control Dam

The SWCD has a volume of 62 ML and an open channel spillway designed to pass the Probable Maximum Flood (PMF). During dry periods, the dam level is kept to a minimum to maximise the storage available to capture stormwater runoff.

Water is discharged from the SWCD to Bellambi Gully Creek via LDP 2 that accounts for seepage through the dam wall which is designed to be permeable and via LDP 3 which is the SWCD spillway (LDP 9) into Bellambi Gully Creek (refer to **Figure 5.3**). The SWCD is registered with the NSW Dams Safety Committee and is a “Prescribed” dam under the *NSW Dams Safety Act 2015*.

Water seeping through the dam wall at LDP 3 is collected in a small sump equipped with a submersible pump. The submersible pump operates on a float switch and transfers the captured water back into the SWCD, however, during high or prolonged rainfall events the capacity of the pump may be exceeded, and water will discharge to Bellambi Gully Creek.

A Dambreak and Consequence Category Assessment has been prepared for the SWCD by Hatch Associates Pty Ltd (2014). The SWCD is near the Princes Highway and downstream industrial and residential development. The dam has “High B” Sunny Day Consequence Category and “High C” Flood Consequence Category. The *NSW Dams Safety Act 2015* requires that a Type 2 Surveillance Report for the dam is prepared and submitted to the Dams Safety Committee every five years.

The most recent Type 2 Surveillance Report for the SWCD was prepared by Douglas Partners in 2017 and found that the dam “is well maintained and in good working order” and provided a list of maintenance items together with guidelines for future inspections and ongoing monitoring expectations.

Douglas Partners recently prepared the *Dam Safety Emergency Plan - Storm Water Control Dam WCL No. 1 Colliery Russell Vale Site* (2019) (DSEP) and was based on the NSW Dam Safety Committee’s (DSC’s) requirements as outlined in *DSC 2G Emergency Management for Dams* (2010) and the Australian National Committee on Large Dams (ANCOLD) document *Guidelines for Dam Safety Management* (2003). The DSEP details:

- methodology for identification, evaluation and classification of potential emergency conditions;
- access and communication procedures;
- potential consequences; and
- preventative actions.

5.4.1.4 Water Sources and Demands

Inflows to the WMS include rainfall on dams, runoff from WMS catchments, groundwater extracted from the underground workings and imported water from the Sydney Water supply.

Outflows include evaporation, dust suppression losses, product coal moisture, licensed discharges and spills during high or prolonged rainfall events that exceed WMS infrastructure capacities. Wastewater from on-site amenities is discharged to sewer.

5.4.2 Improvements to the Water Management System (WMS)

WCL is currently seeking approval modify the existing Preliminary Works Project (PA 10_0046 Modification 4) to retain the existing Bellambi Gully Diversion Pipeline to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek as originally identified in the Bellambi Gully Flood Study (Cardno, 2015) and further refined by recent more detailed investigations by Engeny (2018).

Improvements proposed to the WMS under Modification 4 will involve upgrades and formalisation of drains as well as improvements to maintenance practices. In summary, these improvements will include:

- Construction of a levee upstream of the stockpile area to minimise clean water runoff entering the stockpile and laydown areas from upslope drainage systems.
- Extending the existing noise bund on the northern side of the Pit Top approximately 35 m to the west to reduce the volume of upslope runoff entering the stockpile area.
- Minor regrading of the laydown area to convey flows to the east and limit spilling to Bellambi Lane.
- The laydown area east of the current truck wash will be utilised as a dry detention basin with a low flow channel conveying overflows to the SWCD.
- Construction of a low flow channel from the Dry Detention Basin to allow ponded water to spill to the SWCD and minimise flows to Bellambi Lane when the capacity of the pipes to Dam 1 and Dam 2 are exceeded.
- Construct easy-to-maintain debris control structures at the Bellambi Gully Creek diversion pipe inlets.
- Measures to control and manage turbid water ingress to the Bellambi Gully Diversion Pipeline and manage pipeline loading/capacity.
- The existing and proposed flow control structures will be included in regular maintenance schedules.

A schematic of the proposed WMS is presented in **Figure 5.4** and will continue to allow for the management of clean and dirty water. The proposed improvements to the WMS reduce the quantity of clean catchment runoff entering the Pit Top WMS and reduce the volume of stormwater draining into the dirty water management system. The outcome of the proposed improvements includes an improvement in the quality of water leaving the site during high rainfall events and reduced flood impacts to downstream properties.

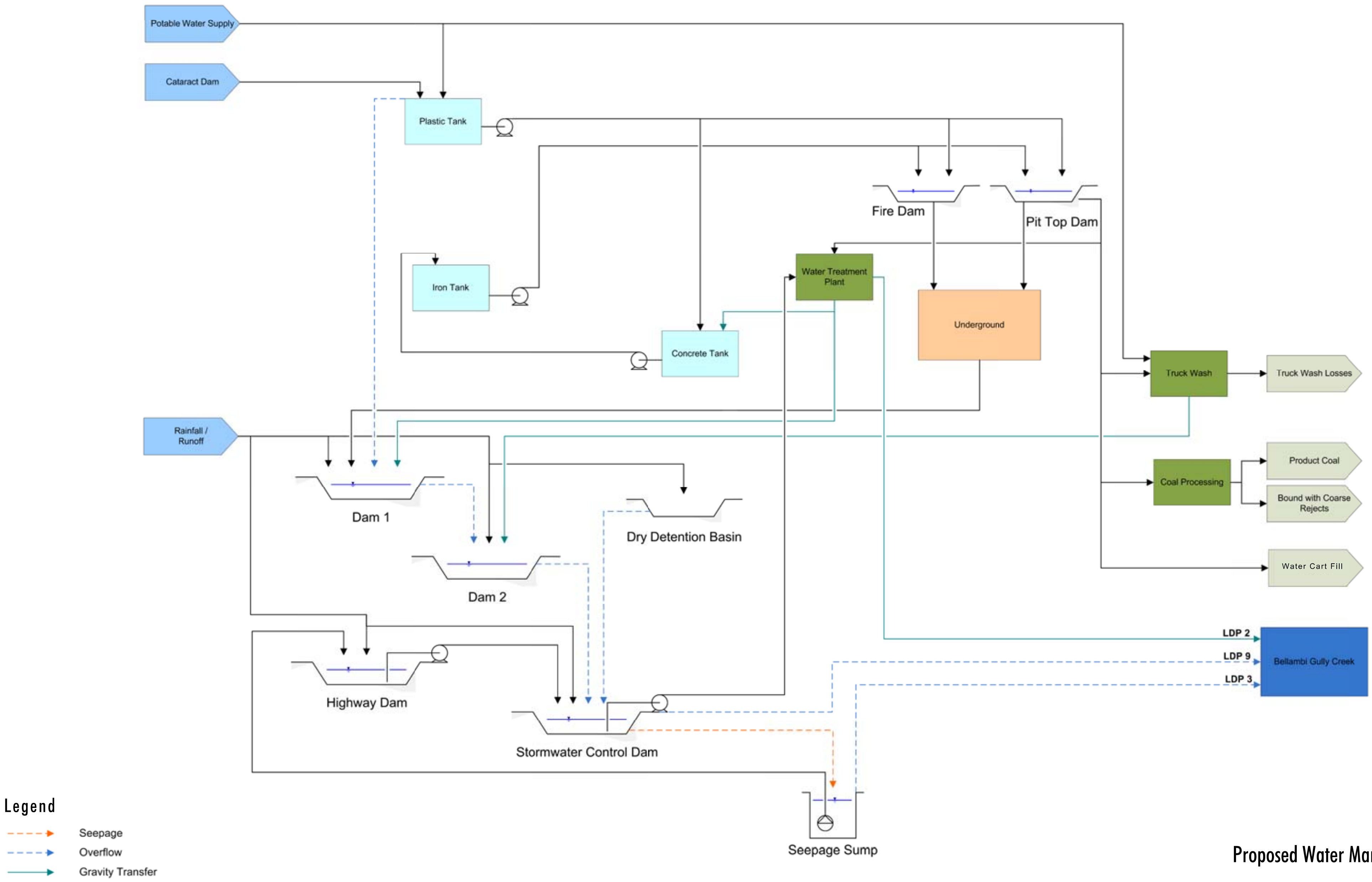


FIGURE 5.4

Proposed Water Management System Schematic

Further, the pre-treatment of inflows to Dam 1 and changes to the management of water seeping through the SWCD wall will improve the operation and outflows for the dirty water system.

In addition, regular and programmed inspection as well as clearing of debris control structures is proposed to optimise performance. Additional management and monitoring measures are discussed further in **Section 5.4.5**.

There are no proposed changes to the site's licensed discharge arrangements set out in EPL 12040. WCL do not propose to modify the current site water supply (refer to **Section 5.4.3**) for the Revised Preferred Project.

5.4.3 Water Balance

As part of the SWIA, a water balance model was developed for the Revised Preferred Project using the Goldsim modelling package. Modelling inputs and assumptions are detailed in **Appendix 3**.

The water balance results indicate that the Revised Preferred Project will have a surplus gross water balance in all years and be able to adequately meet site water demands with little to no import of water from off-site sources.

There is no requirement for Cataract Dam water imports for all modelled years with rainfall runoff and extracted groundwater more than adequate to meet the limited Revised Preferred Project water demands. Further, potable water will only be required to service bathhouse and office amenity needs.

The following observations are made with respect to the predicted licenced discharge results:

- LDP 2 discharges are likely to be required on most days of the year to manage water inventories as a result of the low water demands relative to rainfall runoff and groundwater inflows.
- Minimal off-site discharge volumes are predicted from LDP 3 as water is captured and returned to the SWCD. LDP 3 discharges are only likely during high rainfall events where the seepage sump overflows to Bellambi Gully Creek.
- LDP 9 discharges are predicted to be infrequent and only occur during high or prolonged rainfall events.
- Spill volumes from the Highway Dam are predicted to be relatively small except during high or prolonged rainfall events.

5.4.4 Licencing Assessment

Harvestable rights, which are a basic landholder right under the Water Management Act 2000, allow a landholder to capture and use up to 10% of the average regional runoff from a landholding. Basic landholder rights are exempt from volumetric licensing requirements; however, water extracted under basic landholder rights must be taken into consideration when assessing licensing requirements.

The WCL landholding associated with the Russell Vale Colliery totals approximately 1,410 ha, giving a Maximum Harvestable Rights Dam Capacity (MHRDC) of 183 ML based on an average regional runoff of 1.3 ML/ha/year (NSW Farm Dams Calculator). Dams within the WMS catchment are primarily for pollution control purposes (Dam 1, Dam 2, the SWCD and the Highway Dam) and exempt from surface water licensing requirements. Dam 5 and Dam 6 have negligible catchment areas and an estimated combined capacity of less than 10 ML. The Pit Top Dam and Fire Dam also have negligible catchment areas with upslope runoff diverted around the dams and have not been considered in the

MHRDC assessment. There are 2 dams within the WCL landholding outside of the Pit Top facilities WMS catchment with a conservatively estimated capacity of up to 14 ML.

Given the conservatively estimated assessable dam capacity within the WCL landholding of 14 ML is below the MHRDC of 183 ML there is no requirement for WCL to obtain a surface water access licence for surface water captured on site.

5.4.5 Surface Water Impacts

The following section provides an assessment of surface water impacts to the site and surrounding environment as a result of the Revised Preferred Project.

5.4.5.1 Catchment areas and annual flow volumes

The Pit Top WMS catchment area for the Revised Preferred Project will remain predominantly unchanged from the existing catchment area. However, improvements to the stormwater system will reduce the frequency and volume of upslope clean catchment runoff entering the WMS during high rainfall events. Flow volumes into Bellambi Gully Creek are expected to be unchanged apart from higher rainfall events where the proposed flood mitigation management measures will assist in directing additional upslope clean catchment runoff through the diversion pipe.

5.4.5.2 Flooding

The proposed improvements to the WMS (**Section 5.4.2**) are predicted to reduce flood impacts on downstream properties, Bellambi Lane and the Princes Highway during the 100 year ARI event (Engeny, 2018). The proposed improvements would reduce the frequency and volume of runoff from upslope clean catchments entering the WMS.

Further, the modelling indicates that:

- There will be a reduction in peak flood levels and flood extents as a result of the increased detention of overland flows in the eastern laydown area and the detention of water behind the upstream berm;
- There will be negligible impacts to downstream properties in the 5 year ARI event;
- There will be no impact on flood levels to the properties to the south of the SWCD (Engeny, 2018).

5.4.5.3 Downstream water quality

Water quality impacts associated with the Revised Preferred Project are expected to be reduced in comparison to the existing operation. Improvements to flood management will reduce the frequency and volume of uncontrolled discharges of dirty/mine water from the site during high rainfall events and the proposed water treatment measures will result in lower concentrations of sediment in licensed off-site discharges.

5.4.5.4 Geomorphological and hydrological values

The Revised Preferred Project is not expected to result in impacts to the geomorphological or hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Revised Preferred Project are considered unlikely as flows through Bellambi Gully Creek are expected to remain comparable in magnitude with respect to the existing care and maintenance scenario. The Revised Preferred Project will not change the contributing catchment of Bellambi Gully Creek over its life.

5.4.5.5 Riparian and ecological values of watercourses

Stream flows in Bellambi Gully Creek are expected to remain comparable to the present flows, and further, it is expected that there will be an improvement in water quality downstream of the site as a result of the mitigation and management measures outlined in **Section 5.4.6**.

As such, no negative impacts on riparian and ecological values downstream of the Pit Top are considered likely as a result of the Revised Preferred Project when compared to the existing care and maintenance scenario.

5.4.5.6 Water users

Water quality downstream of the Pit Top is expected to improve as a result of the proposed mitigation and management measures (**Section 5.4.2**), therefore no negative impacts on water users downstream of the Pit Top are considered likely as a result of the Revised Preferred Project when compared to the existing care and maintenance scenario.

5.4.5.7 Cumulative impacts

The receiving waters downstream of the Pit Top have historically been impacted by the presence of the Russell Vale Colliery as well as urban development. As the Revised Preferred Project will not result in any change to the contributing receiving water catchment area, and will result in an improvement to the discharge water quality from the Pit Top, no negative cumulative impacts are considered likely as a result of the Revised Preferred Project when compared to the existing care and maintenance scenario.

5.4.6 Surface Water Management and Monitoring

The key surface water management measures for the Revised Preferred Project involve the implementation of proposed improvements to the WMS set out in **Section 5.4.2** and detailed in MP10_0046 Modification 4.

The existing Russell Vale Surface Facilities Water Management Plan (WMP) will be reviewed and updated to reflect the Revised Preferred Project and MP10_0046 Modification 4, and will include:

- A water balance including details of water supply, use, management and transfers;
- An Erosion and Sediment Control Plan that is consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and Volume 2E Mines and Quarries (DECC, 2008), or the latest versions;
- Relevant baseline data on water quality.
- A surface water monitoring program.
- A description of the WMS including design objectives and performance criteria.
- A Trigger Action Response Plan for identifying and investigating any potentially adverse impacts.

As part of the update of the WMP, the existing surface water monitoring program will be reviewed and updated, and will include, but not be limited to:

- Monitoring of erosion and sediment controls during construction and operation.

- Water balance monitoring, including quantity of water import, water use, water discharge volume and SWCD seepage rate.
- SWCD embankment condition monitoring.
- Water quality monitoring in accordance with EPL 12040.
- Stream flow monitoring in Bellambi Gully Creek.
- Event based inspections of major water conveyance infrastructure following heavy rainfall and high flow weather events.
- Annual audit of the condition of and maintenance works that have been undertaken on water conveyance infrastructure.

Monitoring data will be reviewed regularly to identify any trends or deviations above water quality trigger values that may trigger the WMP TARP.

5.5 Biodiversity

Biosis (2019) has prepared a revised biodiversity impact assessment based on the impacts arising from the Revised Preferred Project first workings mine plan. The key findings are presented in this section and the full report is provided in **Appendix 4**.

5.5.1 Potential Impacts on Biodiversity Values

As discussed in **Section 5.1.1** the Revised Preferred Project first workings mine plan is not expected to cause perceptible surface subsidence or significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. The proposed first workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. As a result, impacts to the biodiversity values of the UEP Application Area are predicted to be negligible.

The proposed upgrades to Pit Top will occur within existing disturbed areas, and no direct or indirect impact on biodiversity is anticipated as a result of these works.

5.5.2 Revised Assessment Findings

A revised impact assessment for those species considered at risk of impact due to subsidence and a moderate or greater likelihood of occurrence in the study area has been conducted. The study area is defined as the area located within 400 m of proposed first workings in the revised mine plan (refer to **Figure 5.5** to **Figure 5.7**).

The sensitive habitats in the study area include (Biosis 2014a):

- Rocky environments.
- Coastal upland swamps (listed as an endangered ecological community).
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

5.5.2.1 Coastal upland swamps

The EPBC Act and BC Act listed endangered ecological community (EEC) *Coastal upland swamps in the Sydney Basin Bioregion* occur commonly throughout the study area. Detailed mapping and characterisation of upland swamps in the study area was undertaken by Biosis in 2012 (Biosis, 2012). A total of 39 upland headwater swamps were recorded in Wonga East, consisting of approximately 49 hectares. The locations of these upland swamps in relation to the Revised Preferred Project first workings mine plan are illustrated in **Figure 5.5** to **Figure 5.7**).

The upland swamps identified in the study area are significantly different to other upland swamps on the Woronora plateau in that they are predominantly drier, generally smaller with shallower soils, have less humic material, have more interspersed sandstone outcrops within their outlines and are less spatially continuous than a “typical” humic, saturated swamp (Biosis 2014b).

In the past, impact assessment for upland swamps in the Southern Coalfield has focused on the use of the criteria outlined in PAC (2010), OEH (2012) and TSSC (2014) to determine the risk of negative environmental consequences. These documents outline six criteria to be used to determine whether an upland swamp is at risk of negative environmental consequences, including:

- All swamps subject to tensile strains greater than 0.5 mm/m.
- All swamps subject to systematic compressive strains greater than 2 mm/m.
- All swamps with depth of cover less than 1.5 times longwall panel width.
- All swamps subject to tilt (transient or final) greater than 4 mm/m.
- All swamps subject to predicted valley closure of greater than 200 mm.
- All swamps subject to maximum observed closure strain of greater than 7 mm/m.
- PAC (2010) states that the criteria above are “a "threshold for investigation – not a conclusion that the swamp will be impacted or suffer consequences".

As outlined in **Section 5.2**, SCT has concluded that the Revised Preferred Project mine plan will not result in any perceptible surface subsidence and are not considered to have any potential to perceptibly impact on natural surface features including upland swamps. As a result, impacts to upland swamps from the Revised Preferred Project mine plan are predicted to be negligible.

Threatened species occupying coastal upland swamps

Upland swamps provide habitat for three threatened species in the study area that have previously been assessed as being vulnerable to impacts from mining:

- The Prickly Bush-pea is restricted to the Woronora Plateau, and has been recorded within the study area in open habitats, including upland swamps and adjacent woodland (Biosis 2014a). Despite this species’ restricted distribution, it is known to be common and widely distributed in the study area (Biosis 2014a; Figure 3).
- the Giant Burrowing Frog has been recorded as adults, metamorphs and tadpoles in a tributary of upland swamp CRUS2 between 2012 and 2016. Although often associated with upland swamps, this association is not direct, rather that upland swamps are associated with minor drainage lines that provide suitable breeding pools and burrowing habitat for this species (DECC 2007).

- the Giant Dragonfly is a groundwater dependant species preferring uplands swamps with open vegetation and free water as habitat (OEH 2013). Previous targeted surveys undertaken by Biosis have identified individuals within the study area. Due to key life stages of the Giant Dragonfly being dependant on the accumulation of groundwater and organic soils, the species is at risk from subsidence-related impacts in the form of habitat reduction.

Amendments to the mining method by the Revised Preferred Project have addressed the issue of subsidence-related impacts. The first-workings mining method will not result in perceptible levels of subsidence and upland swamp habitat is considered at negligible risk of impact; subsequently, prickly bush-pea, giant burrowing frog and the giant dragonfly are considered at negligible risk of impact.

5.5.2.2 Rocky Environments

Rocky environments in the study area include cliffs and rocky outcrops (refer to **Figure 5.5** to **Figure 5.7**). Rocky environments are considered sensitive ecological features in the study area as they provide potential habitat for the Largefooted Myotis and Eastern Bentwing-bat (Biosis 2014a).

Changes to the mining method by the Revised Preferred Project have removed the risk of subsidence-related damage to sensitive rocky environmental features in the study area. Consequently, the Revised Preferred Project is predicted to result in negligible risk of impact to roosting habitat for these species.

5.5.2.3 Aquatic Habitats

Sensitive aquatic habitat includes major streams and their tributaries. These include Cataract River, Cataract Creek and Bellambi Creek in the study area. The study area also includes a number of first, second and third order tributaries of Cataract River, Cataract Creek and Bellambi Creek (refer to **Figure 5.5** to **Figure 5.7**).

Although these tributaries are ephemeral, they influence habitat in the larger waterways for three threatened fish species previously assessed as being vulnerable to impacts associated with subsidence. Targeted fish surveys have been undertaken along Cataract River and Cataract Creek since 2009 by Cardno Ecology Lab and Biosis, and both waterways are known to support populations of Silver Perch, Macquarie Perch and Trout Cod in the lower reaches near Cataract Reservoir (Biosis 2016). However, within the study area these species occur in relatively low abundances and are part of larger populations within the Cataract Reservoir (Hansen Bailey 2015b).

As outlined in **Section 5.2**, the Revised Preferred Project is predicted to result in imperceptible impacts to surface water flows or water quality. In turn, negligible impacts are predicted to occur to the habitat of these threatened fish species.

The Red Crowned Toadlet has previously been recorded at two locations within the study area (Biosis 2014a, Biosis 2017). These two locations are associated with wet depressions situated below rocky outcrops. These environments are at negligible risk of impact as a result of the Revised Preferred Project first workings mine plan.

5.5.2.4 Conclusion

Changes to the mining method have addressed the issue of subsidence-related impacts to the biodiversity values of the study area. The first-workings mining method will not result in perceptible levels of subsidence; negligible impacts to natural surface features including upland swamps, rocky environments and aquatic environments, as well as species occupying these environments.

5.5.3 Management and Monitoring Measures

WCL currently manages and monitors impacts to biodiversity values in accordance with their Biodiversity Management Plan (2018) and Upland Swamp Management Plan (2015). The existing Biodiversity Management Plan will be reviewed and updated to reflect the Revised Preferred Project and associated management and monitoring measures.

Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence impacts as well as primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creeks. This will include:

- continued subsidence monitoring along existing subsidence monitoring lines, and extension of the program to include relevant monitoring for areas within the Revised Preferred Project first workings mine plan
- visual inspection of the rock formation that forms the base of upland swamps CCUS4, CCUS5, CCUS10, BCUS4 and BCUS6 during routine monitoring
- monitoring of groundwater levels and water quality in upland swamps using the existing network of shallow groundwater piezometers
- continued monitoring of surface outflow monitoring in upland swamp CCUS4 using the existing box weir (site CT3a)
- monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites.
- If subsidence impacts and/or primary impacts in excess of those predicted in this report are detected, the monitoring program will be reassessed.

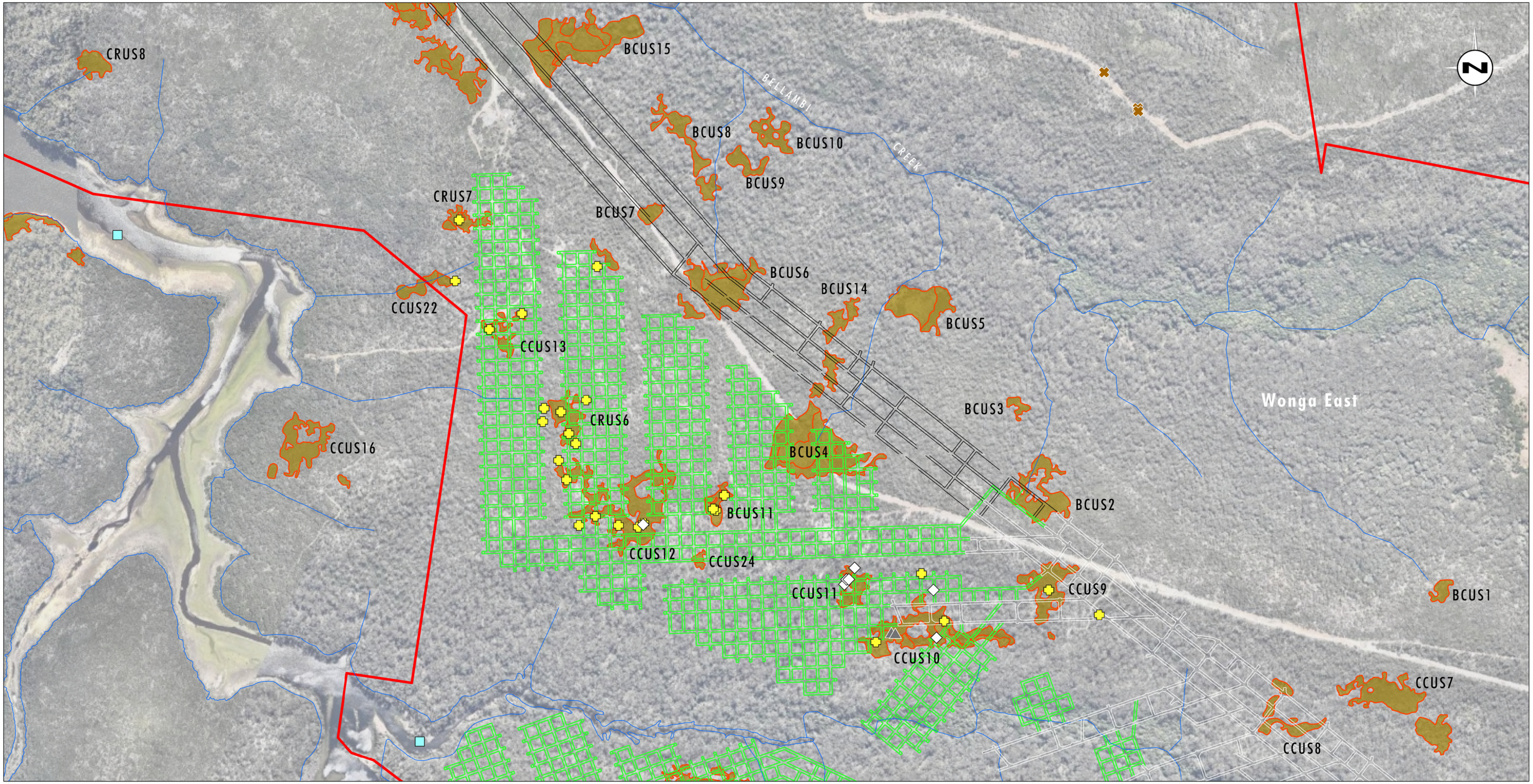


Image Source: Nearmap (Oct 2016)
Data Source: Wollongon Coal (2018); OEH (2019); Biosis (2018)

0 300m 600m
1:12,500

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line
- Prickly Bush-pea (OEH 2019)
- Prickly Bush-pea (Biosis)
- Giant Dragonfly - Exuvia (Biosis 15/16)
- Threatened Fish (Biosis)
- Red-crowned toadlet (OEH 2019 / Biosis)
- Upland swamps

FIGURE 5.5

Sensitive Ecological Features and Threatened Species Records from the Study Area

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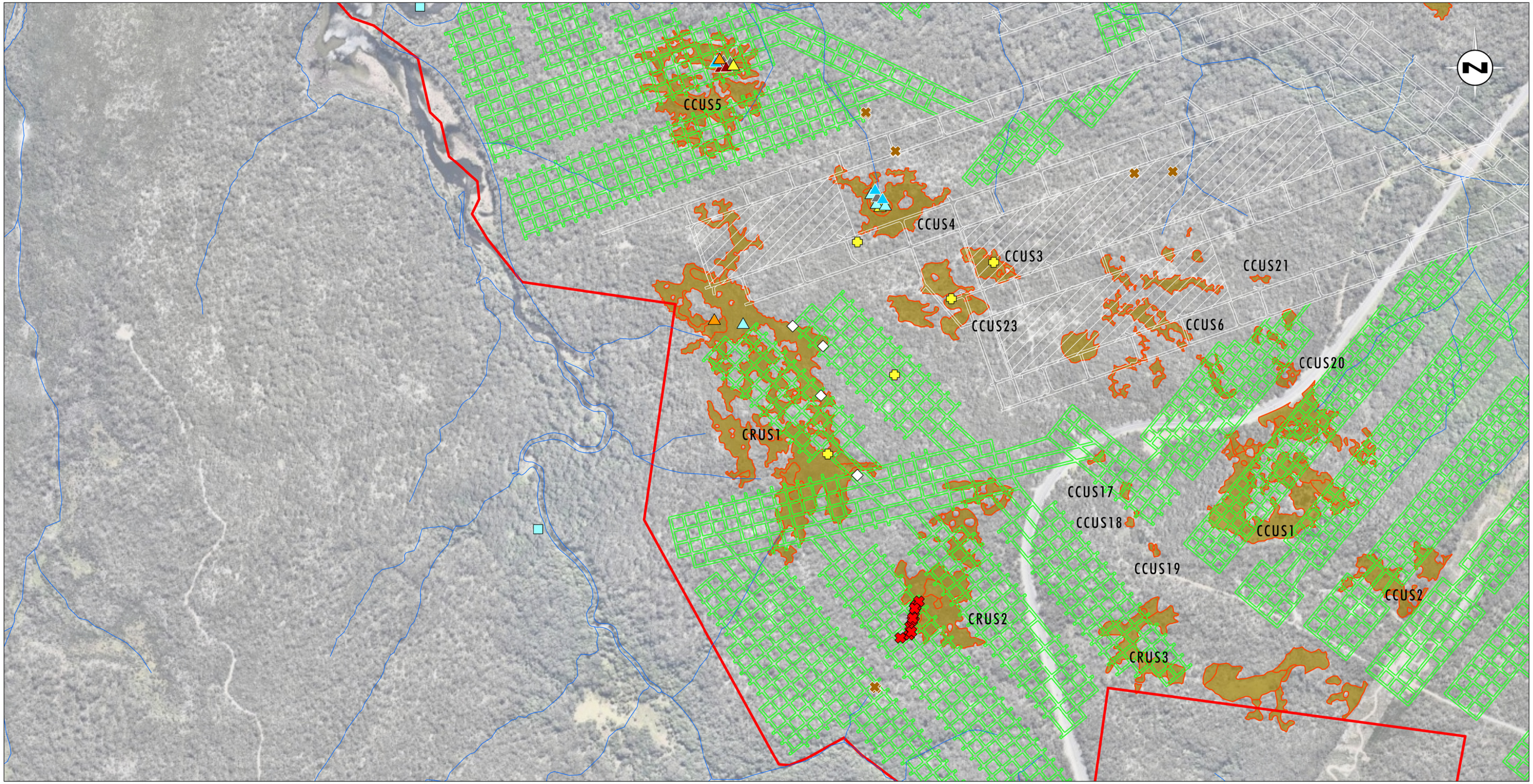

Image Source: Nearmap (Oct 2016)
Data Source: Wollongon Coal (2018); OEH (2019); Biosis (2018)

0 300m 600m
1:12,500

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line
- Prickly Bush-pea (OEH 2019)
- Prickly Bush-pea (Biosis)
- Threatened Fish (Biosis)
- Giant burrowing frog (OEH 2019)
- Red-crowned toadlet (OEH 2019 / Biosis)
- Giant Dragonfly - Exuvia (Biosis 15/16)
- Giant Dragonfly Adult (Biosis 15/16)
- Giant Dragonfly Exuvia (Biosis14/15)
- Giant Dragonfly Adult (Biosis 14/15)
- Giant Dragonfly Exuvia (Biosis 13/14)
- Giant Dragonfly Adult 13/14
- Upland swamps

FIGURE 5.6

Sensitive Ecological Features and Threatened Species Records from the Study Area

File Name (A4): R05/3687.073.dgn
20190715 13.20

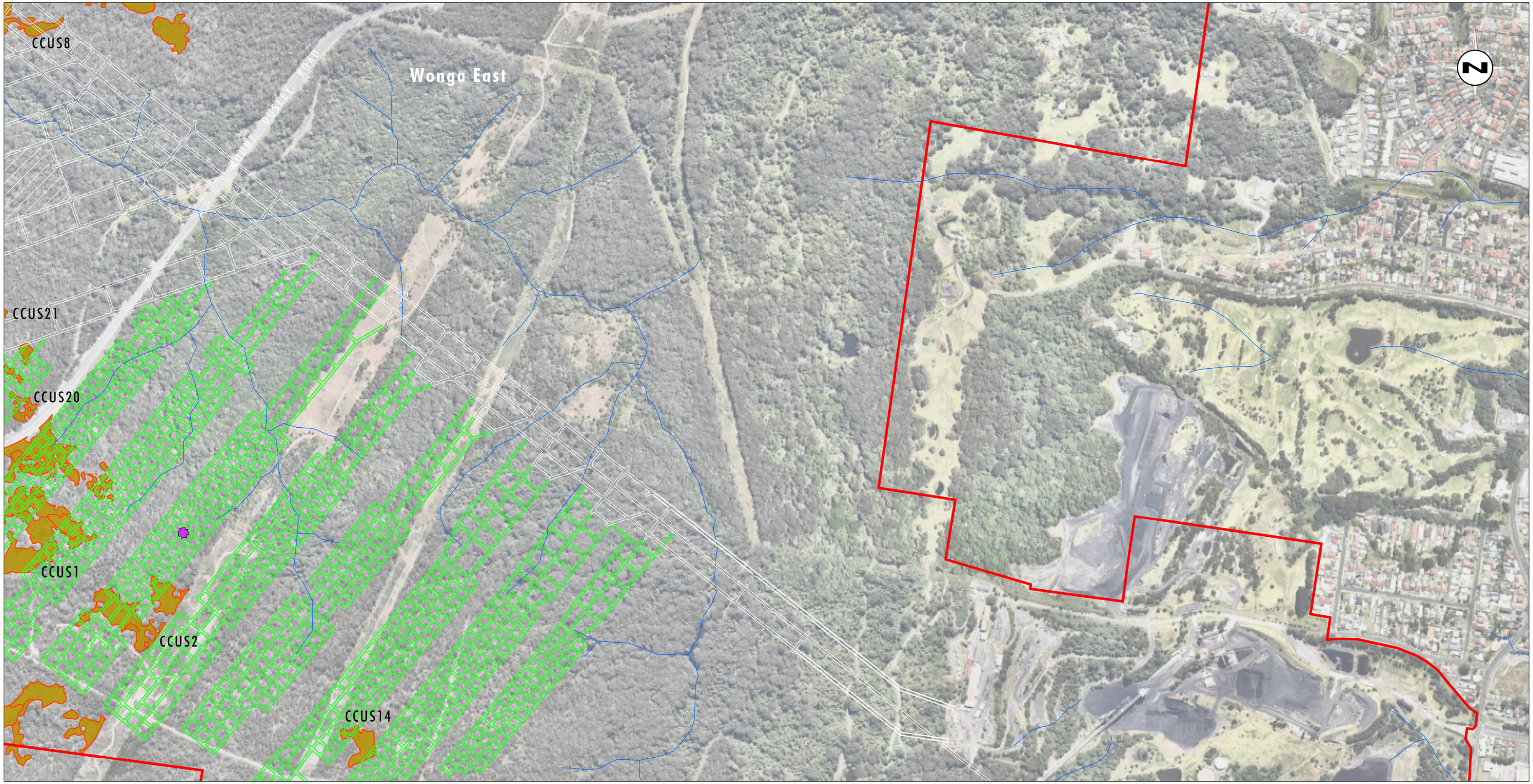

Image Source: Nearmap (Oct 2016)
Data Source: Wollongon Coal (2018); OEH (2019); Biosis (2018)

0 300m 600m
1:12,500

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line
- Leafless Tongue orchid (OEH 2019)
- Upland swamps

FIGURE 5.7

Sensitive Ecological Features and Threatened Species Records from the Study Area

File Name (A4): R05/3687.074.dgn
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5.6 Noise

A key objective of the Revised Preferred Project design has been to develop comprehensive mitigation and management strategies to reduce environmental and social impacts associated with the UEP in order to meet relevant criteria where-ever practicable and feasible. This has included redesigning the Russell Vale Pit Top and identifying further noise mitigation measures to reduce the acoustic impact of surface operations on the surrounding community.

To assess the potential noise impacts of the Revised Preferred Project, a detailed Noise Impact Assessment (NIA) was completed by Wilkinson Murray Pty Ltd (WM) in accordance with the *Noise Policy for Industry* (NPfI) (EPA, 2017). The NIA considers impacts associated with operational noise, construction noise, night time noise and road traffic noise and is included as **Appendix 5**.

It is noted that the Director General's Requirements issued for the UEP on 18 August 2009 reference the former *Industrial Noise Policy* (EPA, 2000). These guidelines have since been superseded by the NPfI (EPA, 2017). While transitional arrangements exist allowing for the continued use of the *Industrial Noise Policy* in some circumstances, consultation with the Department of Planning and Environment has confirmed that the NPfI is the appropriate guideline to assess the potential noise impacts of the Revised Preferred Project.

5.6.1 Project Design Process

The PAC Second Review Report (2016) identified that the previously proposed project design would have significant noise impacts on nearby residences and that it was likely that additional mitigation measures, including mitigation on private residences, would be required to reduce the noise impact to an acceptable level.

To reduce noise impacts associated with the Revised Preferred Project, WCL has undertaken a significant redesign of the Pit Top and identified additional noise mitigation measures to reduce the potential noise impacts associated with surface operations to an acceptable level. This design work builds on a range of noise mitigation measures that have already been implemented at the Pit Top over recent years, including:

- Acoustic treatment of the existing primary sizer building
- Acoustic treatment of the existing tripper system
- Semi-enclosure of the decline conveyor
- Poly rollers and vulcanised joints installed to all conveyors.

As part of the design process for the Revised Preferred Project, a range of additional feasible and reasonable noise control measures were investigated to minimise, control or manage the noise impacts from the project. These measures were tested through an iterative design process to determine their effectiveness at reducing noise impacts.

The noise mitigation measures identified through this process to be reasonable, feasible and effective at mitigating noise impacts from surface operations were incorporated into the noise modelling undertaken for the NIA and include:

- Repositioning infrastructure to provide maximum topographical shielding from surrounding residences, for example relocating the surge bin and secondary sizer building from an exposed location to the toe of a batter.

- Acoustic treatment of new plant and equipment, including enclosing the Coal Processing Plant and Secondary Sizer in an acoustically treated building, acoustic treatments to the Surge bin and conveyors and attenuation pack and grouser treatment of the dozer.

- extension and increase in the height of existing berms in strategic locations surrounding the Pit Top to shield trucks and equipment. The extension to the height of the main northern bund (Bund 1) will be prioritised and commenced prior to the commencement of 'phase-in' operations as discussed in **Section 2.2.1**.

- construction of a 4 m high noise barrier along the northern side of the site access road between the site entrance and turn off to the truck parking area to mitigate impacts of trucks accessing the site. Construction of the access road noise barrier will be completed prior to the commencement of 'phase-in' operations.

- establishing a temporary stockpile of ROM coal as early as possible in 'phase-in' operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile.

- voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane.

- 40 km/hr speed limit on site.

- operational noise mitigation measures such as:

    - restricting the operation of the dozer, rejects front-end loader, rejects truck, and underground loader to daytime only use

    - generally restricting the operation of the reclaim conveyor system, Secondary Sizer, Surge Bin, Processing Plant and truck loading bins to daytime use only, however noise impacts of operation of these items during the evening period has been considered in the noise impact assessment to cater for unexpected Port closures or interruptions

    - Dozer movements restricted to near ground level during 'phase-in' operation to maximise shielding provided by temporary ROM coal stockpile.

5.6.2 Existing Environment

5.6.2.1 Existing Acoustic Environment

The existing acoustic environment surrounding the site has been established using a combination of long-term noise monitoring data collected at two on-site monitoring stations and the results from a previous survey conducted by Wilkinson Murray in 2014. The location of these noise monitoring locations is shown on **Figure 5.8**.

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016), Wilkinson Murray (2018)

0 100 200 400m
1:7 500

Legend

- UEP Project Application Area
- Representative Noise-Sensitive Receiver Location
- Long Term Noise Monitoring Location
- Short Term Noise Monitoring Location

FIGURE 5.8

Noise Monitoring and Representative Noise Sensitive Receiver Locations

File Name (A4): R05/3687_046.dgn
20190621 16.23

Continuous 15-minute interval noise monitoring data collected by the two on-site monitoring stations over the entire 2016 period was processed in accordance with NPfI methodology. Russell Vale Colliery went into care and maintenance in late 2015 and was not operational throughout the whole of 2016. This long-term data is therefore considered to provide the most accurate representation of the existing background noise environment for receivers in the vicinity of the monitoring locations, that is, to the north and south of the site.

For receivers to the east of the site that are likely to be more affected by traffic noise from the Princes Highway, noise survey data collected by Wilkinson Murray over a 12 day period in 2014 in the absence of operational mine noise was used to establish background noise levels at these locations.

The Rating Background Levels (RBLs) established for the representative sensitive receiver locations surrounding the site are provided in **Table 5.8**.

Table 5.8 RBLs relevant to the Revised Preferred Project

Monitoring Location/ Representative Receiver ID	Measured RBLs (dBA)			
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 5am)	Early Morning Shoulder (5am – 7am)
NMT1 (R1, R2, R3, R4)	39	38	37	39
M1 (R5, R6, R7, R8)	43	40	37	39
NMT2 (R9, R10, R11, R12, R13, R14)	39	38	34	36

RBLs have been established for the early morning shoulder period (5.00 am - 7.00 am) in order to allow for accurate assessment of night time operations with early morning truck arrivals.

5.6.2.2 Existing Meteorological Conditions

Meteorological data was sourced from the on-site continuous monitoring weather station over the entire year of 2016 for modelling purposes. This meteorological data was analysed in accordance with Fact Sheet D of the NPfI to determine the significance of noise-enhancing meteorological conditions.

No noise enhancing meteorological conditions were identified during the day or evening period. Moderate to strong temperature inversions were found to be applicable during the night and early morning shoulder periods, as were a range of drainage flow winds during these temperature inversions. All standard and applicable noise-enhancing meteorological conditions were considered for the assessment, with the highest noise prediction resulting from all meteorological scenarios reported in the results.

5.6.2.3 Noise Sensitive Receivers

The site is located on the lower slopes of the Illawarra Escarpment and is bounded to north-northeast and south-southeast by the residential areas of Russell Vale and Corrimal. The potentially most exposed residential receivers are located in Russell Vale along Broker Street and West Street, and in Corrimal along Midgley Street, Wilford Street, Lyndon Street and Taylor Place.

A set of receivers considered to be representative of the potentially most impacted receivers surrounding the site are shown on **Figure 5.8**. These receivers broadly represent the noise catchments around the site and intervening residential properties adjoining the site are subject to the same considerations as their closest representative receiver.

Three schools or childcare centres were also identified in proximity to the site, these being Russell Vale Pre-school, Early Learning Corrimal and NSW Aspect South Coast School.

5.6.3 Operational Noise Assessment

5.6.3.1 Methodology and Approach

Operational noise levels were predicted using RTA Technology's Environmental Noise Model (ENM) to determine the acoustic impact of operations. This modelling software is recommended by the NPfI. The assessment models the total noise at each receiver from the operation of the Revised Preferred Project. Total predicted operational noise levels are then compared with the operational noise criteria established in accordance with the NPfI.

5.6.3.2 Operational Noise Assessment Criteria

Residential Receivers

The NPfI considers two components for establishing suitable criteria for industrial noise sources; these being project intrusiveness noise levels and project amenity noise levels. When assessing the noise impact of industrial sources, both components are considered for residential receivers.

The Project Noise Trigger Levels (PNTLs) reflect the more stringent noise levels derived from both the intrusive and amenity noise levels. The PNTLs set the benchmark against which noise impacts and the need for noise mitigation are assessed. The PNTLs for the Revised Preferred Project have been established in accordance with the NPfI and are presented in **Table 5.9**.

Table 5.9 Project Noise Trigger Levels - Representative Residential Receivers, $L_{Aeq,15minute}$ dB(A)

<table>
<tr><th colspan="2">Representative Residential Receiver</th><th colspan="4">Project Noise Trigger Levels, $L_{Aeq,15min}$ (dBA)</th></tr>
<tr><th>ID</th><th>Address</th><th>Day
(7am – 6pm)</th><th>Evening
(6pm – 10pm)</th><th>Night
(10pm – 5am)</th><th>Early Morning Shoulder
(5am – 7am)</th></tr>
<tr><td>R1</td><td>16 West St, Russell Vale</td><td rowspan="4">44</td><td rowspan="4">43</td><td rowspan="4">42</td><td rowspan="4">44</td></tr>
<tr><td>R2</td><td>30 West St, Russell Vale</td></tr>
<tr><td>R3</td><td>13 West St, Russell Vale</td></tr>
<tr><td>R4</td><td>13 Broker St, Russell Vale</td></tr>
<tr><td>R5</td><td>4 Broker St, Russell Vale</td><td rowspan="4">48</td><td rowspan="4">45</td><td rowspan="4">42</td><td rowspan="4">44</td></tr>
<tr><td>R6</td><td>659 Princes Hwy, Russell Vale</td></tr>
<tr><td>R7</td><td>34 Princes Hwy, Corrimal</td></tr>
<tr><td>R8</td><td>95 Midgley St, Corrimal</td></tr>
<tr><td>R9</td><td>109 Midgley St, Corrimal</td><td rowspan="6">44</td><td rowspan="6">43</td><td rowspan="6">39</td><td rowspan="6">41</td></tr>
<tr><td>R10</td><td>6 Lyndon St, Corrimal</td></tr>
<tr><td>R11</td><td>22 Lyndon St, Corrimal</td></tr>
<tr><td>R12</td><td>46 Lyndon St, Corrimal</td></tr>
<tr><td>R13</td><td>6 Taylor Pl, Corrimal</td></tr>
<tr><td>R14</td><td>15 Taylor Pl, Corrimal</td></tr>
</table>

Non-Residential Receivers

When assessing the noise impact of industrial sources on non-residential receivers, the project amenity noise levels are used to establish the PNTL. **Table 5.10** presents the PNTL for non-residential receivers surrounding the site.

Table 5.10 Project Noise Trigger Levels - Non-Residential Receivers, $LA_{eq,1hr}$ dB(A)

Receiver	Period	Project Noise Trigger Level
R15 - Russell Vale Pre-school	Noisiest 1-hour period when in use (i.e. day time period)	35 dBA (internal) 45 dBA (external)
R16 - Autism Association NSW Aspect South Coast School		
R17 – Early Learning Corrimal		

5.6.3.3 Modelling Scenarios

As discussed in **Section 2.2**, construction of the new Coal Processing Plant and associated site infrastructure is expected to take 12 to 24 months. During this period, the site will be operational with ROM coal being transported off-site without processing. This phase of the Revised Preferred Project is referred to as the 'phase-in' operation. Once the Coal Processing Plant is complete, coal beneficiation activities will commence, and the site will enter the 'full operation' phase.

For the purposes of the NIA, two operational scenarios have been modelled:

- 'Phase-in' Operation, where the daytime predictions also include construction activities and are assessed against the operational noise criteria since the site would be operational at the same time and construction noise would be indiscernible from operational noise by the community
- Full Operation, representative of when the Coal Processing Plant is operational, and the site is operating at full production capacity.

5.6.3.4 Operational Noise Assessment Findings

'Phase-in' Operation

The predicted $L_{Aeq,15min}$ operational noise levels representative of the 'phase-in' operation under the Revised Preferred Project are presented in **Table 5.11**. Results are reported as $L_{Aeq,15min}$ noise levels under Fact Sheet D meteorological conditions, with the maximum result of applicable standard and noise-enhancing conditions being presented.

Table 5.11 Predicted $L_{Aeq,15min}$ Noise Levels from Project – 'Phase-in' Operation

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day (7am – 6pm)		Evening (6pm – 10pm)		Night (10pm – 5am)		Early Morning Shoulder (5am – 7am)	
	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL
R1	41	44	37	43	**43**	42	44	44
R2	42	44	39	43	**43**	42	43	44
R3	41	44	39	43	42	42	42	44

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day (7am – 6pm)		Evening (6pm – 10pm)		Night (10pm – 5am)		Early Morning Shoulder (5am – 7am)	
	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL
R4	40	44	37	43	**43**	42	43	44
R5	43	48	42	45	41	42	43	44
R6	45	48	43	45	42	42	44	44
R7	40	48	38	45	41	42	42	44
R8	40	48	38	45	42	42	43	44
R9	37	44	36	43	**41**	39	41	41
R10	37	44	34	43	**41**	39	41	41
R11	36	44	33	43	38	39	38	41
R12	37	44	34	43	37	39	37	41
R13	38	44	36	43	38	39	38	41
R14	37	44	35	43	39	39	39	41
R15	39	45	37	45	-	NA	-	NA
R16	35	45	34	45	-	NA	-	NA
R17	30	45	28	45	-	NA	-	NA

Results indicated that no exceedances of the PNTL's are expected during the day, evening and early morning shoulder periods at any of the identified representative receivers.

A 1 decibel (dB) exceedance is anticipated at R1, R2 and R4, and up to a 2 dB exceedance is expected at R9 and R10 during the night time period under adverse weather conditions. It is noted that the only noise generating activity occurring on the surface during the night time period is the running of ROM coal onto the ROM stockpile.

The NPfI and Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) defines a 1-2 dB exceedance as a negligible residual noise impact indiscernible by the average listener.

Full Operation

The predicted $L_{Aeq,15min}$ operational noise levels representative of the full operation (once all infrastructure items and upgrades have been built) under the Revised Preferred Project are presented in **Table 5.12**.

Results are reported as $L_{Aeq,15min}$ noise levels under Fact Sheet D meteorological conditions, with the maximum result of applicable standard and noise-enhancing conditions being presented.

Table 5.12 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Full Operation

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day (7am – 6pm)		Evening (6pm – 10pm)		Night (10pm – 5am)		Early Morning Shoulder (5am – 7am)	
	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL	Prediction $L_{Aeq,15min}$	PNTL
R1	41	44	39	43	**43**	42	44	44
R2	42	44	40	43	**43**	42	43	44
R3	42	44	40	43	42	42	43	44
R4	41	44	38	43	**43**	42	43	44
R5	44	48	43	45	41	42	43	44
R6	44	48	42	45	42	42	44	44
R7	40	48	39	45	41	42	42	44
R8	40	48	39	45	42	42	43	44
R9	38	44	36	43	**41**	39	41	41
R10	37	44	35	43	**41**	39	41	41
R11	36	44	34	43	38	39	38	41
R12	37	44	35	43	37	39	37	41
R13	39	44	37	43	38	39	38	41
R14	38	44	36	43	39	39	39	41
R15	40	45	38	45	-	NA	-	NA
R16	37	45	36	45	-	NA	-	NA
R17	31	45	29	45	-	NA	-	NA

Results indicated that no exceedances of the PNTL's are expected during the day, evening and early morning shoulder periods at any of the identified representative receivers.

A 1 decibel (dB) exceedance is anticipated at R1, R2 and R4, and up to a 2 dB exceedance is expected at R9 and R10 during the night time period under adverse weather conditions. As with the 'Phase In' Operation scenario, the only noise generating activity occurring on the surface during the night time period is the running of ROM coal onto the ROM stockpile.

Again, the NPfI and Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) defines a 1-2 dB exceedance as a negligible residual noise impact indiscernible by the average listener.

Frequency and Extent of Residual Noise Exceedances

Further analysis has been undertaken to define the frequency of occurrence of residual 1-2 dB night-time noise exceedances. These predicted night-time noise exceedances relate to noise levels during temperature inversions which occur primarily in Winter. Analysis of the cumulative frequency of occurrence of night-time noise levels identifies that residual noise exceedances are only expected to occur between 2 and 5% of the night-time period in Winter.

Further analysis was also completed to define the extent of predicted residual night-time noise impacts. Noise contours and additional point-source noise predictions have been completed for the full operation scenario to identify all receivers expected to be subject to residual noise exceedances and determine the level of exceedance for each of those receivers. A summary of all noise-sensitive receivers where exceedances are expected during full operation is presented in **Table 5.13** and the noise contours produced for the full operation scenario are presented in **Appendix 5**. As noted above, these night-time noise exceedances are predicted to occur between 2 and 5 percent of Winter nights.

Table 5.13 Predicted Night-time Noise Exceedances – Full Operation

Receiver Address	LAeq,15min Noise Level (dBA) Night	
	Prediction	PNTL - Night
16 West Street, Russell Vale	43	42
18 West Street, Russell Vale	43	42
20 West Street, Russell Vale	43	42
22 West Street, Russell Vale	43	42
24 West Street, Russell Vale	43	42
26 West Street, Russell Vale	43	42
28 West Street, Russell Vale	43	42
30 West Street, Russell Vale	43	42
11 Broker Street, Russell Vale	43	42
131 Broker Street, Russell Vale	43	42
15 Broker Street, Russell Vale	43	42
17 Broker Street, Russell Vale	43	42
19 Broker Street, Russell Vale	43	42
23 Broker Street, Russell Vale	43	42
25 Broker Street, Russell Vale	43	42
4 Lyndon Street, Corrimal	40	39
6 Lyndon Street, Corrimal	41	39
8 Lyndon Street, Corrimal	41	39
8 Wilford Street, Corrimal	41	39
10 Wilford Street, Corrimal	40	39
101 Midgley Street, Corrimal	41	39
103 Midgley Street, Corrimal	41	39
105 Midgley Street, Corrimal	41	39
107 Midgley Street, Corrimal	41	39
109 Midgley Street, Corrimal	41	39
76 Midgley Street, Corrimal	40	39
78 Midgley Street, Corrimal	40	39

5.6.3.5 Low-Frequency Noise Assessment

An assessment of low-frequency noise was conducted in accordance with the NPfI to determine whether a modifying factor correction was applicable to the predicted operational noise levels. The low frequency assessment indicates that the difference between overall 'C' weighted and 'A' weighted predicted levels are less than 15 dB at each of the representative receivers assessed, therefore it is unlikely that the receivers surrounding the site would be subject to dominant low-frequency noise. No modifying factor correction for low-frequency noise therefore applies.

5.6.3.6 Comparison with Previous UEP Noise Predictions

The proposed mitigation measures outlined in **Section 5.6.1** and the reconfiguration of the Pit Top have significantly reduced the predicted operational noise levels in comparison with the pre-existing operation of the site and when compared to the previous Preferred Project site configuration. Under the previous site configuration, exceedances of the then Industrial Noise Policy criterion of up to 11db, 1dB and 9dB were predicted during the day, evening and night respectively (Wilkinson Murray 2014). When compared under the same meteorological conditions, this equates to a reduction in predicted noise levels of 0-9dB, 2-11dB and 1-11dB for the day evening and night periods respectively when compared with the levels predicted in the UEP assessment.

5.6.4 Maximum Noise Level Event Assessment

Two noise sources were identified as potentially triggering sleep arousal during the night or early morning shoulder period:

- coal and rocks impacting the tripper leg chutes as it is discharged onto the ROM stockpile and
- early morning truck arrivals.

A maximum noise level event screening assessment was conducted for each of these sources indicating that the L_{AFmax} noise levels are predicted to be below the L_{AFmax} trigger levels at all surrounding representative receivers.

An assessment of night time and early morning shoulder $L_{Aeq,15min}$ noise levels was also undertaken against the $L_{Aeq,15min}$ trigger levels for the maximum noise level event screening assessment. Night time noise levels are predicted to exceed the $L_{Aeq,15min}$ trigger levels for the maximum noise level event screening assessment by 1 dB at five representative receiver locations surrounding the site. No exceedances are expected during the early morning shoulder periods. A 1 dB exceedance represents a negligible residual noise impact indiscernible by the average listener according to the NPfI and the VLAMP. Additionally, as the maximum noise levels are below the L_{AFmax} trigger levels, no noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.

5.6.5 Construction Noise Assessment

As outlined in **Section 2.2.1**, the construction phase of the Revised Preferred Project includes the extension and increase in height of existing noise berms surrounding the Pit Top as well as the construction of a noise barrier along the northern side of the site access road. The construction of the access road noise barrier will be completed prior to the commencement of 'phase in' operation. The construction of Bund 1 will be commenced prior to phase-in operations and completed as a priority as discussed in **Section 2.2.1** to mitigate noise from the 'phase-in' and remaining construction activities. If phase-in operations or infrastructure construction commence prior to Bund 1 achieving its planned height, phase-in operations and infrastructure construction will be managed to meet the operational project noise trigger levels outlined in **Section 5.6.3** until such time as Bund 1 achieves its planned height.

The construction of the remaining bunds will be completed prior to commencing full operation.

The EPA recognises that construction activities could potentially generate higher noise levels than those of an industrial operation. The *Interim Construction Noise Guideline* (ICNG) provides noise management criteria for construction activities and these have been applied for the assessment. These criteria are outlined in **Table 5.14**.

The recommended standard hours in accordance with the ICNG are Monday to Friday 7.00 am to 6.00 pm, Saturday 8.00 am to 1.00 pm and no work on Sundays or public holidays. The 'noise affected' management level criteria is RBL + 10 dBA and 'highly affected' management level is 75 dBA. Outside recommended standard hours, the 'noise affected' management level is RBL + 5 dBA.

Construction noise levels were predicted for all identified bunds and the worst-case noise predictions were reported. The predictions represent noise levels generated when constructing the bund closest to a receiver in question.

Table 5.14 $L_{Aeq,15min}$ Levels from Bund Construction

ID	$L_{Aeq,15min}$ Noise Level (dBA)	'Noise Affected' Level (dBA)	'Highly Noise Affected' Level (dBA)
R1	61	49	75
R2	65	49	75
R3	63	49	75
R4	56	49	75
R5	57	53	75
R6	57	53	75
R7	54	53	75
R8	57	53	75
R9	59	49	75
R10	52	49	75
R11	41	49	75
R12	36	49	75
R13	39	49	75
R14	44	49	75

Results indicate that construction noise levels comply with the ICNG 'highly noise affected' management level at all identified receivers. However, at some point in time during the construction of bunds, the ICNG 'noise affected' management level is likely to be exceeded at representative receiver locations R1 – R10. These exceedances would however only occur for a short duration during the construction of closest bund (s) and under adverse weather conditions. For the remainder of time, construction noise is expected to comply with the 'noise affected' management level.

As a result of the predicted brief exceedances of the 'noise affected' management levels, WCL will implement the following reasonable and feasible work practices in accordance with the ICNG:

- Schedule activities to minimise noise impacts
    - All bund construction works will be undertaken during recommended standard construction hours
    - Bund construction will be scheduled as early as possible within the phase-in period so that they can be used as noise barriers.
    - Minimise the duration of bund construction where feasible and reasonable
    - Consult with affected neighbours about scheduling bund construction to minimise noise impacts.

- Equipment selection and methods
  - Dump truck access to be provided to bunds on the side further away from the closest receivers to maximise distance to receivers and shielding from bunds
  - Use mobile equipment with less annoying alternatives to the typical 'beeper' alarms where feasible and reasonable
  - Regularly inspect and maintain equipment in good working order.
- Notification before and during bund construction
  - Provide information regarding construction activities to potentially affected neighbours, including the nature and expected duration of construction activities
  - Provide signage at the front of the site providing contact information, construction hours and any updates on construction activities.
- Implement a complaints handling procedure, maintain a complaints register and implement all feasible and reasonable measures to address the source of complaints.
- Undertake attended noise monitoring at the nearest and potentially most impacted residence(s) when construction of noise bunds is occurring within 200 metres of noise-sensitive receivers to confirm construction noise levels are consistent with predicted levels.

5.6.6 Road Traffic Noise Assessment

As discussed in **Section 2.1.5**, coal will be transported by truck to PKCT using road registered semi-trailer trucks and may in the future utilise B-double trucks. The proposed transport route is via Bellambi Lane and Memorial Drive, consistent with previously approved operations. Traffic generation of the Revised Preferred Project will be similar to the previous traffic generation of Russell Vale Colliery when it was operational.

In accordance with EPA's *NSW Road Noise Policy* (RNP) (EPA 2011), Bellambi Lane is identified as a 'principal haulage route', and therefore the criteria for arterial/sub arterial roads apply. The assessment considered the increase in noise levels from the existing traffic volumes and takes into consideration an average 1.5% per year background traffic growth rate for Bellambi Lane. As per the RNP, an increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

The analysis indicated that the Revised Preferred Project traffic may be expected to result in relative noise level increases of:

- 2.0 dB during the day (associated with light and heavy vehicles accessing the site), and
- 0.5 dB at night (associated with light vehicles accessing the site).
- This indicates an acceptable relative traffic noise increase to residents along Bellambi Lane and surrounds under the RNP.

WCL has sought to limit traffic noise impacts to residents along Bellambi Lane by restricting haulage to the RNP day period only and mandating a reduced speed limit for coal trucks along Bellambi Lane.

5.6.7 Noise Management and Monitoring Measures

WCL will continue to operate two continuous noise monitoring stations within the Russell Vale Colliery site.

WCL will implement the operational noise mitigation measures outlined in **Section 5.6.1** for the Revised Preferred Project.

WCL will implement feasible and reasonable construction noise management measures as outlined in **Section 5.6.5**.

WCL will review and update the existing Noise Management Plan for the Russell Vale Colliery to incorporate the Revised Preferred Project and associated additional noise management measures.

5.7 Air Quality

5.7.1 Assessment Methodology

An assessment of predicted air quality impacts for the Revised Preferred Project was undertaken by ERM Australia Pacific (ERM). The assessment, provided in full as **Appendix 6**, follows the EPA's Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016). EPA (2016) specifies how assessments based on the use of atmospheric dispersion models should be completed along with impact assessment criteria of particulate matter and selected gaseous emissions.

The operations of the Revised Preferred Project were analysed and estimates of particulate matter produced by each activity were made based on standard emission factors developed both in Australia, and by the US EPA. The emission factors applied are considered to be the most reliable, contemporary methods for determining dust generation rates.

An emissions inventory was prepared for two operating scenarios as follows:

- Scenario 1 considers the construction and phasing in period for the new processing plant and associated infrastructure. This scenario included emissions from the activities where ROM coal is delivered to the ROM stockpile, loaded to trucks and transported off site without processing, combined with construction of the new processing plant and noise bunds around the Pit Top. This scenario is indicative of the first 12 to 24 months of operation of the UEP as described in the Revised Preferred Project during which ROM coal production would be in the order of approximately 500 000 tpa.

- Scenario 2 considers emissions generated when the new processing plant and associated infrastructure is fully operational. The scenario conservatively includes emissions associated with ongoing construction of noise bunds, however WCL has committed to complete these works prior to full operation commencing. This scenario is indicative of emissions at the full production rate of up to 1 Mtpa of product coal.

For each scenario, emissions at receivers surrounding the Revised Preferred Project were predicted by computer dispersion modelling using the AERMET/AERMOD modelling package. The dispersion modelling considered the emissions inventory for each scenario, local terrain factors, local meteorological data and background air quality over a 365 day period in order to predict annual and 24 hour emission levels at selected locations.

5.7.2 Local Meteorology

Local meteorological conditions were established based on measured conditions at the Russell Vale Colliery Automated Weather Station (AWS). Data for the full 2016 period was used for modelling purposes. The data illustrates that winds are predominantly from the western and southern quadrants, with those from the west significantly stronger.

5.7.3 Background Air Quality

WCL maintains two Tapered Element Oscillating Microbalance (TEOM) air quality monitors on the Russel Vale Colliery site that continuously monitor PM_{10} and $PM_{2.5}$ concentrations. The location of these air quality monitoring stations and the representative sensitive receptors considered in this assessment are provided in **Figure 5.9**.

The PM_{10} and $PM_{2.5}$ data collected at TEOM2 has been used to provide a conservative evaluation of background air quality concentrations for the cumulative assessment. The assumed background levels are conservative because the contributions from existing operations will already be captured to some extent in the 2016 monitoring data. The Russell Vale Colliery was in care and maintenance during 2016 therefore contributions from existing operations relate primarily to emissions from exposed areas around the surface infrastructure site and Russell Vale Emplacement Area to the north.

The 24-hour background levels for PM_{10} and $PM_{2.5}$ are also conservative as they have adopted the 95$_{th}$ percentile measured values, with the vast majority of measured levels falling well below the adopted background levels. TEOM2 data was used for background concentrations because, for predominant wind directions, this monitor is located upwind of the major particulate matter sources at the mine, in close proximity to sensitive residential receptors.

For the purposes of estimating background concentrations of PM_{10} and $PM_{2.5}$, the following has been assumed:

- 24-hour average PM_{10} concentration equivalent to the 95th percentile 24-hour average values collected at TEOM2 during 2016 (22.6 µg/m^3).
- Annual average PM_{10} concentration at TEOM2 during 2016 (10.7 µg/m^3).
- 24-hour average $PM_{2.5}$ concentration equivalent to the 95th percentile 24-hour average values collected at TEOM2 during 2016 (11.2 µg/m^3).
- Annual average $PM_{2.5}$ concentration at TEOM2 during 2016 (5.0 µg/m^3).

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016), Wilkinson Murray (2018)

0 100 200 400m
1:7 500

Legend

- UEP Project Application Area
- Representative Sensitive Receptors
- Automatic Weather Station (AWS)
- TEOM Station

FIGURE 5.9

Location of Dust Monitoring Sites

5.7.4 Impact Assessment Criteria

Air quality assessment criteria relevant for assessing impacts from air pollution are provided in the NSW EPA (2016) and follows National Environment Protection (Ambient Air Quality) Measure produced by the Commonwealth Department of the Environment and last amended February 2016. These criteria are shown in **Table 5.15** and present the air quality criteria for concentrations of particulate matter (PM_{10} and $PM_{2.5}$) that are relevant for industrial projects.

Table 5.15 Impact assessment criteria for particulate matter concentrations

Pollutant	Criterion	Averaging period	Source
PM_{10}	50 µg/m^3 25 µg/m^3	24-Hour Annual	NSW EPA (2016)
$PM_{2.5}$	25 µg/m^3 8 µg/m^3	24-Hour Annual	NSW EPA (2016)

Note: µg/m^3 – micrograms per cubic metre

In addition to health impacts, airborne dust also has the potential to cause nuisance dust effects by depositing on surfaces such as buildings, outdoor furniture etc. The criteria for deposited dust levels set to protect against nuisance impacts (NSW EPA, 2016) are shown in **Table 5.16**.

Table 5.16 Impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase (due to project)	Maximum total level
Deposited dust (insoluble solids)	Annual average	2 g/m^2/month	4 g/m^2/month

Note: g/m^2/month – grams per m^2 per month

5.7.5 Emissions Inventory

The emissions inventory provided in detail in **Appendix 6** identifies that the primary sources of particulate emissions include FEL loading, off-site haulage, dozer operations and wind erosion on exposed areas. Methods to mitigate, manage and reduce these sources of emissions are described in **Section 5.7.7**.

5.7.6 Results

The predicted 24 hour and annual average particulate matter concentration and deposition levels arising from the Revised Preferred Project at 10 representative residential receivers surrounding the site are presented in **Table 5.17** and **Table 5.18**. The predictions include both the incremental contribution of the Revised Preferred Project to annual average PM_{10}, $PM_{2.5}$ and dust deposition, as well as cumulative emissions when considering background emissions.

Contour plots presenting the predicted cumulative 24 hour and annual average $PM_{2.5}$ and PM_{10} concentrations for the full operation scenario are shown in **Figure 5.10** and **Figure 5.11**.

umwelt

Predicted Maximum Cumulative 24-Hour Average $PM_{2.5}$ Concentrations

Predicted Maximum Cumulative 24-Hour Average PM_{10} Concentrations

Legend

- UEP Project Application Area
- Air Contours
- Criterion Concentration Contour
- Representative Sensitive Receptors

0 100 250 500m

1:10 000

Image Source: Nearmap (Oct 2016)

Data Source: Wollongong Coal (2016), Wilkinson Murray (2018), ERM (2018)

FIGURE 5.10

Predicted Maximum Cumulative 24-Hour Average $PM_{2.5}$ and PM_{10} Concentrations due to the Proposed Operations and Background Concentrations

File Name (A4): R05/3687_075.dgn

20190715 11.25

Predicted Annual Average Cumulative $PM_{2.5}$ Concentrations

Predicted Annual Average Cumulative PM_{10} Concentrations

Legend

- UEP Project Application Area
- Air Contours
- Criterion Concentration Contour
- Representative Sensitive Receptors

0 100 250 500m

1:10 000

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016), Wilkinson Murray (2018), ERM (2018)

FIGURE 5.11

Predicted Annual Average Cumulative $PM_{2.5}$ and PM_{10} Concentrations due to the Proposed Operations and Background Concentrations

Table 5.17 Predicted Particulate Concentration and Deposition – Scenario 1 (Phase-in and Constructions Period)

Sensitive Receptor	24-hour average (µg/m³) Increment (Total)		Annual average (µg/m³) Increment (Total)		Increment (g/m²/month)	Total (g/m²/month)
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	Deposited Dust	
Criterion	25	50	8	25	2	4
R1	2.8 (13.9)	22.4 (45.0)	0.2 (5.2)	2.1 (12.8)	0.5	2.5
R2	2.7 (13.9)	19.0 (41.6)	0.3 (5.3)	2.35 (13.0)	0.6	2.6
R3	0.3 (11.5)	3.5 (26.1)	0.0 (5.0)	0.2 (10.9)	0.2	2.2
R4	0.4 (11.6)	6.0 (28.6)	0.1 (5.1)	0.4 (11.1)	0.3	2.3
R5	1.6 (12.7)	16.6 (39.2)	0.1 (5.1)	1.1 (11.8)	0.5	2.5
R6	1.7 (12.9)	16.9 (39.5)	0.1 (5.1)	1 (11.7)	0.2	2.2
R7	1.3 (12.5)	10.4 (33.0)	0.1 (5.1)	0.8 (11.5)	0.2	2.2
R8	1.1 (12.3)	8.7 (31.3)	0.0 (5.0)	0.3 (11.0)	0.1	2.1
R9	1.2 (12.4)	13.4 (36.0)	0.1 (5.1)	0.7 (11.4)	0.1	2.1
R10	2.3 (13.5)	18.8 (41.4)	0.2 (5.2)	1.4 (12.1)	0.3	2.3
Complies?	Yes	Yes	Yes	Yes	Yes	Yes

Source: ERM (2019) – Table 6.1

Table 5.18 Predicted Particulate Concentration and Deposition – Scenario 2 (Full Operation)

Sensitive Receptor	24-hour average (µg/m³) Increment (Total)		Annual average (µg/m³) Increment (Total)		Increment (g/m²/month)	Total (g/m²/month)
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	Deposited Dust	
Criterion	25	50	8	25	2	4
R1	3.1 (14.3)	23.9 (46.5)	0.4 (5.4)	3.2 (13.9)	0.8	2.8
R2	2.6 (13.8)	19.9 (42.5)	0.4 (5.4)	3.0 (13.7)	0.7	2.7
R3	0.2 (11.4)	1.7 (24.3)	0.0 (5.0)	0.2 (10.9)	0.1	2.1
R4	0.3 (11.5)	2.5 (25.1)	0.0 (5.0)	0.4 (11.1)	0.2	2.2
R5	0.8 (12.0)	5.8 (28.4)	0.0 (5.1)	0.7 (11.4)	0.3	2.3
R6	1.3 (12.5)	9.1 (31.7)	0.2 (5.2)	1.2 (11.9)	0.3	2.3

Sensitive Receptor	24-hour average (µg/m³) Increment (Total)		Annual average (µg/m³) Increment (Total)		Increment (g/m²/month)	Total (g/m²/month)
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	Deposited Dust	
R7	1.9 (13.1)	15.4 (38.0)	0.1 (5.1)	1.2 (11.9)	0.2	2.2
R8	0.7 (11.9)	4.7 (27.3)	0.0 (5.0)	0.3 (11.0)	0.1	2.1
R9	0.9 (12.1)	7.0 (29.6)	0.1 (5.1)	0.6 (11.3)	0.1	2.1
R10	2.9 (14.1)	22.0 (44.6)	0.3 (5.3)	2.2 (12.9)	0.5	2.5
Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Source: ERM (2019) – Table 6.2

The assessment results were compared to relevant air quality criteria for PM_{10}, $PM_{2.5}$ and deposited dust and no exceedances of relevant criteria were predicted at any sensitive receptor locations off site.

With respect to 24 hour particulate matter, the results presented in **Table 5.17** and **Table 5.18** present average concentrations. In order to assess the daily varying PM_{10} concentrations, ERM (2018) considered the output for each day individually at Sensitive Receptors R1, R2 and R10 (which are predicted to receive the highest average 24 hour incremental levels). As is illustrated by Figures 6.13 to 6.15 of ERM (2018) (refer to **Appendix 6**), the cumulative PM_{10} 24 hour concentration remains well below the 50 µg/m³ criterion.

5.7.7 Air Quality Management and Monitoring Measures

A range of air quality mitigation measures and controls have been included in the Revised Preferred Project design and will be implemented by WCL in the ongoing operation of the Revised Preferred Project. These include:

- Enclosure of conveyors and material transfer points
- Enclosure of Processing Plant
- Water sprays on ROM stockpile
- Water carts on unsealed haul routes
- Water sprays on stockpiles and exposed areas triggered during periods of high winds
- Water sprays on the noise berms during construction
- Trucks will be covered before leaving the site
- Trucks will be washed before leaving the site
- Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes
- Revegetation/rehabilitation of exposed disturbed areas.

WCL will review and update the existing Russell Vale Colliery Air Quality and Greenhouse Gas Management Plan for the Revised Preferred Project. In addition to the dust control measures outlined above, the plan will be updated to incorporate a range of proactive and reactive dust control strategies. Proactive air quality management would involve the planning of activities in advance of potentially adverse conditions. Specifically, the proactive air quality management approach will include:

- implementation of a system to provide the operation with a daily forecast of expected dust conditions in the vicinity of the operation
- discussion of the weather conditions and dust considerations at daily pre-shift meetings
- modifying or suspend the planned activities, as appropriate, to minimise dust impacts.

Reactive air quality management will include the modification or suspension of activities in response to the following triggers:

- visual conditions, such as visible dust from trucks above wheel height.
- meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors, and/or
- ambient air quality conditions (that is, elevated short-term PM_{10} concentrations).

5.7.8 Conclusion

Air dispersion modelling indicates that with the implementation of feasible and reasonable mitigation measure, particulate concentration and deposition levels will remain well below the NSW EPA (2016) impact assessment criteria at all representative sensitive receiver locations off site with the operation of the Revised Preferred Project.

5.8 Traffic

Transport and Urban Planning Pty Ltd was commissioned to undertake a Traffic and Transport Impact Assessment (TTIA) for the Revised Preferred Project. This section sets out the key findings of the assessment of the TTIA, provided in full as **Appendix 7**, and includes:

- a description of the existing road network and traffic conditions, including information on projected traffic growth over the five year life of the Revised Preferred Project;
- a summary of the proposed controls and management measures to be implemented to reduce potential impacts on the road network and users;
- assessment of the potential changes to existing conditions as a result of the Revised Preferred Project and impact on:
    - Operational capacity of principal intersections
    - Cumulative impacts from existing and proposed developments
    - Road condition and road safety.

5.8.1 Existing Conditions

Principal Roads and Intersections

The principal road network that services Russell Vale Colliery includes, the Colliery Access Road, Bellambi Lane, Memorial Drive, M1 Princes Motorway, Masters Road, Springhill Road and Port Kembla Road (refer to **Figure 5.12**). The public roads are all approved 25/26 metre B Double routes.

Russell Vale Colliery Access Road provides the main vehicle access to the Colliery. It is a 40km/h speed limited, two lane road (i.e. single lane in each direction) widening to four lanes at the Princes Motorway intersection. The Colliery Access Road forms a signalised cross junction intersection with Princes Motorway and Bellambi Lane.

Bellambi Lane between the Princes Motorway and Memorial Drive is a 60km/h speed limited, four lane road intersecting with Memorial Drive approximately 730 m east of the Colliery Access Road. The eastbound lanes provide two traffic lanes. Westbound lanes provide one traffic lane and parking in the kerbside lane. Bellambi Lane forms a signalised cross junction intersection with Memorial Drive.

Memorial Drive is a State road which generally provides a four lane divided road between Bellambi Lane and the M1 Princes Motorway (i.e. two lanes in each direction). Additional right and left turning lanes are provided at the at-grade signalised intersections.

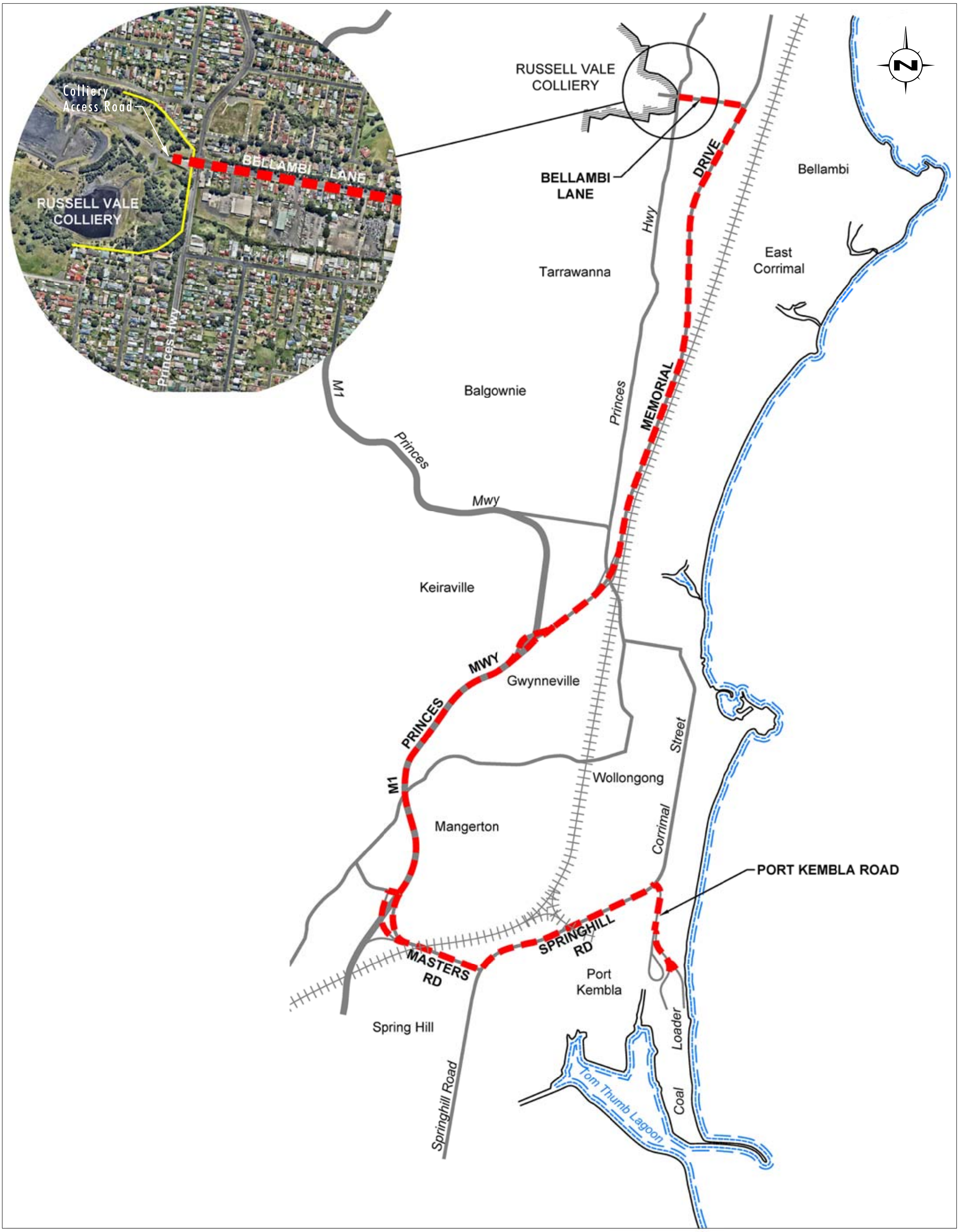

FIGURE 5.12

Road Network and Transport Route

Image Source: Transport & Urban Planning Pty Ltd (2018)
Note: Not to Scale

Existing Traffic Volumes

Classified traffic counts were undertaken in Bellambi Lane and Memorial Drive near the Russell Vale Colliery to establish current traffic volumes using the road network. The results of the traffic counts conducted between 2 and 8, and 15 and 21 May 2017 for Bellambi Lane and Memorial Drive respectively are summarised as follows:

- The two-way traffic volumes of Bellambi Lane are 5,525 vehicles per day (vpd) on an average weekday (5.3% heavy vehicles[3]) and 5,124 vpd per day (7 day average) (5.1% heavy vehicles). Two way hourly volumes, between 7am and 10pm, vary between 90 and 519 vehicles per hour (vph) on an average weekday and between 86 and 451 vph per day (see **Table 5.19**)
- The two-way traffic volumes of Memorial Drive are 32,128 vpd (5 day average) (4.0% heavy vehicles) and 30,562 vpd (7 day average) (3.4% heavy vehicles).

Table 5.19 Hourly traffic volumes - Bellambi Lane east of Princes Motorway

Time	5 Day Average			7 Day Average		
	*West	*East	Total	*West	*East	Total
Midnight – 1am	6	4	10	8	9	17
1am-2am	4	3	7	6	4	11
2am-3am	2	3	5	4	4	7
3am-4am	3	6	9	3	5	8
4am-5am	7	13	19	6	11	17
5am-6am	28	59	87	24	47	71
6am-7am	88	140	228	72	114	186
7am-8am	138	207	345	113	168	281
8am-9am	183	336	519	156	278	434
9am-10am	162	231	393	151	224	374
10am-11am	145	193	339	147	209	356
11am-12 noon	139	190	328	152	208	360
12 noon-1pm	148	173	320	154	179	334
1pm-2pm	152	178	330	155	181	337
2pm-3pm	172	201	373	168	186	354
3pm-4pm	245	268	513	215	237	451
4pm-5pm	265	229	494	232	207	439
5pm-6pm	231	202	433	198	178	376
6pm-7pm	156	133	289	135	123	258
7pm-8pm	94	90	183	82	79	161
8pm-9pm	67	57	124	62	53	116
9pm-10pm	48	43	90	43	43	86
10pm-11pm	30	28	58	32	30	63
11pm-Midnight	14	13	26	16	15	31

Source: Traffic Counts undertaken 2-8 May 2017, Transport and Urban Planning 2017

*Direction of Travel. NB: Hourly directional volumes may not total due to rounding.

[3] Austroads Class 3-12)

Based on the traffic data collected within 15 minute increments, the TTIA adopted the hours of 7.45 am to 8.45 am, and 3.45 pm to 4.45 pm as the AM and PM peak hours for both intersections.

Intersection Performance

The existing operational capacity of the two principal intersections being the Princes Motorway/Bellambi Lane/Colliery Access Road intersection and the Memorial Drive/Bellambi Lane intersection was modelled using the SIDRA 8 software package. The criteria used for assessing intersections controlled by traffic signals are Level of Service, Degree of Saturation and Average Vehicle Delay. **Table 5.20** shows the Level of Service Criteria for intersections as presented in the RMS (formerly RTA) *Guide to Traffic Generating Developments*.

Table 5.20 Level of Service criteria for intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Intersection is oversaturated	Oversaturated, requires other control mode

Source: Table 4.1 Guide to Traffic Generating Developments October 2002

Site observations made during the TTIA confirmed that:

- The Princes Motorway/Bellambi Lane/Colliery Access Road intersection operated as an isolated intersection with variable cycle lengths between 39 seconds and 70 seconds
- The Memorial Drive/Bellambi Lane intersection operated with cycle lengths that varied between 110 seconds and up to 150 seconds, although the higher cycle lengths were not required by the traffic demands at this intersection. The higher cycle lengths appeared to be associated with traffic signal co-ordination with other signalised intersections in Memorial Drive

For the purpose of the traffic modelling a cycle length of 70 seconds was adopted for the Princes Highway/Bellambi Lane/Colliery Access Road intersection and 120 seconds was adopted for Memorial Drive/Bellambi Lane intersection. A network benefit of 10% was adopted for the through lanes in Memorial Drive to account for the benefits of traffic signal co-ordination in Memorial Drive.

The SIDRA modelling of the TTIA identifies the principal intersections as having the following Level of Service.

- Princes Motorway/Bellambi Lane/Colliery Access Road intersection displays Level of Service A (Good) operation with average vehicle delays in the order of 11.0 to 14.4 seconds per vehicle in the AM and PM peak hours.

- Memorial Drive/Bellambi Lane intersection has a Level of Service C (Satisfactory) operation in both AM and PM peak hours with average vehicle delays of 28.4 to 30.3 seconds per vehicle in the AM and PM peak hours.

The RMS recommends Level of Service of D operation or better (i.e. A, B, C or D) is currently achieved at these intersections.

Future Development, Road Network Changes and Traffic Growth

Over the period of the Revised Preferred Project, the TTIA reports:

- traffic growth from developments in this part of the Wollongong Region is expected to be in the order of 1-2% per year over the next 5 - 10 years (i.e. average of 1.5% per year)
- the proposed upgrade plans in the Illawarra Region will not have any traffic impact on the road transport associated with the Revised Preferred Project.

The TTIA considered specific traffic generating developments in the locality (including the Bunnings development), based on the traffic assessment information available at that time.

5.8.2 Traffic Management and Mitigation Measures

The proposed traffic for the Revised Preferred Project represents similar volumes to that of the Russell Vale Colliery when previously operational. This notwithstanding, the following project design improvements and mitigation measures will be implemented for the Revised Preferred Project:

- WCL will review and update the existing Russell Vale Colliery Traffic Management Plan and Drivers Code of Conduct, and implement the updated plan for the Revised Preferred Project.
- Truck movements associated with the Revised Preferred Project will be limited as follows:
  - Coal transport will be limited to an average rate of 16 laden trucks per hour leaving the site between 7.00 am - 6.00 pm Monday to Friday and between 8.00 am - 6.00 pm Saturday, with no haulage on Sunday or Public Holiday; Coal transport may occasionally be required until 10.00 pm Monday to Friday as a result of unexpected Port closures or interruptions. If this is the case, outbound laden truck movements will be further limited to an average of 12 trucks per hour between 6.00pm - 10.00pm, Monday to Friday only.
  - Haulage of reject material from rejects stockpile to the mine portal limited to 7.00 am - 6.00 pm Monday to Friday
  - Maximum of one truck per hour associated with fuel supplies, deliveries, maintenance, etc
- Designated truck parking area on site to prevent queuing of trucks onto the adjoining public road system. All trucks awaiting loading will park in this area with engines switched off.
- Retention of the voluntary speed limit along Bellambi Lane of 50km/hr for all trucks accessing the Colliery, with the continued aim of achieving 95% compliance with the voluntary speed restriction.
- Construction activities, and associated construction traffic, will be undertaken during standard construction hours 7.00 am - 6.00 pm Monday to Friday and 8.00 am - 1.00 pm Saturday. No construction works will be undertaken on Sundays or public holidays.

- WCL will seek to reach agreement with WCC for a road maintenance contribution for the maintenance of Bellambi Lane within 12 months of project approval.

5.8.3 Impact Assessment

Construction Phase

For the purpose of assessing construction phase traffic, the TTIA considered the workforce and associated traffic required for the proposed construction activities as follows:

- 22 workers (i.e. light vehicle trips) arrive between 6.00 am - 7.00 am and departing between 6.00 pm - 7.00 pm
- Up to 8 heavy vehicles per day (i.e. 8 in/8 out) including 2 oversize vehicles per week.

While noting there may be some overlap with operational traffic as the transport of ROM coal is phased in over the initial 12 - 24 months of the Revised Preferred Project, traffic generated during this overlap period would remain below the total traffic generation assessed for the operational phase, which will represent the worst case traffic generation of the Revised Preferred Project for assessment purposes.

Operational Phase

The proposed average traffic generation of the Revised Preferred Project during the operational phase will be as follows for the AM and PM peak hour periods:

- AM (7.45 am - 8.45 am):
  - 17 inbound/17 outbound heavy vehicles (comprising 16 trucks associated with coal transport plus 1 delivery truck)
  - 35 outbound light vehicle trips.
- PM (3.45pm - 4.45pm):
  - 17 inbound/17 outbound heavy vehicle trips
  - 95 outbound light vehicle trips.

The above truck numbers are based on the use of 19 metre articulated vehicles (i.e. semi-trailers, truck and dog trailers). WCL may, in the future, use B double vehicles which will reduce the average number of outbound trucks to approximately 12 laden trucks per hour.

SIDRA traffic modelling was completed with these traffic volumes included for the principal intersections. **Table 5.21** and **Table 5.22** present the results of the SIDRA modelling with and without the traffic of the Revised Preferred Project as well as future growth scenario.

Future modelling of cumulative impacts includes an allowance for an additional 1.5% lineal growth per year up to 2023 to account for background traffic growth and the traffic generation of the Revised Preferred Project.

Table 5.21 SIDRA modelling results for Princes Motorway/Bellambi Lane/Colliery access road intersection

Criteria	Existing		With Revised Preferred Project*		Cumulative Impact (including background traffic growth) *	
	AM	PM	AM	PM	AM	PM
Level of Service	A	A	A	B	A	B
Degree of Saturation	0.277	0.401	0.289	0.420	0.326	0.461
Average Vehicle Delay (secs)	11.0	14.4	11.5	15.3	11.9	15.6

**Source: Transport and Urban Planning (2018) – Tables 4.1 and 4.3*

Table 5.22 SIDRA modelling results for Memorial Drive /Bellambi Lane intersection

Criteria	Existing		With Revised Preferred Project**		Cumulative Impact (including background traffic growth) *	
	AM	PM	AM	PM	AM	PM
Level of Service	B	C	C	C	D	C
Degree of Saturation	0.811	0.704	0.859	0.748	0.924	0.815
Average Vehicle Delay (secs)	28.4	30.3	34.2	33.6	42.7	35.2

**Source: Transport and Urban Planning (2018) – Table 4.2 and 4.4*

Results from this modelling indicate that even when background traffic growth is considered:

- the Princes Motorway/Bellambi Lane/Colliery Access Road intersection would continue to operate at a good Level of Service A/B with low average vehicle delays (11.9 - 15.6 seconds per vehicle)
- the Memorial Drive/Bellambi Lane will operate at a satisfactory Level of Service C/D with average vehicle delays in the order of 35.2 - 42.7 seconds per vehicle.

In order to assess a potential worst-case scenario traffic generation for the Revised Preferred Project, the TTIA assessed intersection performance during periods where an increased number of coal trucks arrive-depart during the peak hours. The TTIA notes that this may occur due to the bunching of arrivals and departures of the trucks, caused by the traffic conditions on the road network and other factors. These higher levels would not occur every hour and every day but may occur from time to time due to a number of coinciding external factors. To account for this worst-case scenario, the TTIA modelled 25 trucks entering and departing the Colliery during the peak AM and PM periods in 2018 and with the cumulative impacts in 2023. The results indicate:

- the intersection of Princes Motorway/Bellambi Lane/Colliery Access Road will continue to operate at a good Level of Service A/B, with average vehicles delays remaining below 15.7 seconds per vehicle
- the Memorial Drive/Bellambi Lane intersection will also continue to operate at a satisfactory Level of Service C in 2018 and C/D in 2023, with average vehicles delays remaining between 34.1 and 34.5 seconds per vehicle in 2018 and between 37.3 and 43.3 seconds per vehicle in 2023.

Road Safety and Other Road Users

The Revised Preferred Project is not expected to have any adverse impacts on road safety on the road network, or on other road users.

While there will be an increase in traffic using the road network due to the Revised Preferred Project, the traffic volumes generated by the Revised Preferred Project will generally be of the same level as previously generated by the colliery. The transport route via Bellambi Lane/Memorial Drive to PKCT uses Bellambi Lane to Memorial Drive and then state arterial roads and motorways. All these roads are approved 25/26 metre B-Double routes.

The principal adjacent intersections to the colliery in Bellambi Lane are signalised and the RMS are proposing phasing changes at the Memorial Drive intersection that will improve the potential safety for vehicles turning right out of the western approach of Bellambi Lane into Memorial Drive to travel south.

Traffic conditions at both these intersections are expected to remain satisfactory over the life of the Revised Preferred Project.

WCL will maintain a voluntary 50km/h speed restriction in Bellambi Lane on all trucks generated by the colliery and will continue to maintain the truck speeds aiming to achieve 95% compliance with the voluntary speed restriction and 100% compliance with the signposted 60km/h speed limit. Compliance will be assessed using GPS monitoring.

Bellambi Lane Pavement

On the basis that WCL contribute towards pavement upgrade and maintenance of Bellambi Lane (as per their previous commitment to do so), any impacts on road pavement resulting from the transport of product from the Revised Preferred Project would be mitigated, should the Revised Preferred Project be approved.

5.8.4 Conclusion

The volume of traffic to be generated by the Revised Preferred Project would be similar to that of the Russell Vale Colliery when previously operating. The TTIA modelled the performance of the two principal intersections of the transport route between the Colliery and PKCT under existing peak hour (AM and PM) traffic conditions, as well as with the addition of average and maximum traffic to be generated by the Revised Preferred Project for both 2018 and 2023. The modelling indicates that these intersections will continue to operate at a satisfactory to good Level of Service with the Revised Preferred Project. Specifically:

- The Princes Motorway/Bellambi Lane/Colliery Access Road intersection would continue to operate at a good level of service (A/B operation) with low average vehicle delays
- The Memorial Drive/Bellambi Lane would continue to operate at a satisfactory Level of service (C/D operation) with average vehicle delays remaining below 43.3 seconds per vehicle.

Based on the controls to be implemented by WCL, and the retention of a satisfactory level of service at the principal intersections, the Revised Preferred Project is unlikely to result in an adverse impact on road safety, the road network or road users. The proposed contribution to the maintenance of Bellambi Lane would further mitigate any impacts of the Revised Preferred Project on the condition of this local road.

5.9 Land Resources

5.9.1 Existing Environment

The Russell Vale Colliery is located on the lower slopes of the Illawarra Escarpment above the suburb of Russell Vale (refer to **Figure 1.4**). The Pit Top facilities occupy an area of approximately 100 hectares (ha) at the eastern extent of the Colliery holdings. The Colliery holdings extend to the west of the Escarpment across a large tract of undeveloped bushland within the Sydney Drinking Water Catchment boundary and encompassing the Cataract Reservoir. The UEP Application Area is located entirely within the headwaters of the Cataract River and the Cataract Reservoir and predominantly within the catchment of Cataract Creek. Surface features include sections of rainforest in the valleys, a variety of upland swamps located mainly on the valley sides, Cataract Reservoir and numerous sandstone rock formations associated with the Hawkesbury Sandstone outcrop on the upper slopes. The surface is traversed by the Mount Ousley Road and a number of high-voltage power transmission lines.

According to the *Wollongong-Port Hacking 1:100,000 Soil Landscape Series Sheet 9029-9129*, soil landscapes (and therefore soil properties) within the UEP Application Area are variable depending on topography. The Russell Vale Pit Top is located within the Illawarra Escarpment soil landscape (refer to **Figure 5.13**). The Warragamba and Hawkesbury soil landscapes occur to the west of the Escarpment and the Lucas Heights and Maddens Plains soil landscapes occur to the east of Cataract Reservoir. A small area of the Gymea soil landscape occurs along the north-eastern edge of Cataract Reservoir. The Bundeena soil landscape is present along Bellambi Creek.

Elevation at the lip of the escarpment is approximately 400 mAHD. The land slopes steeply from the top of the escarpment to the Russell Vale Pit Top offices which are at approximately 140 mAHD. From here the terrain slopes relatively gently to the coast to the east. The processing area is located on relatively flat land which has been modified by historical earthworks and establishment of infrastructure and bunds, and ranges in elevation from approximately 30 to 70 mAHD.

The Russell Vale Pit Top lies within the Illawarra Escarpment soil landscape (refer to **Figure 5.13**) on land of limited capability for agricultural production due to severe slope limitations and rock outcrops. Mass movement and rock fall hazards are characteristic of the Illawarra Escarpment landscape.

The Russell Vale Pit Top is adjoined by Low Density Residential, Light Industrial and Main Roads zones. The site has been used for mining-related activities since the mid-19th century.

umwelt

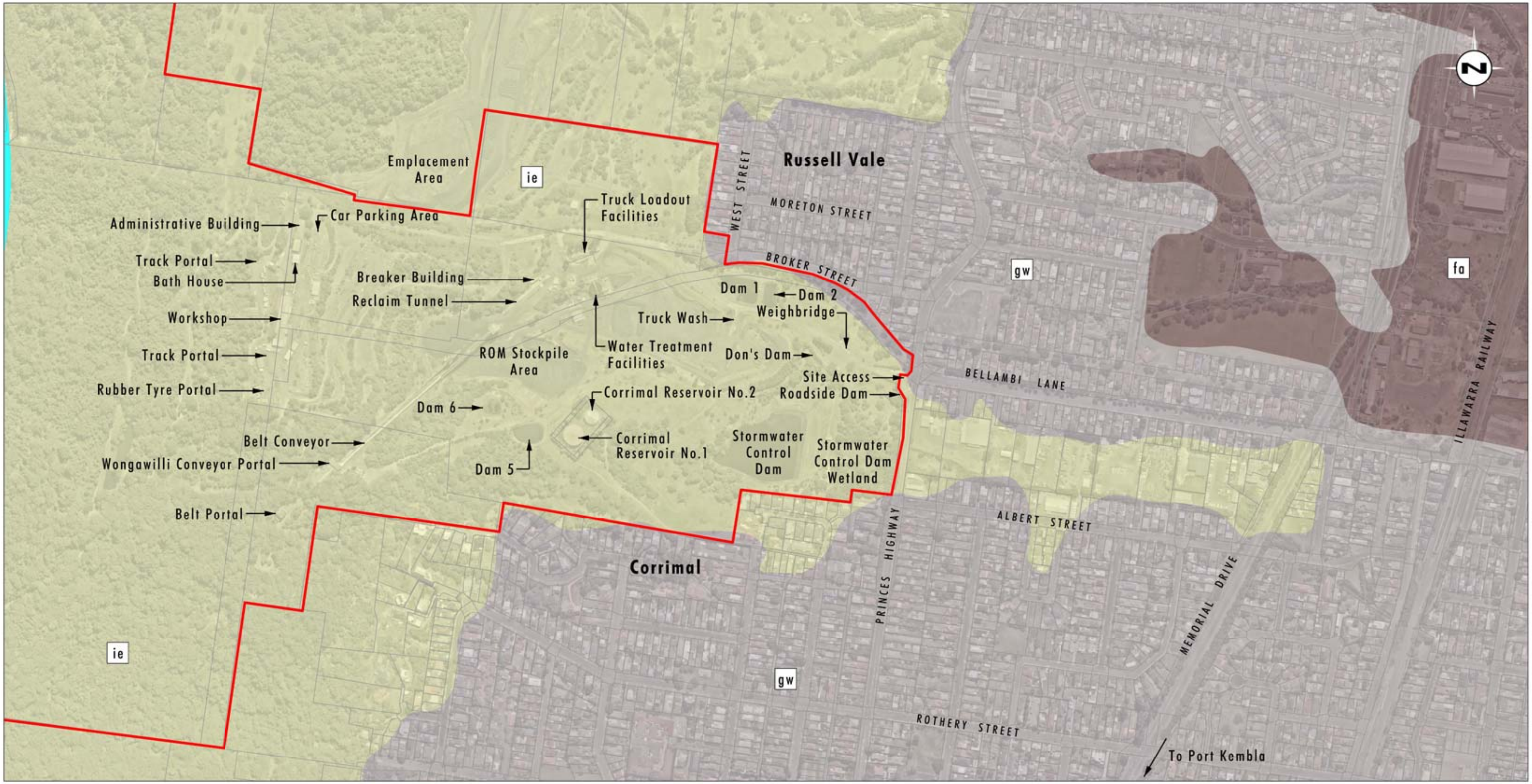

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

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Legend

UEP Project Application Area

Soil Landscapes:

- Fairy Meadow (fa)
- Gwynneville (gw)
- Illawarra Escarpment (ie)
- Warragamba

FIGURE 5.13

Soil Landscapes Russell Vale Pit Top

File Name (A4): R05/3687_051.dgn
20181220 11.22

5.9.2 Potential Impacts on Land Resources

As discussed in **Section 5.1.1** the proposed underground mining method comprises first workings that are not predicted to have any perceptible impact on natural surface features. The Revised Preferred Project will therefore not result in any significant subsidence related impacts on land resources and no subsidence remediation works are likely to be required as a result of the Revised Preferred Project.

Construction of new surface infrastructure will be restricted to areas of previous disturbance within the existing Pit Top, this includes construction of the Processing Plant, associated infrastructure and extension to bunds surrounding the Pit Top. These works will all occur within the existing disturbance footprint of the Russell Vale Pit Top, therefore no additional impacts on land resources will occur.

5.9.3 Compatibility with Surrounding Land Uses

Mining at the Russell Vale Colliery has been undertaken since 1887. Over time, urban development has encroached on the Russell Vale Pit Top and these facilities are now bordered by residential land uses. Russell Vale Colliery has therefore coexisted with these neighbouring land uses over an extended period with a degree of impact on the amenity of these residential land uses. Key elements of the Revised Preferred Project have been designed to minimise impacts on these surrounding land uses, including substantial noise mitigation works around the Pit Top to reduce noise impacts on surrounding residents and controls on the speed and timing of trucks entering and leaving the site.

As discussed in **Section 5.1.1** the proposed first workings mine plan is not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs (including the Illawarra Escarpment), steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. The Revised Preferred Project is therefore unlikely to have any adverse impact on current surrounding or overlying land uses as a result of subsidence.

5.10 Visual Amenity

The following aspects of the Revised Preferred Project have the potential to change the existing visual amenity of the local area:

- earthworks required to increase the height of existing bunds surrounding the Russell Vale Pit Top
- changes to the Pit Top layout in order to maximise topographic shielding of plant
- construction of coal processing infrastructure within the Pit Top area
- continued use of night lighting at the Pit Top.

It is important to note that the proposed changes to the Pit Top layout and bund heights have been specifically designed to maximise topographic shielding between the Pit Top facilities and surrounding residences in order to reduce potential line of site to this infrastructure. These changes have the effect of minimising both noise and potential visual amenity impacts to surrounding residences.

Due to the nature of the proposed first workings mining, there is negligible potential for visual impacts associated with subsidence or subsidence remediation works, as a result of the Revised Preferred Project.

5.10.1 Existing Landscape Setting

Regional Setting

The visual landscape is characterised by the steep slopes of the Illawarra Escarpment and the urban development on the lower slopes at the base of the escarpment. Large areas of undeveloped, densely vegetated land are located west of the Illawarra Escarpment, along with transport and utilities infrastructure, waterbodies and other mining related infrastructure. The escarpment itself is a highly visible landscape regionally and of high scenic quality. To the east of the escarpment, the landscape slopes gently to the coastline and is dominated by residential suburbs, commercial and industrial land-uses and supporting infrastructure.

Russell Vale and Local Setting

The Russell Vale Colliery sits at the foot of the Illawarra Escarpment, against the backdrop of its steep and densely vegetated slopes. The local topography of the site ranges from the steep slopes and cliff faces of the Illawarra Escarpment to the west of the Pit Top facilities, to gentle undulating slopes at the base of the escarpment which transition into the residential areas of Russell Vale and Bellambi. Neighbouring residential properties directly north, east and south of the Colliery are located on gently sloping land.

As discussed in **Section 5.9.3**, the Russell Vale Colliery has been in operation at the site since the 1880s and over that time, urban development has encroached on the Russell Vale Pit Top. The Pit Top is now bordered by residential land uses to the north, east and south. Mining related infrastructure has been a feature of the visual landscape for over 120 years and these surrounding land uses have developed in the context of this existing land use.

Visibility of the site

The Russell Vale Pit Top area is predominately cleared and re-contoured undulating land with vegetation (mainly mature trees) bordering the north, east and southern site boundary. Residential properties border the north, east and southern site boundary. Direct views onto the site are possible from some residential locations however a combination of topography, vegetated bunds and mature screening vegetation generally obscures views of the active Pit Top areas for the majority of residences surrounding the site.

Views from a number of viewpoints surrounding the site are demonstrated in **Plates 1 to 9**. The location of these viewpoints is shown on **Figure 5.14**. These views demonstrate that some existing mining related infrastructure is visible in the residential areas surrounding the site, such as the disused surge bin and administration building (as illustrated on **Plates 4 and 8**), however much of the site remains obscured by topography or vegetation. The Pit Top area is generally not visible from publicly accessible areas or public roads, including Bellambi Lane and the Princes Highway, as illustrated on **Plates 5 and 6**.

Visibility of the site increases in the south-eastern corner, as screening vegetation is reduced, and surface elevations slope away to the east and south-east. Limited views of the administration building are possible from these locations (**see Plate 8**). However, views of the tripper system, ROM stockpile and coal loading facilities from these areas are not available due to distance, topography and screening vegetation.

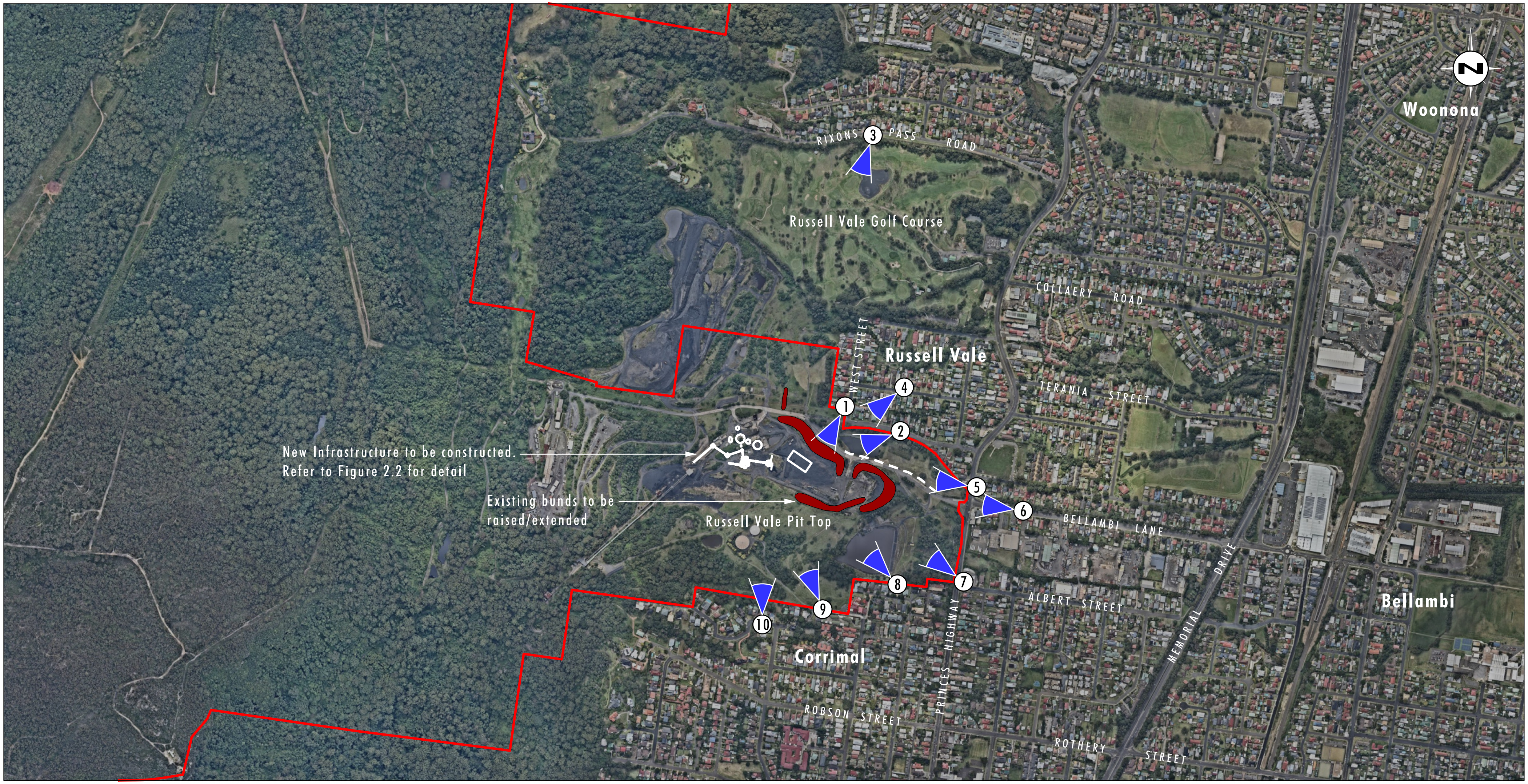

Image Source: Nearmap (Mar 2019)

0 250 500 750m
1:15 000

Legend

- UEP Project Application Area
- Representative Viewpoint Location
- Existing bund to be raised/extended

FIGURE 5.14

Representative Viewpoints surrounding the Russell Vale Pit Top

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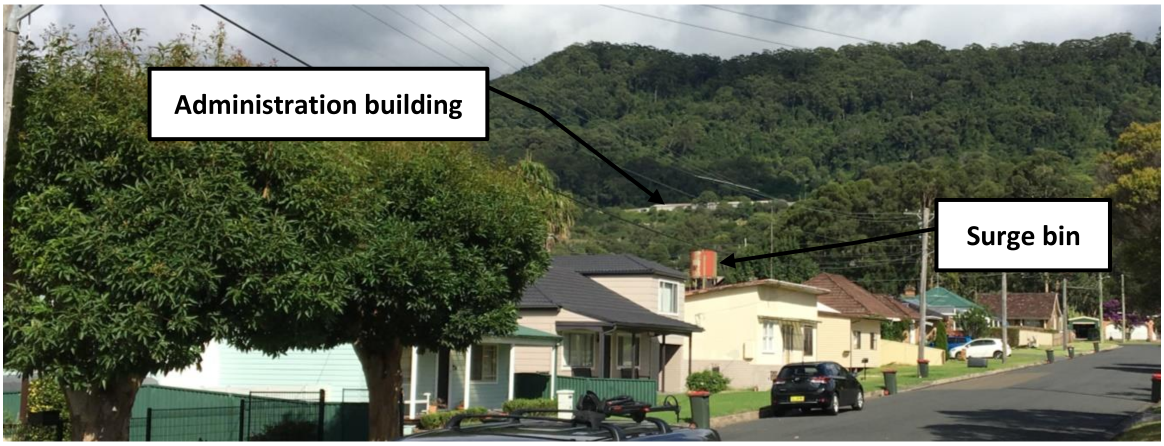
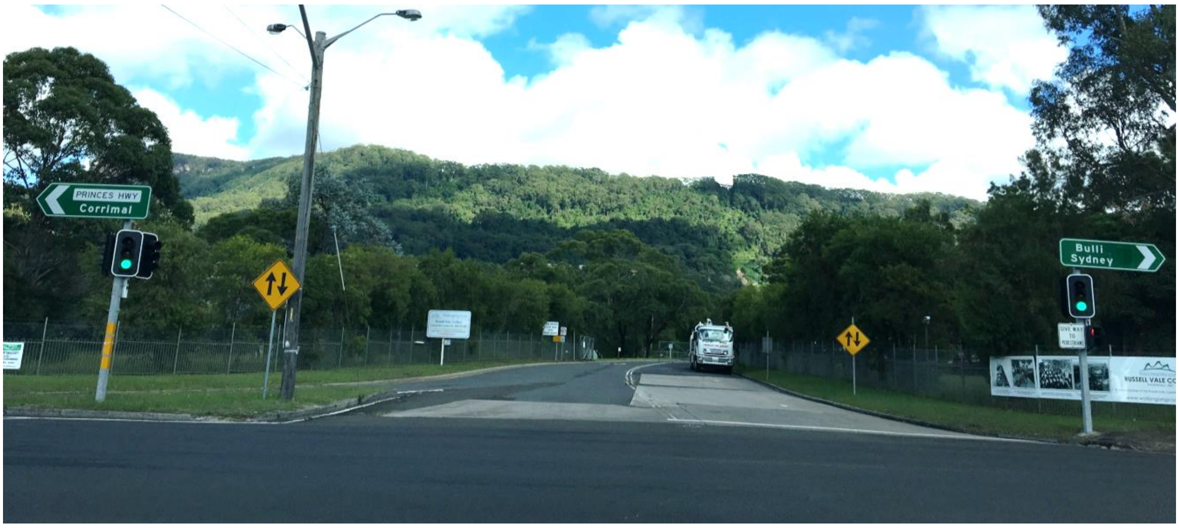
■ Plate 1 – View towards the Pit Top facilities area from West Street

■ Plate 2 – View towards the Pit Top facilities area from Broker Street.

■ Plate 3 – View towards to the Pit Top facilities from Rixons Pass Road.



■ Plate 4 – View from Moreton Street towards the Pit Top facilities, with the surge bin and administration building visible in the background.



■ Plate 5 – View towards the Russell Vale Colliery, from the Princes Highway / Bellambi Lane intersection.

■ Plate 6 – View towards the Pit Top facilities, from the corner of the Princes Highway and Albert Street

■ Plate 7 – View from Midgley Street towards the Pit Top facilities.

■ Plate 8 – View from Wilford Street towards the Pit Top facilities, with the administration building slightly visible in the background.

■ Plate 9 – View from Lyndon Street, towards the Pit Top facilities.

5.10.3 Assessment of Impacts

Bund Construction

As discussed in **Section 2.2.1**, the existing bunds surrounding the Pit Top will be raised in order to improve noise mitigation from site operations. This will result in temporary views of earthworks and associated mobile equipment for residences surrounding the site. It is important to note that once complete, these bunds will act to further limit views of the Pit Top and site operations from surrounding locations in the medium and long term.

Once the final bund heights are achieved, the bunds will be progressively rehabilitated, spread with topsoil and planted with a selection of native species.

Coal Handling Infrastructure

The Revised Preferred Project proposes changes to the Pit Top layout to strategically relocate infrastructure to more shielded locations. For example, the existing surge bin will be replaced and relocated from its current exposed location (shown in **Plate 4**) to the toe of a batter. The proposed Coal Processing Plant and associated infrastructure will also be sited to maximise shielding provided within the site (refer to **Figure 2.2**).

This design work, in combination with the proposed extension to the height of existing bunds, will assist in minimising the visual amenity impacts of the existing and proposed operation.

Night Lighting

While coal beneficiation and coal transport activities will not be undertaken during the night-time period, lighting will continue to be required on site to meet maintenance and safety requirements. Lighting will be kept to a minimum, directed away from surrounding residences and will be maintained in accordance with the relevant Australian Standard (*Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*).

5.10.4 Visual Mitigation and Management Measures

WCL will implement the following measures to improve the visual amenity of the site and minimise the visual impact of the Revised Preferred Project:

- Bunds surrounding the Pit Top will be progressively rehabilitated, spread with topsoil and planted with a selection of native species as soon as practical once final bund height is achieved
- Existing vegetation outside the Pit Top disturbance area will be regularly maintained and supplemented or replaced, if necessary, to maintain visual screening
- Areas of disturbance will be kept to the minimum practicable and rehabilitated as soon as practical
- Proposed coal handling infrastructure will be coloured in non-reflective natural tones to minimise contrast against the surrounding environment
- all outdoor lighting will be installed and operated in accordance with *Australian Standard AS4282 (INT) 1995 – Control of the Obtrusive Effects of Outdoor Lighting*, including measures such as directing lighting downwards towards work areas and not toward private residences and roads, and where appropriate, using shields to limit the emission of light off site.

5.11 Hazard and Risk

A preliminary risk screening has been completed for the Revised Preferred Project in accordance with *State Environmental Planning Policy No 33 – Hazardous and Offensive Development* (DoP, 1992) (SEPP 33), and *Applying SEPP 33* (DoP, 2011).

The preliminary risk screening involves identification and assessment of the storage of specific dangerous goods classes that have the potential for significant off-site effects. If, at the proposed location, and in the presence of controls, the risk level exceeds the acceptable criteria for impacts on the surrounding land use, the development is classified as a 'hazardous' and/or 'offensive' industry and may not be permissible within certain land zones in NSW.

A 'hazardous industry' under SEPP 33 is one which, when all locational, technical, operational and organisational safeguards are employed, continues to pose a significant risk. An 'offensive industry' is one which, even when controls are used, has emissions that result in a significant level of offence e.g. odour or noise emissions. A proposal cannot be considered either hazardous or offensive until it is firstly identified as 'potentially hazardous' or 'potentially offensive' and subjected to the assessment requirements of SEPP 33. A Preliminary Hazard Analysis (PHA) is required if a proposed development is potentially hazardous.

A proposed development may also be potentially hazardous if the number of traffic movements for the transport of hazardous materials exceeds the annual or weekly criteria outlined in *Table 2 of Applying SEPP 33* (DoP, 2011). If these thresholds are exceeded, a route evaluation study is likely to be required.

5.11.1 Preliminary Risk Screening

Preliminary risk screening is undertaken to determine if a PHA is required. The preliminary risk screening compares the hazardous material storage quantities for the proposed development, as well as transport quantities and frequency, with the screening thresholds in SEPP 33. If any of the screening thresholds are determined to be exceeded, the proposed development should be considered potentially hazardous and SEPP 33 will apply (DoP, 2011).

Table 5.23 provides an indicative list of the hazardous materials to be stored at the Russell Vale Colliery, dangerous goods class of the material, indicative storage quantity and the respective SEPP 33 screening threshold. The hazardous materials to be stored at the site with the greatest inventory is Class C1 combustible liquid (diesel fuel). Lesser quantities of Class C2 combustible liquids (engine and hydraulic oils) as well as minor quantities of Class 3 flammable liquids (solvents and paints), Class 2.1 flammable gases (cutting gases and aerosols) and Class 8 corrosive materials (cleaning products) will be stored in the workshop and store. Hydraulic fluid (Solcenic) will also be stored at the site; however, this material is not classified as a dangerous good with respect to the *Australian Code for the Transport of Dangerous Goods by Road and Rail*. All materials listed in **Table 5.23** will be stored within the Russell Vale Pit Top area.

Table 5.23 demonstrates that the hazardous materials to be stored at the site are below the SEPP 33 screening threshold. As such, a PHA is not required to be undertaken for the Revised Preferred Project with respect to hazardous materials storage.

Table 5.24 presents the expected transport movements for hazardous materials and the SEPP 33 transportation screening thresholds. The number of transport movements for the hazardous materials will not exceed either the weekly or annual transport frequency screening thresholds. As such, a transport route evaluation study is not required to be undertaken for the Revised Preferred Project.

5.11.2 Flammable and Combustible Liquids Storage and Handling

All Class 3 flammable and Class C1 and C2 combustible liquids to be stored at the site will be stored in accordance with AS1940 – 2017 *The storage and handling of flammable and combustible liquids* (AS1940). The existing bulk diesel tank bund is approximately 35 m^3 which is greater than 110% of the tank capacity (25 m^3) and therefore has adequate capacity with respect to AS1940.

Table 5.23 Hazardous Material Inventory

Material	Storage Type	ADG Code[1] Class (PG)	Estimated Revised Preferred Project Storage Capacity (kg)	Screening Threshold (kg)	Trigger SEPP 33
Diesel	Above Ground Tank	C1	21,000	-[2]	NA
Engine and Hydraulic Oil	Drums/IBCs	C2	<5,000	-[2]	NA
Paints and Solvents	Packages	3 (II)	<1,000	5,000	No
Acetylene	Cylinders	2.1	<100	100	No
Aerosols	Cans	2.1	<100	100	No

1. ADG Code – Australian Dangerous Goods Code
2. No SEPP 33 quantity screening thresholds for these materials

Table 5.24 Transportation Screening Threshold

Material	ADG Code[1] Class (PG)	Bulk or Package	Estimated Project Vehicle Movements		Maximum Project	Vehicle Movement Screening Threshold		Minimum Quantity (kg)
			Cumulative Annual	Peak Weekly		Annual	Weekly	
Diesel	C1	Package	12	1	-[2]	-[2]	-[2]	-[2]
Engine and Hydraulic Oil	C2	Package	12	1	-[2]	-[2]	-[2]	-[2]
Paints and Solvents	3 (II)	Package	12	1	200	>1,000	>60	10,000
Flammable Gases	2.1	Cylinders and Cans	12	1	100	>500	>30	5,000

1. ADG Code – Australian Dangerous Goods Code
2. No SEPP 33 quantity screening thresholds for these materials

5.12 Greenhouse Gas and Energy

A Greenhouse Gas and Energy Assessment (GHGEA) for the Revised Preferred Project was prepared by Umwelt. This section sets out the key findings of the assessment with the full report provided in **Appendix 8**.

5.12.1 Context

Three 'Scopes' of emissions (Scope 1, Scope 2 and Scope 3) are defined for GHGEA accounting and reporting purposes as prescribed by relevant guidelines (refer to GHGEA in **Appendix 8**). These scopes are briefly outlined below.

Scope 1 emissions are direct emissions which occur from sources owned or controlled by the reporting entity, over which they have a high level of control (such as fuel use).

Scope 2 emissions are those generated from purchased electricity consumed by the reporting entity, which can be easily measured and can be influenced through energy efficiency measures. Scope 2 emissions physically occur at the facility where electricity is generated.

Scope 3 emissions are indirect emissions that are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another reporting entity. Scope 3 emissions are only estimates and may have a relatively high level of uncertainty, unreliability and variability.

5.12.2 Methodology

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the *National Greenhouse Accounts (NGA) Factors 2017* (DEE 2017). Fugitive emissions have been calculated using the Method 1 approach, as described in the *National Greenhouse Accounts (NGA) Factors 2017* (DEE 2017).

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 2017* (DEE 2017).

5.12.3 Estimated Greenhouse Gas Emissions and Energy Use

Greenhouse gas and energy use estimates have been calculated for the operational stage of the Revised Preferred Project and are discussed in this section.

Predicted Greenhouse Gas Emissions

The Revised Preferred Project's life of mine (LOM) greenhouse gas emissions are summarised in **Figure 5.15**.

LOM forecasts are based on the Revised Preferred Project recovering approximately 3,700,000 ROM tonnes and extending the life of mine by five years.

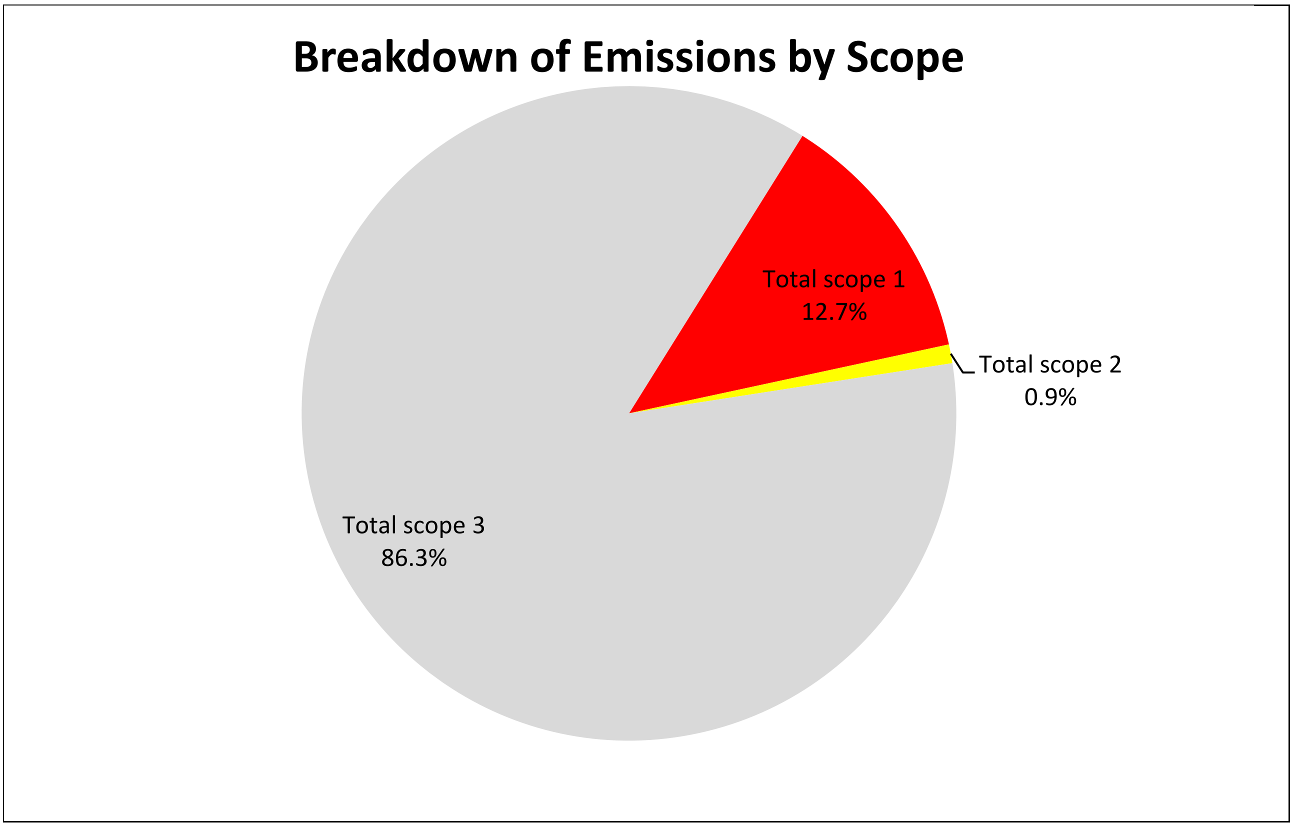


Figure 5.15 Breakdown of Emissions by Scope

Scope 1 emissions from the Revised Preferred Project relate primarily from the combustion of diesel and release of fugitive emissions. Fugitive emissions result from the release of gas stored in the materials mined (primarily carbon dioxide and methane). The Revised Preferred Project is forecast to generate approximately 1,419,000 t CO2-e of Scope 1 emissions during its operational phase. Annual average Scope 1 emissions are forecast at approximately 284,000 t CO2-e per annum.

Scope 2 emissions are those emissions associated with the production of electricity used by the Revised Preferred Project. These emissions occur at the point of energy generations, not at the mine site. The Revised Preferred Project is forecast to be associated with approximately 21,000 t CO2-e per annum during its operation phase.

The Revised Preferred Project is forecast to be associated with approximately 9,624,000 t CO2-e of Scope 3 emissions during its operation phase. Scope 3 emissions will be generated by third parties who transport and consume coal products. Annual average Scope 3 emissions are forecast at approximately 1,925,000 t CO2-e per annum.

Figure 5.15 demonstrates that the Revised Preferred Project's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 86% of the Revised Preferred Project's greenhouse gas emissions occur downstream of the Revised Preferred Project. Approximately 14% of the greenhouse gases associated with the Revised Preferred Project are related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions).

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Revised Preferred Project. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

Energy Use

The Revised Preferred Project is forecast to require approximately 537,000 Gigajoules (GJ) of energy from diesel and grid electricity. The Revised Preferred Project is expected to use approximately 108,000 GJ per annum.

The industry average energy use for underground coal mines in Australia ranges between 140 and 490 Megajoules (MJ)/Product tonne (Energetics 2009). The Revised Preferred Project is forecast to operate with an average energy use intensity of approximately 162 MJ/Product Tonne. The forecast energy use intensity of the Revised Preferred Project is within the normal operating range for Australian underground coal mines.

5.12.4 Assessment of Impacts

This section provides an assessment of the potential environment impacts and impacts on policy objectives as a result of the Revised Preferred Project.

Impact on the Environment

The Revised Preferred Project's GHG emissions will be highly mobile and generated across multiple policy jurisdictions along the product value chain. The accumulation of GHG or carbon in 'carbon sinks' is the primary impact of GHG emissions. Anthropogenic GHG 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 GHG 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 GHG in the ocean is also an important driver of ocean acidification (IPCC 2013).

As noted in **Section 5.12.3**, the Revised Preferred Project's direct emissions (Scope 1) are forecast to be approximately 284,000 t CO2 –e per annum. To put the Revised Preferred Project'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 Revised Preferred Project will contribute approximately 0.0005% to global emissions per annum (based on its projected Scope 1 emissions). The relative environmental impact of the Revised Preferred Project is likely to be relative to its proportion of global GHG emissions.

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 GHG 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.

A qualitative assessment of climate change requires a regional reference and future emission trajectory assumptions. The Revised Preferred Project, 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 Revised Preferred Project 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.

Impact on Policy Objectives

Australian Targets

As discussed in **Appendix 8**, in order for Australia to achieve its commitment to the Paris Agreement of a 28% reduction in GHG emissions by 2030, the Department of Environment and Energy (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 Revised Preferred Project). It is difficult to determine whether the Revised Preferred Project'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 Revised Preferred Project's emissions will inflate 2030 projections.

If as a worst case, it is assumed that the none of the Revised Preferred Project's Scope 1 emissions have been included in DoEE's forecast (and all other assumptions hold true), then the Revised Preferred Project's cumulative Scope 1 emissions (1,419,000 t CO_2-e) will increase the required national mitigation effort by approximately 0.19 %.

The Revised Preferred Project may increase the national effort required to reach Australia's 2030 GHG mitigation target, however, the Project 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 Revised Preferred Project's Scope 2 and 3 emissions will be generated by Australian facilities and/or in international jurisdictions with environmental approval to generate GHG emissions.

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 5.25**.

Table 5.25 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

Policy Direction	Rationale/Goals
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 Revised Preferred Project is unlikely to affect the objectives of the NSW Climate Change Policy Framework in a material way.

5.12.5 Management and Mitigation Measures

WCL will review and update the Greenhouse Gas Management Plan to consider both the construction and operational phase of the Revised Preferred Project.

WCL will continue to seek operational energy use efficiencies where commercially feasible and will review renewable energy opportunities as new technology is developed and becomes viable.

5.12.6 Conclusion

The Revised Preferred Project is a small-scale coal operation that will produce energy commodities over 5 years. The Revised Preferred Project's forecast energy use intensity is considered to fall within the normal operating range for an Australian underground coal mine and expected to generate approximately 1,523,000 t CO2-e of Scope 1 and 2 emissions.

The Revised Preferred Project is also forecast to be associated with approximately 9,624,000 t CO2-e of Scope 3 emissions. The Revised Preferred Project's Scope 3 emissions are beyond the operational control of WCL, and the majority of Scope 3 emissions will be generated downstream of the Revised Preferred Project, when coal products are combusted to produce coke.

5.13 Social Impact and Opportunities Assessment

A detailed Social Impact and Opportunities Assessment (SIOA) for the Revised Preferred Project was prepared by Umwelt. This section sets out the key findings of the assessment with the full report provided in **Appendix 9.**

Engagement with the community has been a key component of the updated environmental assessment and SIOA (refer to **Section 4.1**). As part of the SIOA programme, stakeholders were engaged through a wide range of mechanisms including the use of one-on-one interviews, community information sessions, newsletters, focus groups, surveys and community group meetings (refer to **Section 4.1**).

5.13.1 Methodology

SIOA 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 SIOA 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 SIOA program was designed to identify, assess and address the potential social impacts of the Project on neighbouring and local communities, and more specifically to:

- profile key communities in proximity to, and associated with, the Revised Preferred Project
- identify potential social impacts and opportunities associated with the Revised Preferred Project on these communities, including consideration of cumulative impacts
- develop strategies to address significant identified impacts and opportunities,
- ensure effective integration of study outputs with other environmental assessment studies to inform broader design and planning
- monitor and manage social impacts associated with the Revised Preferred Project, should the project be approved.

A wide range of assessment methods have been used to develop a detailed understanding of current interactions between the existing mine and local communities and to identify potential social impacts that may be associated with the Project. A summary of the methods and approaches adopted in the assessment are presented in **Table 5.26.**

Table 5.26 Summary of Social Impact and Assessment and Engagement Methods

Phase	Engagement Method
Phase 1 – Program Planning	Development of a stakeholder engagement strategy for the Revised Preferred Project.
Phase 2 – Community Profiling	Review of secondary data sources e.g. census, social and community indicators, historical accounts of the region, local media sources; and collection of primary data through face to face interviews with key stakeholders.
Phase 3 – Scoping of Issues and Opportunities	Review and analysis of previous stakeholder consultation outcomes and complaints data from the Russell Vale operations and other relevant assessment studies to obtain an understanding of perceived issues and opportunities in the locality. Face to face meetings with proximal neighbours of the Project to identify perceived issues and opportunities, followed by ranking of perceived issues and opportunities relative to frequency of response. Briefings with relevant non-government organisations, business and community groups, and other interested stakeholders, to identify perceived Project issues and opportunities.

Phase	Engagement Method
Phase 4 – Assessment of Impacts and Opportunities	Assessment of the social risks and prediction of social impacts associated with the Project. During this phase, a further round of community engagement was conducted
Phase 5 – Prediction of Impact and Strategy Development	Identification and development of appropriate strategies to address predicted Project impacts and to monitor change.

5.13.2 Community Engagement

Engagement with the community has been a key component of the SIOA and the various assessment studies and is described in detail within **Section 4.1**.

Community engagement has been used to obtain a comprehensive understanding of the issues and perspectives of neighbouring landholders in proximity to the Russell Vale Colliery and other key stakeholders with an interest in the UEP; and has been structured at key phases of the assessment program.

Specific engagement techniques that have been utilised include:

- personal interviews with near neighbours and landholders to outline key aspects of the Revised Preferred Project and document issues and opportunities
- personal meetings with key regional stakeholders drawn from across key community service sectors (including education, local business and community groups) in Russell Vale and Corrimal
- project briefings provided to group members of the Illawarra Residents for Responsible Mining (IRRM) 26 June 2017 and 22 May 2019, as well as the Knitting Nannas Against Greed (KNAG) on 22 May 2019
- regular briefings and presentation of progress on the updated environmental studies at CCC meetings, including a project briefing and presentation on 6 June 2017 and 21 May 2019
- provision and distributed of two Community Information Sheets summarising key aspects and progress/outcomes of the environmental and social assessment program to neighbouring community and relevant stakeholders
- meetings with relevant local, State and Commonwealth government organisations and representatives to provide updates on the Revised Preferred Project and discuss other relevant project and assessment matters
- facilitation of a community information drop-in session to present the Revised Preferred Project and document perceived community issues and opportunities
- publication of relevant Project information on WCL's website.

5.13.3 Perceived Issues and Opportunities

A key component of the SIOA is understanding, from a community perspective, the perceived impacts and opportunities associated with the Revised Preferred Project, as well as identifying broader community values and land uses associated with the assessment area.

Issues and concerns of importance within the community, as relevant to the Revised Preferred Project, were identified through analysis of materials from the previous UEP PAC processes and through direct engagement with potentially affected stakeholders as described in **Section 4.1**.

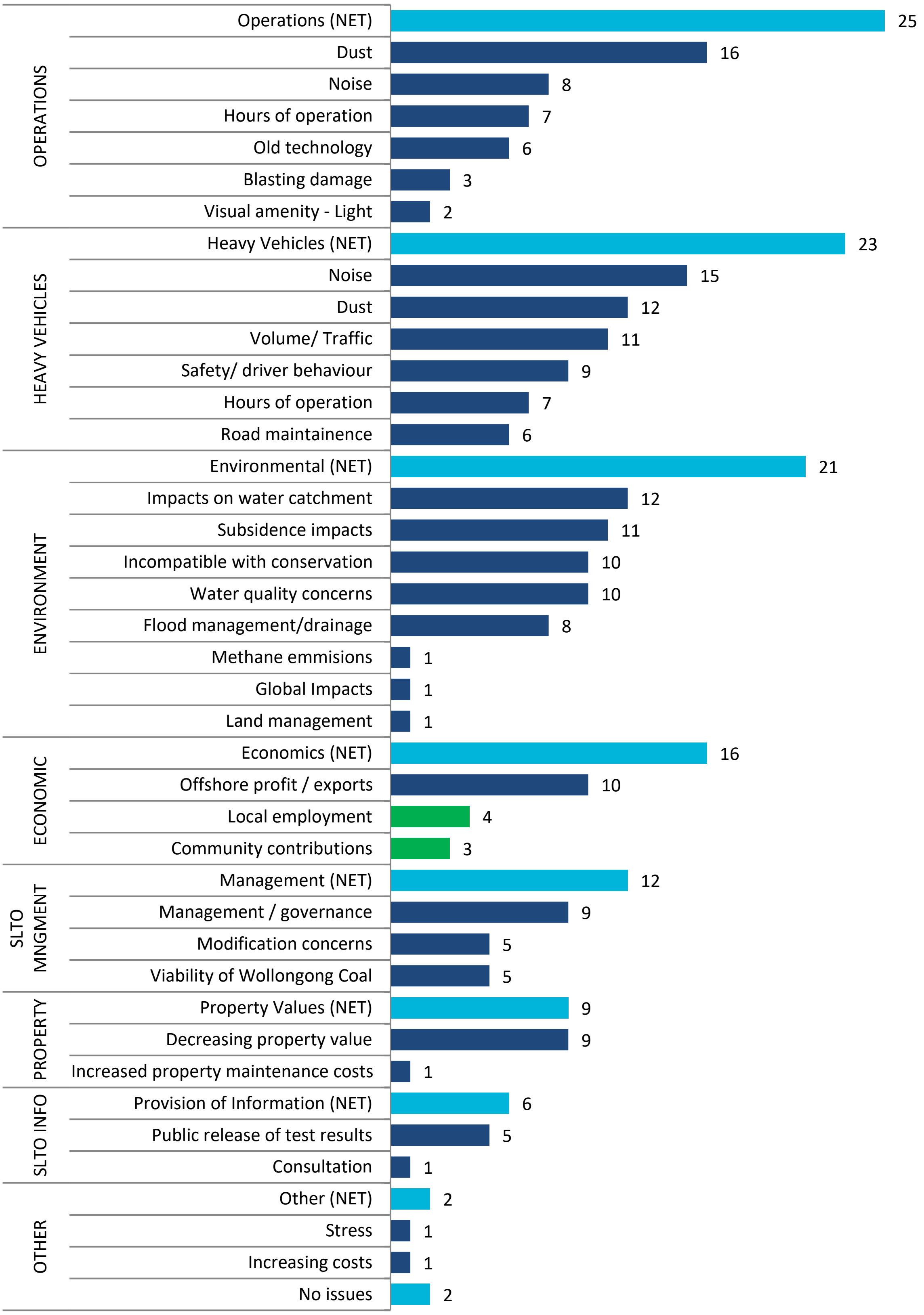
As part of the engagement process, all participants were asked a range of questions that related to their perception of WCL, their history with the Russell Vale mine operation, perceived issues/impacts of the Project and suggested mitigation measures. The following sections outline the results of this aspect of the engagement.

Phase 1 Engagement - Issues and Impact Feedback

Feedback received as part of the Phase 1 community engagement were categorised into 37 different categories and 6 overarching themes, including:

1. Operational (i.e. issues related to the operation of the mine);
2. Heavy vehicles (i.e. issues in relation to the use of heavy vehicles (trucks) in and around the operation);
3. Environmental (i.e. issues around the potential impacts on the environment);
4. Economic concerns (issues around the economic impacts of the Revised Preferred Project);
5. Property values (i.e. concerns about decreased property values and increased property maintenance costs);
6. Provision of information (i.e. timing of public consultation and provision of test results to the community).

The frequency of the above themes is shown in **Graph 5.1**, with the green bars indicating perceived positive impacts and dark blue bars indicating perceived negative impacts. There were also two participants that indicated that they had no concerns with the Revised Preferred Project.

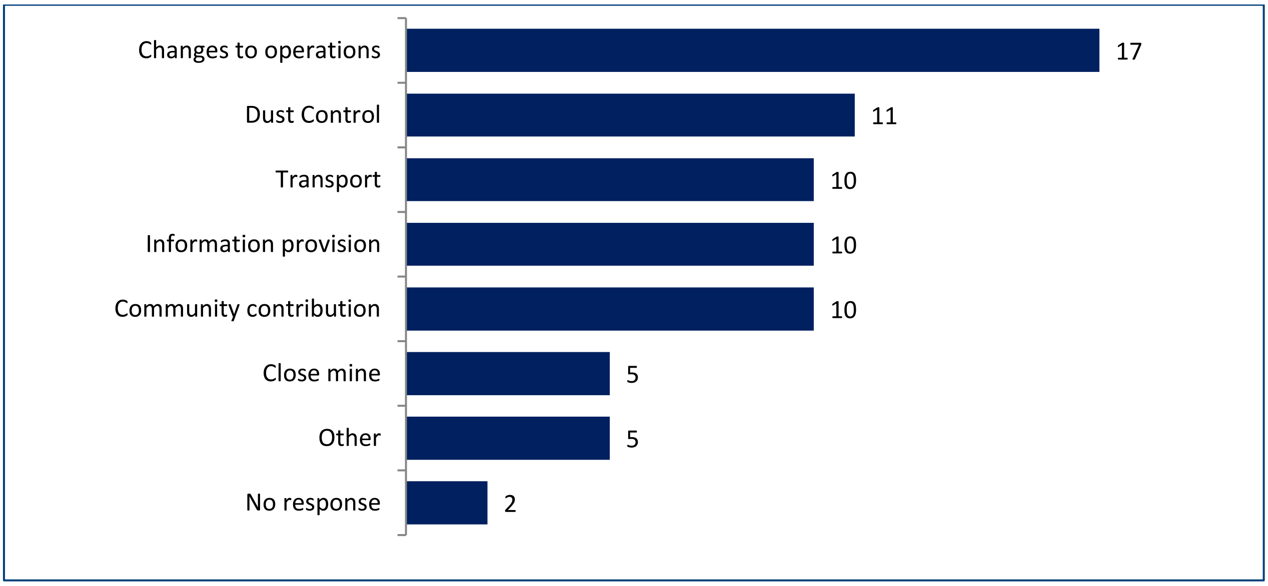


Graph 5.1 Phase 1 – Perceived social impacts (frequency)

Stakeholders were also asked to suggest mitigation measures that could be employed by the company to address the impacts that they had raised. The following range of suggestions were provided as illustrated in **Graph 5.2**:

- Changes to operations
- Dust control
- Transport related mitigation
- Information provision
- Community contribution.

In addition, five participants felt that the only solution was to close the mine and a further five responses have been categorised as ‘other’. These included ‘build trust by doing the right thing’, put up walls to filter noise, fix drainage, consider gas offset and create shields for lights.

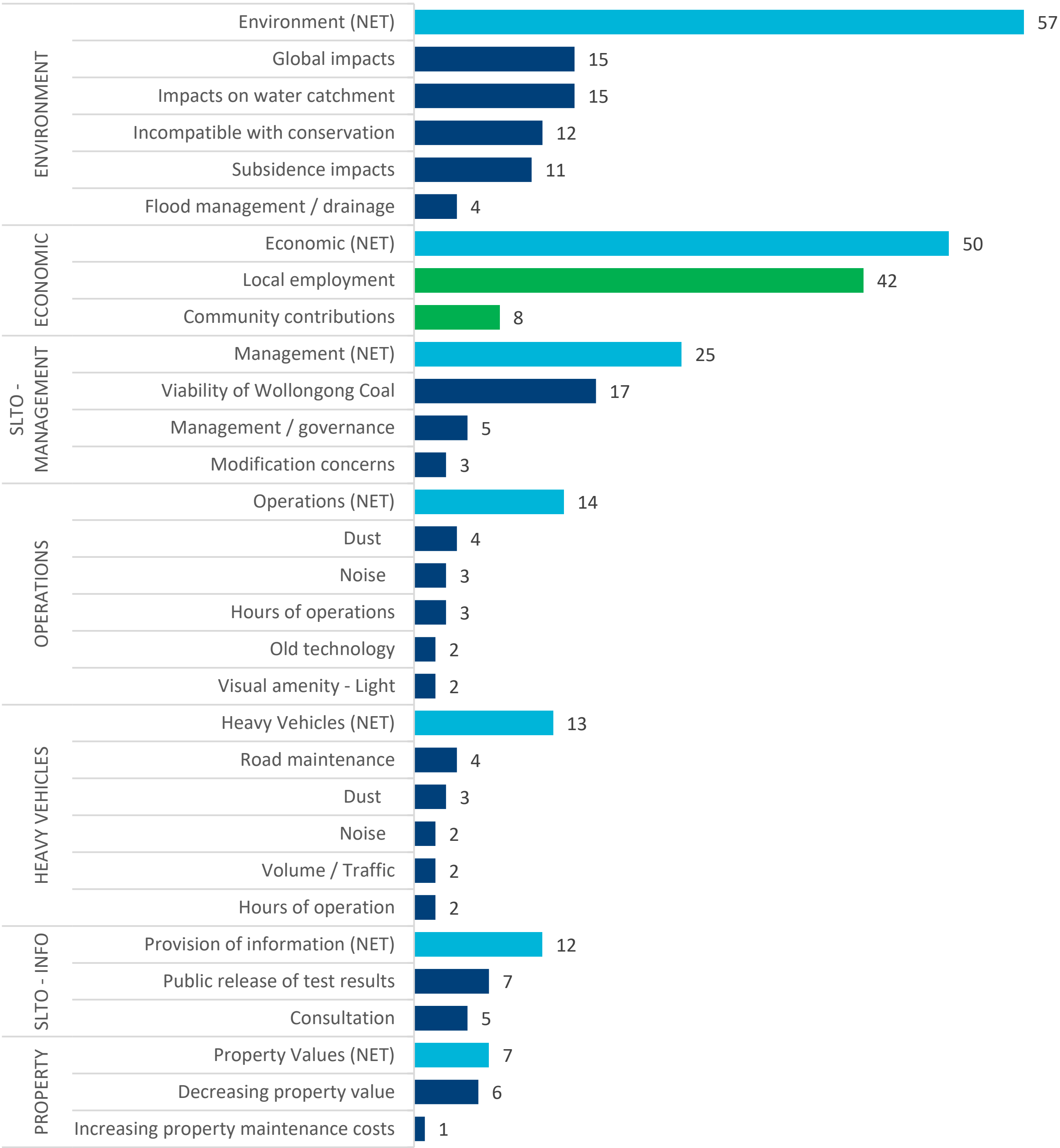


Graph 5.2 Phase 1 - Mitigation categories (frequency)

Phase 2 Engagement - Issues and Impact Feedback

Outcomes of the Phase 2 engagement indicate some positive changes to people’s perceptions regarding operational issues (refer to **Graph 5.3**) in particular, local employment and increased opportunities for community investment.

Phase 2 engagement results indicate (as illustrated in **Graph 5.3**) that issues relating to the environment were the most prominent, such as climate change, potential for subsidence, impacts on water resources and flooding. Concern regarding the viability of WCL as an operator and the company’s ability to effectively manage and meet regulatory compliance requirements during operations were raised. Whist operational issues like dust, noise and traffic remained concerns, these concerns were rated slightly lower than previously (refer to **Graph 5.1**).



Graph 5.3 Phase 2 – Community Information Session Issues Ranking

5.13.4 Evaluation of Social Impacts

To assess the social risks/impacts of the Revised Preferred Project, social factors were rated as being of ‘low’, ‘moderate’, ‘high’ or ‘extreme’. Stakeholder perceptions of risk were also included in the assessment process, based on outcomes of the engagement program.

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 (sensitivity), thus affords a true integration of expert and local knowledge in SIOA 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 SIOA guidelines (DPE, 2017) in relation to estimating material effects.

Table 5.27 summarises the assessed social risks associated with the Revised Preferred Project.

Table 5.27 Impact Assessment Summary

Project Aspect	Geographic scope	Duration	Affected stakeholders	Perceived Stakeholder risk	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Population change – construction workforce influx	Wollongong LGA	Construction	Russell Vale and LGA residents	**Low**	**Low**	NA
	Wollongong LGA	Construction	Local Businesses and Service providers	**Low *(Positive)***	**Low (*Positive*)**	NA
Population change – operational workforce	Wollongong LGA	Operation	Russell Vale and LGA residents	**Low (*Positive*)**	**Moderate (*Positive*)**	NA
	Wollongong LGA	Operation	Local Businesses and Service providers	**Low (*Positive*)**	**Low (*Positive*)**	NA
Dust emissions - impact on social amenity	Russell Vale Residents Wollongong LGA	Construction	Russell Vale and LGA residents	**High**	**High**	**Low**
	Russell Vale Residents Wollongong LGA	Operation	Russell Vale and LGA residents	**High**	**High**	**Low**
Dust emissions – health and wellbeing	Russell Vale Residents	Construction Operation	Russell Value Residents Russell Vale Pre-school	**High**	**High**	**Low**
Noise emissions – social amenity, health and wellbeing	Russell Vale Residents	Construction	Russell Vale residents Aspect South Coast School	**High**	**High**	**Moderate**
	Russell Vale Residents	Operation	Russell Vale Residents Aspect South Coast School	**High**	**High**	**Low**
Traffic and transport – impact on social amenity	Residents/businesses along the Transport route	Operation	Russell Vale Residents Wollongong LGA Residents	**High**	**High**	**Moderate**
Traffic and road safety – public safety	Residents/businesses along the Transport route	Operation	Russell Vale Residents Wollongong LGA Residents	**High**	**Moderate**	**Low**

Project Aspect	Geographic scope	Duration	Affected stakeholders	Perceived Stakeholder risk	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Traffic and transport – impact on social amenity	Residents/businesses along the Transport route	Operation	Russell Vale Residents Wollongong LGA Residents	**Medium**	**Moderate**	**Low**
Impact on water - ground and surface water quality and quantity	Sydney Water Catchment	Permanent	Russell Vale Residents Wollongong LGA Residents Water Catchment users	**High**	**Low**	**Low**
Surface water management – flooding and water quality	Local Creeks Sydney Water Catchment	Operation	Russell Vale Residents Wollongong LGA Residents Water Catchment users	**High**	**Moderate**	**Low**
Greenhouse Gas Emissions	Project area	Operation	Key environmental groups Wollongong LGA residents	**High**	**Moderate**	**Moderate**
Biodiversity	Local National	Permanent	Local, regional and national residents Key stakeholders (IRRM, KKAG, CCC, other key environmental groups)	**Medium**	**Low**	**Low**
Local employment	Wollongong LGA residents Regional residents	Operation	WCL Employees Local and regional businesses and service providers Local/Regional/State Communities	**Medium (Positive)**	**High (Positive)**	**High (Positive)**
Social license to operate	Russell Vale Residents Wollongong LGA		Russell Vale Residents Wollongong LGA State Government	**High**	**High**	**Moderate**
Property values and maintenance	Russell Vale Residents		Russell Vale Residents	**Medium**	**Low**	**Low**

5.13.5 Management and Mitigation Measures

A social impact management plan (SIMP) will be prepared to monitor social impacts and commitments made as part of the Revised Preferred Project.

The proposed monitoring framework should draw upon multiple methods, which may include:

- Monitoring socio-economic trends that will provide context and provide an appreciation of community change
- Monitoring organisational inputs and outputs which will provide an understanding of what WCL is contributing to the community e.g. in relation to employment, expenditure, local procurement.
- Monitoring outcomes of inputs and outputs which will provide an understanding of what impact community projects and investments are having in the community. WCL has a current community support program that provides contributions to local community groups and organisations, these programs will be further developed to address key community needs
- Monitoring objective indicators of impact which will ensure WCL is monitoring key risks and trends in relation to key impact areas identified through the SIA process e.g. monitoring of key impacts such as noise and air quality
- Monitoring community perceptions of impact (e.g. feelings of trust towards the company, resident experience of social impacts), which will ensure regular engagement with the community and ensure emerging issues and impacts are identified proactively.

The SIMP will be developed in consultation with key stakeholders and will also include a process for evaluating ongoing community engagement and efforts from WCL to take account of feedback from the community, to effectively identify, investigating and as relevant implement further measures to minimise construction and operational impacts.

5.14 Economic Assessment

An Economic Impact Assessment (EIA) has been completed for the Revised Preferred Project in accordance with:

- *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government 2015) (the Guidelines)
- *Technical Notes supporting the guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (the Technical Notes).

The assessment is based on a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA), estimating the net benefits of the Revised Preferred Project to the State and the local benefits to the Wollongong region.

The following section provides a summary of the key findings of the EIA with the full report provided in **Appendix 10**.

5.14.1 Cost Benefit Analysis

A CBA is a method of obtaining a consolidated estimate of the net economic value of a project by identifying the incremental costs and benefits of the project relative to the base case (i.e. no project), placing a quantitative value on these items wherever possible and deriving the share of each item that is attributable to NSW.

To carry out the economic assessment, a base case (representing the closure of the Russell Vale Colliery) was compared to a Project case (being the Revised Preferred Project for the UEP).

Under the base case scenario in the CBA, WCL will be obligated to rehabilitate the Russell Vale Colliery including the underground access points and the Pit Top facilities which is estimated at $215 million to be expended in 2020, with no future mining at Russell Vale.

The Project case essentially involves undertaking additional capital investment and operating expenditure to commence and implement the Revised Preferred Project. In the Project case, an additional 3.7 Mt of ROM coal is produced, generating a net benefit of approximately $174.3 million in Net Present value (NPV) terms. The Project case also incorporates a total of $35.3 million in capital investment in present value (approximately $39.9 million in undiscounted terms) which for the economic assessment purposes has been assumed to be spent between 2020 and 2024.

As illustrated in **Figure 5.16**, capital expenditure is comprised of project capital and sustaining capital. Project capital is a once off expenditure of $21.3 million in 2020 for works required to develop the underground workings and to upgrade the Pit Top facilities. The UEP will also require $14.0 million in NPV terms of additional sustaining capital.

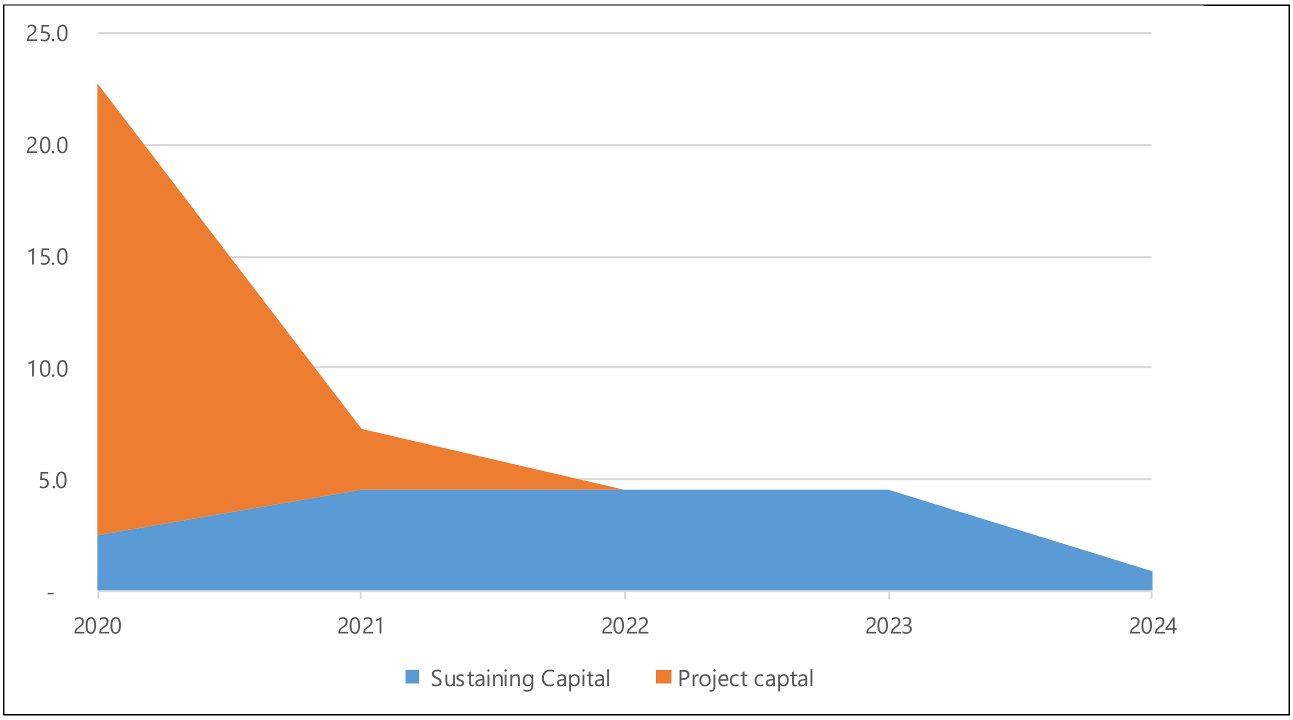


Figure 5.16 Capital expenditure profile (2019 $ million)

A summary of the UEP financials is presented in **Table 5.28** below. From revenue of $481.5 million in NPV terms, the financial model showed operating costs of $213.7 million in NPV terms, and depreciation of $10.2 million in NPV and environmental costs of $4.3 million in NPV terms.

All operating costs, except for royalties, include a 10 % cost contingency. Depreciation was estimated using a straight-line depreciation method with an assumed 10-year asset life.

Based on these figures, the UEP is expected to generate an accounting profit of $257.6 million in NPV terms.

Table 5.28 Summary of UEP Financials ($ million)

	NPV	2020	2021	2022	2023	2024	2025
Revenue							
Coal Sales	461.8	70.3	148.9	155.4	155.4	29.1	-
Residual value of capital	19.8	-	-	-	-	27.7	-
Total	**481.5**	**70.3**	**148.9**	**155.4**	**155.4**	**56.8**	**-**
Operating cost							
Pit-top costs	47.8	8.4	15.4	15.4	15.4		
Surface costs	45.9	-	14.5	19.4	19.4		
Logistics	44.7	11.0	14.6	12.7	12.7		
Royalties	33.2	5.1	10.7	11.2	11.2		
Labour	95.5	19.0	29.6	29.6	29.6		
Environmental	4.3	0.8	1.4	1.4	1.4		
Rehabilitation	-57.7	-215.0	-	-	-	-	215.0
Operating cost	**213.7**	**-170.8**	**86.2**	**89.6**	**89.6**	**-**	**215.0**
Depreciation	**10.2**	**2.3**	**3.0**	**3.5**	**3.5**	**-**	**-**
Total costs	**223.9**	**-168.5**	**89.2**	**93.1**	**93.1**	**-**	**215.0**
Profit	**257.6**	**238.8**	**59.7**	**62.3**	**62.3**	**56.8**	**-215.0**

The overall finding of the CBA is that the Revised Preferred Project is estimated to contribute a total net economic benefit for the NSW community of approximately $174.3 million in net present value (NPV) (i.e. how much a future sum of money is worth today). This is comprised of $116.9 million and $57.5 million in direct and indirect benefits respectively. Indirect costs of the UEP are estimated to be $0.019 million. That is, the benefits for NSW in present value terms are estimated to exceed the costs of the Project borne by NSW. Each estimate is measured in NPV terms, calculated using a 7 % real discount rate, in 2019 price terms, calculated over the period 2020 to 2025.

Direct Benefits

Based on the Guidelines, the direct benefits to NSW of the Revised Preferred Project are comprised of three elements:

- The net producer surplus generated by the project that is attributable to NSW.
- 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 analysis shows that the combination of relatively low capital requirement, and the high value of coal extracted underpins the economic viability of the UEP. As a result, the Revised Preferred Project is predicted to generate:

- Total net producer surplus of $112.2 million in NPV terms, of which $39.7 million is attributable to NSW based on a 35.4 % NSW ownership share of WCL.

- Total corporate taxes of $120.3 million in NPV terms for Australia, of which $38.5 million is attributed to NSW.

- $38.7 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $33.2 million with council rates and land taxes of $2.1 million and payroll taxes contributing $3.4 million.

Indirect Benefits

Consistent with the Guidelines, the indirect benefits of the UEP accrue to workers, suppliers and landowners.

The analysis shows that the total indirect benefits are estimated at $57.4 million and consists of:

- Worker benefits are predicted to amount to $43.6 million in NPV terms, over the life of the Revised Preferred Project.

- Supplier benefits are predicted to amount to $13.8 million in NPV terms.

- No expected benefits to landowners.

Indirect costs

The indirect costs of the UEP are related to the costs borne on the NSW community through the generation of externalities by the UEP and 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 analysis shows that a total of $19,158 in NPV terms in indirect costs will be borne by the NSW community which is the cost of water licences and greenhouse gas attributable to NSW.

The CBA therefore shows that when all potential costs and benefits are considered, the Revised Preferred Project will deliver a net benefit to the NSW community.

Summary of Net Benefit Analysis

In summary, the CBA is based on comparing the net direct and indirect benefits and subtracting the indirect costs of the Revised Preferred Project, as discussed above, against the baseline scenario (no Project).

As noted above, the estimated net benefit to NSW is $174.3.0 million in NPV terms with the direct benefits of the Revised Preferred Project estimated to be $116.9 million in NPV terms. The UEP is also expected to generate total indirect benefits of $57.4million in NPV terms, comprised of $43.6 million of worker benefits and $13.8 million of supplier benefits.

The UEP is expected to generate modest incremental indirect costs on the NSW community of about $19,158, which is the cost of water licences and greenhouse gas attributable to NSW (bearing in mind that the majority of mitigation and monitoring costs, $4.3 million in NPV terms, associated with environmental impacts relating to the UEP are incorporated in the capital and operating costs of the project).

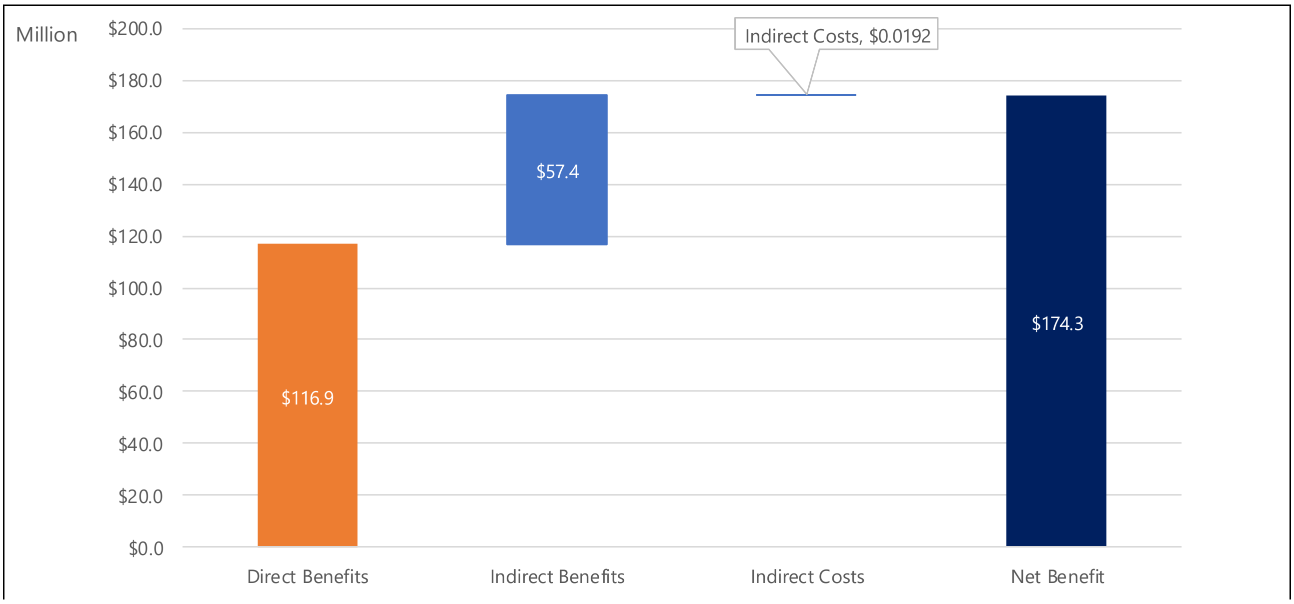


Figure 5.17 Summary of the net benefits of the Revised Preferred Project under central case assumptions ($ million)

Source: Cadence Economics estimated based on information from various sources

CBA - Sensitivity Analysis

The CBA results are subject to the assumptions and valuations applied to each cost and benefit. A sensitivity analysis was completed in order to test the sensitivity of the estimate of net economic benefit by also considering upper and lower bound discount rates, and varying the size of a number of parameters of interest.

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% is used. In areas where the figures are deemed more certain, a range of plus/minus 10% is used

The results of the systematic sensitivity analysis are summarised in **Figure 5.18.** 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 10**.

In isolation, the estimated net benefit of the UEP 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 to be $134.7 million in NPV terms.

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 $117.3 million in NPV terms. The upper bound, or best-case, estimate, based on the most optimistic assumptions, is $220.1 million in NPV terms.

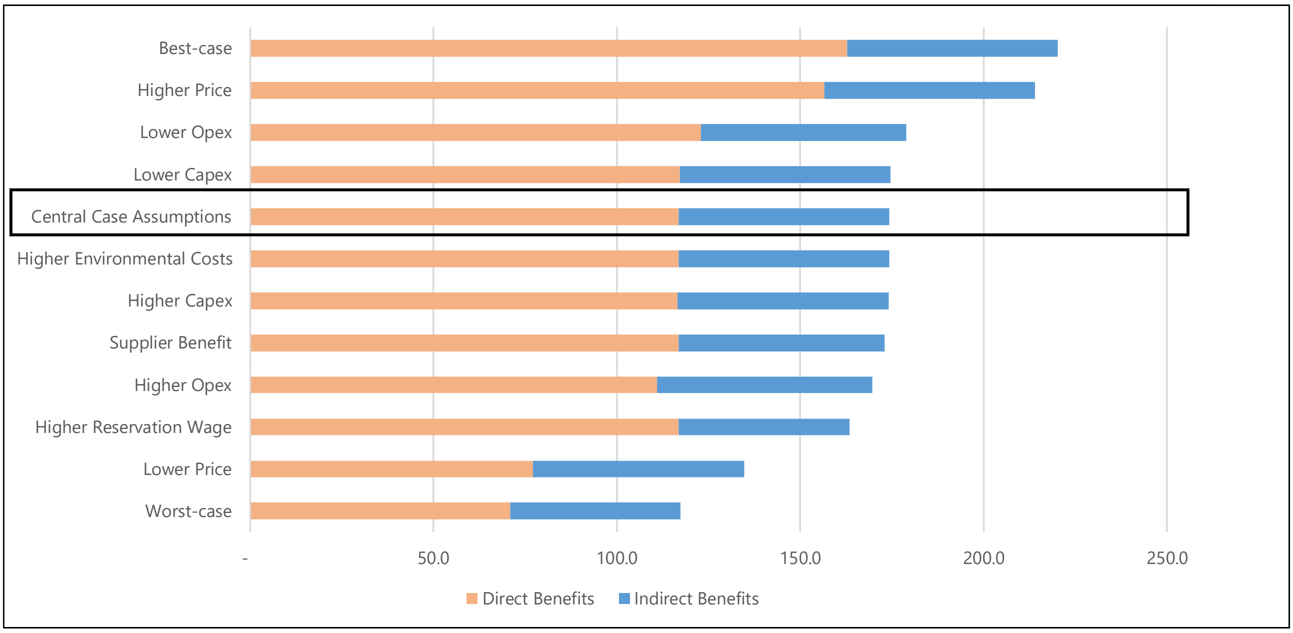


Figure 5.18 Systematic sensitivity analysis of the CBA to key assumptions (NPV, $ million)

Source: Cadence Economics estimated based on information from various sources.

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 Revised Preferred Project 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 $117.3 million in NPV terms before the Revised Preferred Project would return a net negative return to NSW.

As a result of the relatively short time frame of the Revised Preferred Project (2020 to 2024), the net benefits are not sensitive to the discount rate used for the analysis.

5.14.2 Local Effects Analysis

The LEA uses a similar framework to the CBA, presented in **Section 5.14.1**, but is focussed on the net economic impacts to the local community in the Wollongong region of NSW. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. As shown in **Figure 5.19**, the Wollongong SA3 takes in a relatively narrow and built up area with the Pacific Ocean to the east and the Illawarra Escarpment to the west. The SA3 includes the city of Wollongong, north Wollongong and East Corrimal. To the north, the SA3 occupies the area south of the Royal National Park and the Dharawal National Park. Running through the middle of the SA3 is the Princes Highway.

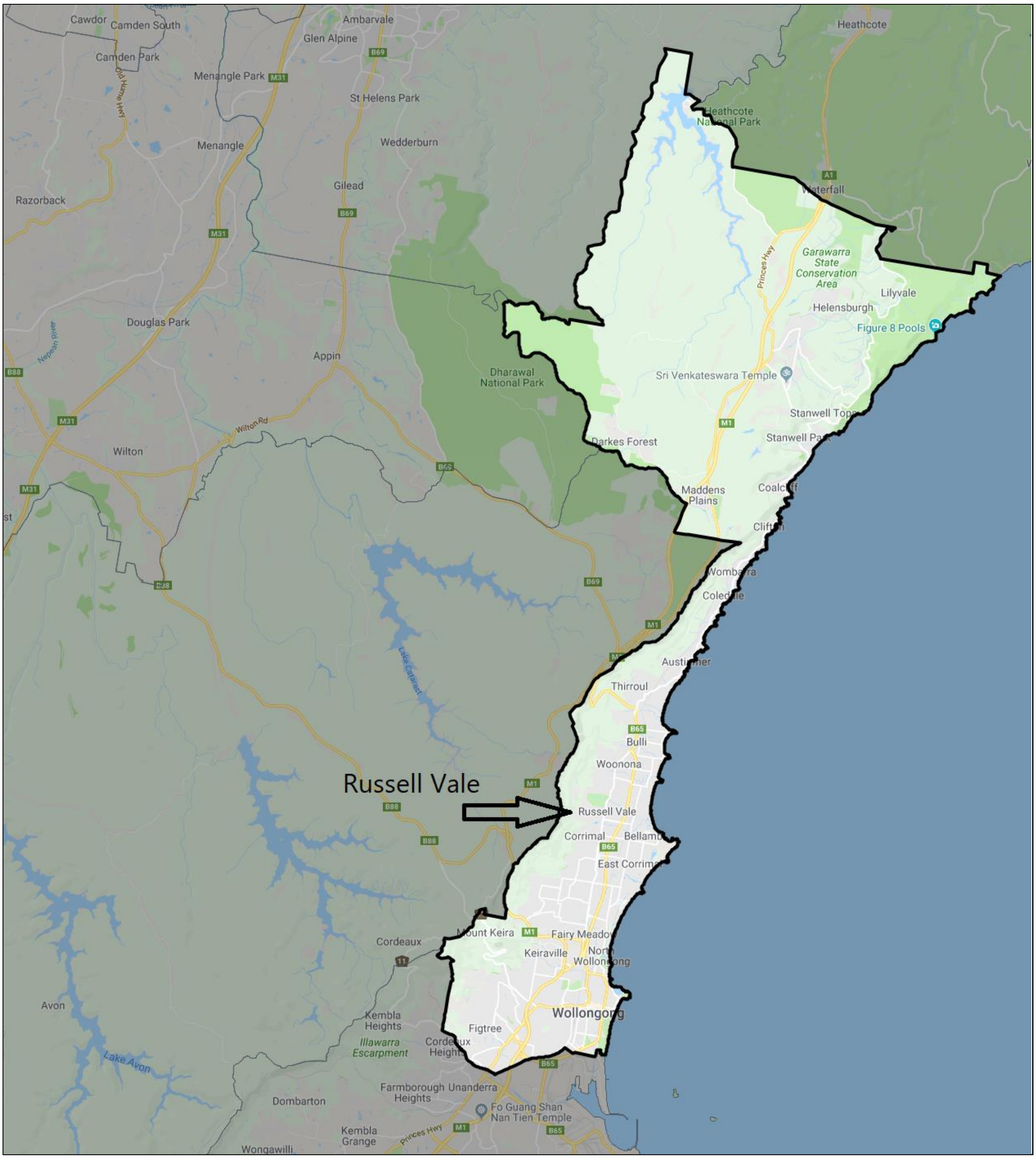


Figure 5.19 Wollongong SA3 local area

Source: Remplan (http://mapbuilder.remplan.com.au/?link=e1f7954ca97943e79af46bd140cddd17)

The analysis shows a total estimated net benefit of $14.3 million in NPV terms to local suppliers and employees in the Wollongong local area. This is driven largely by:

- Benefits to local workers of $8.7 million in NPV terms based on the assumption that 20% of the mine's direct employees is located in the local area,
- Benefits to local suppliers of $5.5 million in NPV terms based on the assumption that 20% of the inputs to production are suppled from the region.

LEA - Sensitivity Analysis

The sensitivity analysis for LEA shows that the estimated net benefits are robust in the sense that it remains strongly positive after testing all key assumptions underpinning the analysis.

The results of the systematic sensitivity analysis are summarised in **Figure 5.20**. 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 $14.2 million in NPV terms. The upper bound, or best-case, estimate based on the most optimistic assumptions, is $17.4 million in NPV terms. Full detail of the sensitivity analysis is presented in **Appendix 10**.

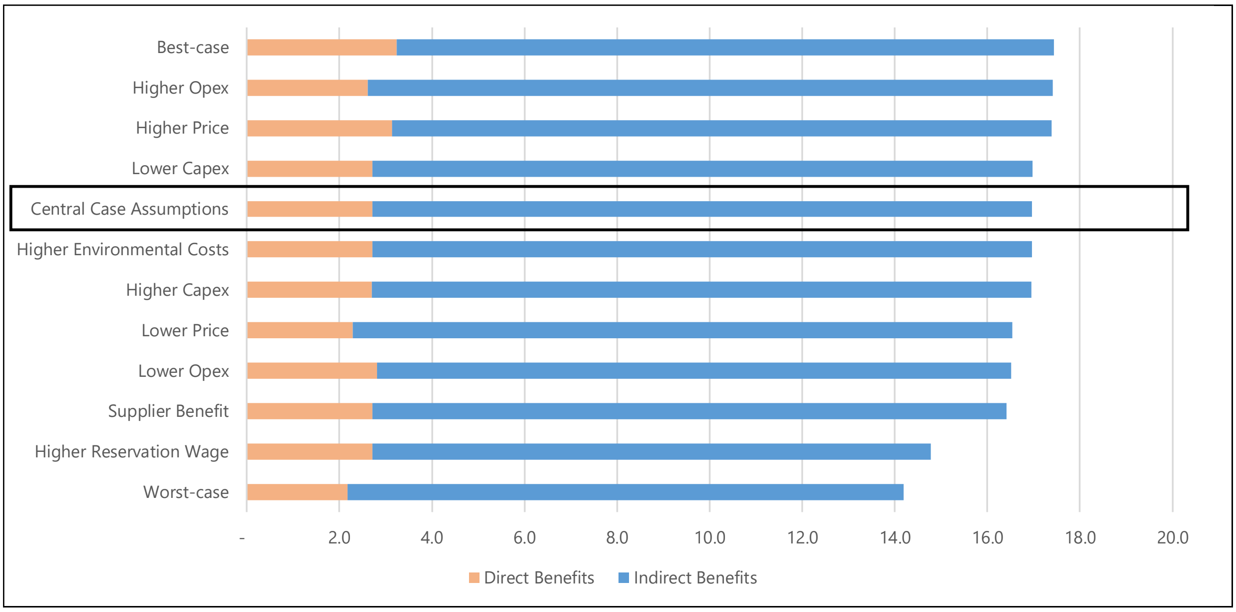


Figure 5.20 Systematic sensitivity analysis of the LEA to key assumptions (NPV, $ million)

Source: Cadence Economics estimated based on information from various sources.

6.0 Statement of Commitments

This section presents a consolidated Statement of Commitments for the Revised Preferred Project (09_0013). The Statement of Commitments includes key surface water management commitments made under the Preliminary Works Project (PA 10_0046) MOD 4 application currently under assessment. This is due to the reliance of the Revised Preferred Project on surface water management controls proposed under the Preliminary Works Project and the anticipated transition of approval for mining to 09_0013, should the UEP be approved.

Table 6.1 Statement of Commitments

Commitment	Timing
Future Mine Planning	
WCL will not be seeking future approval for longwall mining within the Russell Vale Colliery lease holding.	Ongoing
Hours of Operation	
Mining operations and the transfer of ROM coal to the surface will be undertaken 24 hours a day, 7 days a week.	Ongoing
Coal beneficiation, truck loading and coal transport will typically be limited to daytime hours only between: • 7.00am - 6.00pm Monday to Friday • 8.00am - 6.00pm Saturday. • No coal beneficiation, truck loading and coal transport will occur on Sundays or Public Holidays. Coal beneficiation, truck loading and coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closure or supply interruption, however such circumstances would be rare and as a result of unexpected events.	Ongoing
Haulage of reject material from the reject stockpile to the mine portal will be limited to 7.00 am - 6.00 pm Monday to Friday.	Ongoing
All construction works will be undertaken during standard working hours as defined in the Interim Construction Noise Guidelines (ICNG) (DECCW, 2009), being: • 7.00am - 6.00pm Monday to Friday • 8.00am - 1.00pm Saturday • No construction works on Sundays or Public Holidays.	During construction
Environmental Management Plans	
WCL will prepare a Construction Environmental Management Plan, prior to the commencement of construction, that identifies the environmental and social management controls to be implemented during the construction phase.	Prior to the commencement of construction
All existing operational environmental management plans and monitoring networks will be reviewed and revised (where necessary) to reflect the Revised Preferred Project approval requirements, should the project be approved. Each environmental management plan will include (where relevant): • detailed baseline data; • a description of: - the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Within 3 months of approval

Commitment	Timing
- any relevant limits or performance measures/criteria; - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; • a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; • a program to monitor and report on the: - impacts and environmental performance of the project; - effectiveness of any management measures; • a contingency plan to manage any unpredicted impacts and their consequences; • a program to investigate and implement ways to improve the environmental performance of the project over time; • a protocol for managing and reporting any: - incidents; - complaints; - non-compliances with statutory requirements; and - exceedances of the impact assessment criteria and/or performance criteria; and • a protocol for periodic review of the plan.	
Social and Economic	
WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project, including quarterly website updates and annual community information sessions.	Ongoing
WCL will continue to operate the Russell Vale Community Consultative Committee following relevant DPIE guidelines	Ongoing
WCL will continue to implement the existing community complaints response and management program	Ongoing
Subsidence	
WCL will review and update existing Built Features Management Plans for all surface infrastructure within the vicinity of the proposed first workings to manage any potential subsidence-related impacts on surface infrastructure. The Built Features Management Plans will be reviewed in consultation with the asset owner prior to proposed first workings near the surface infrastructure.	Prior to proposed first workings near the surface infrastructure
The existing subsidence monitoring program will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The monitoring program will be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mining below subsidence sensitive infrastructure.	Within 3 months of approval
Groundwater	
The existing Russell Vale East Water Management Plan will be reviewed and updated in consultation with DPI Water and DPIE and the updated plan will be implemented for the Revised Preferred Project.	Within 3 months of approval and ongoing
The existing groundwater monitoring network will continue to be utilised to monitor impacts associated with the Revised Preferred	Within 3 months of approval and ongoing

Commitment	Timing
Project. The existing groundwater monitoring program will be reviewed and updated to reflect the Revised Preferred Project as part of an update to the existing Russell Vale East Water Management Plan. The groundwater monitoring program will include monitoring of groundwater levels, water quality, mine water inflows, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model as required.	
Existing monitoring and management measures associated with the mining of longwalls 4 to 6, as set out in the existing Russell Vale East Water Management Plan and LW5 Water Management Plan will remain in place.	Ongoing, with regular review of the results, effectiveness and ongoing need for monitoring as set out in the Water Management Plan
As part of the mine closure process, a suitable funding arrangement will be negotiated with the relevant stakeholders to fund the ongoing monitoring and treatment of future water outflows from the adit, if required. The funding arrangement will consider appropriate water quality targets based on an agreed potential end use at the time of closure and will be sufficient for 10 years of monitoring and treatment.	Prior to mine closure
Soil and Water	
WCL will implement pre-treatment of dirty water using flocculant block at the inlet to Dam 1 to aid settling of solids prior to overflowing into Dam 2.	Ongoing as required
Ongoing real time turbidity monitoring of LDP 2 discharge, Bellambi Gully Creek upstream and Bellambi Gully Creek downstream to allow rapid response to deviations above water quality trigger values.	Ongoing
WCL will implement upgrades to the existing Water Management System as proposed in the Bellambi Gully Flood Assessment (Engeny, 2018), Response to Submissions for Modification 4 (Umwelt, 2018) and Further Response to Submissions for Modification 4 (Umwelt, 2019). These will include: • Construct upstream levee to detain and divert upslope catchment runoff through the Bellambi Gully Diversion Pipeline • Implement debris control structures at the inlets to both the 1800 mm and 600 mm pipes • Regrade eastern laydown area to form a dry detention basin with an effective capacity in the order of 2.1 ML. Construct channel from laydown area to SWCD to manage and divert flows in excess of the capacity of Dam 1 and Dam 2 and the new dry detention basin in the laydown area to the SWCD.	In accordance with timing requirements established under MOD 4
The detailed plans of the revised Water Management System will be prepared by a suitably qualified civil engineer in consultation with Council and OEH and provided to the consent authority for approval prior to commencement of works.	Prior to the commencement of construction
WCL will maintain the existing Bellambi Gully Diversion Pipeline as the method to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek.	Ongoing
WCL will undertake a Pipeline Condition Assessment and develop a Pipeline Integrity Management Strategy, as detailed in Appendix 5 of the Further Response to Submissions for Modification 4 (Umwelt, 2019).	Within 6 months of approval of the Mod 4
WCL will manage the proposed ROM stockpile height to not exceed 7m above the Bellambi Gully Diversion Pipeline.	Ongoing

Commitment	Timing
WCL will implement dedicated crossings for heavy vehicles driving over the Bellambi Gully Diversion Pipeline with offset areas of 5 m from the centreline of the pipe either side.	Prior to the commencement of construction
A maintenance schedule will be prepared and implemented for the new on-site stormwater system.	Within 3 months of approval and ongoing
New and existing flood structures and controls will be included on regular maintenance schedules.	Ongoing
WCL will implement the management, monitoring and contingency measures described in Section 7.0 of the Response to Submissions for Modification 4 (Umwelt, 2018) and Section 4.2 of the Further Response to Submissions for Modification 4 (Umwelt, 2019).	Following the approval of MOD 4 and ongoing
WCL will update the Surface Facilities Water Management Plan, including and / or taking account of: • Conditions and commitments set out in the Modification 4 approval • Water Balance • Erosion and Sedimentation Control Plan • Baseline data on water quality • Monitoring program details • Trigger levels for the investigation of any potentially adverse impacts.	Within 3 months of approval
The Water Management Plan will include a Monitoring, Management and Maintenance Plan for the proposed flood levee and existing SWCD. This will include an effective monitoring, management and maintenance program designed to ensure the ongoing and safe operation of the flood levee and SWCD in the event of a significant flood.	Within 3 months of approval
Hazardous materials, including diesel fuel, water treatment chemicals and hydraulic fluid emulsions will be stored in appropriately sized bunds. All hydrocarbon storage and handling will be undertaken in accordance with *AS1940-2017: The storage and handling of flammable and combustible liquids*.	Ongoing
Biodiversity	
WCL will review and update the existing Biodiversity Management Plan and Upland Swamp Management Plan and implement the updated plans for the Revised Preferred Project.	Within 3 months of approval and ongoing
Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence monitoring and monitoring required to detect primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creeks. If subsidence impacts and/or primary impacts in excess of those predicted are detected, the monitoring program will be reassessed.	Ongoing in accordance with the Biodiversity Management Plan

Commitment	Timing
Noise	
WCL will review and update the existing Noise Management Plan for the Russell Vale Colliery and implement the updated plan for the Revised Preferred Project.	Within 3 months of approval and ongoing
Construction of the access road noise barrier will be completed prior to phase-in operations commencing.	Prior to phase-in operations commencing
The construction of Bund 1 will be completed over as short a timeframe as possible, indicatively 6-8 weeks to achieve planned height. If phase-in operations or infrastructure construction commence prior to Bund 1 achieving is planned height, phase-in operations and infrastructure construction will be managed to meet the operational project noise trigger levels until such time as Bund 1 achieves its planned height.	Prior to and during phase-in operations
The proposed extension to Bunds 2 to 5 will be completed prior to full operation commencing.	Prior to full operation commencing
WCL will implement the following feasible and reasonable construction noise management measures during construction of bunds around the Pit Top, in accordance with the ICNG. These measures will be identified in the Construction Environmental Management Plan: • Schedule activities to minimise noise impacts o All bund construction works will be undertaken during recommended standard construction hours o Construction of Bunds 2 to 5 will be scheduled as early as possible within the phase-in period so that they can be used as noise barriers. o Minimise the duration of bund construction where feasible and reasonable o Consult with affected neighbours about scheduling bund construction to minimise noise impacts. • Use quieter equipment and methods o Dump truck access to be provided to bunds on the side further away from the closest receivers to maximise distance to receivers and shielding from bunds o Use mobile equipment with less annoying alternatives to the typical ‘beeper’ alarms where feasible and reasonable o Regularly inspect and maintain equipment in good working order. • Notification before and during bund construction o Provide information regarding construction activities to potentially affected neighbours, including the nature and expected duration of construction activities o Provide signage at the front of the site providing contact information, construction hours and any updates on construction activities. • Implement a complaints handling procedure, maintain a complaints register and implement all feasible and reasonable measures to address the source of complaints. • Undertake attended noise monitoring at the nearest and potentially most impacted residence(s) when construction of noise bunds is occurring within 200 m of noise-sensitive receivers to confirm construction noise levels are consistent with predicted levels.	Ongoing during construction
WCL will implement the following operational noise mitigation measures for the Revised Preferred Project:	

Commitment	Timing
• Acoustic treatment of new plant and equipment, including enclosing the Coal Processing Plant and Secondary Sizer in an acoustically treated building, acoustic treatments to the Surge bin and conveyors and attenuation pack and grouser treatment of the dozer	During construction
• establishing a temporary stockpile of ROM coal as early as possible in 'phase-in' operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile	Established as early as possible in 'phase-in' operations on maintained throughout 'phase-in' operations
• Dozer movements will be restricted to near ground level during 'phase-in' operation to maximise shielding provided by temporary ROM coal stockpile	During 'phase-in' operations
• operation of the dozer, rejects front-end loader, rejects truck, and underground loader will be restricted to daytime only use	Ongoing
• the operation of the reclaim conveyor system, Secondary Sizer, Surge Bin, Processing Plant and truck loading bins will generally be to daytime use only	Ongoing
• voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane	Ongoing
• 40 km/hr speed limit on site	Ongoing
WCL will continue to operate two continuous noise monitoring stations within the Russell Vale Colliery site.	Ongoing
Air Quality	
WCL will review and update the existing Russell Vale Colliery Air Quality and Greenhouse Gas Management Plan and implement the updated plan for the Revised Preferred Project. The Air Quality and Greenhouse Gas Management Plan will detail the monitoring and management controls to be implemented to manage air quality impacts associated with the Revised Preferred Project including implementation of proactive and reactive management protocols in response to air quality trigger levels defined in the plan. Specifically, the proactive air quality management approach will include: • implementation of a system to provide the operation with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the weather conditions and dust considerations at daily pre-shift meetings • modifying or suspend the planned activities, as appropriate, to minimise dust impacts. Reactive air quality management will include the modification or suspension of activities in response to the following triggers: • visual conditions, such as visible dust from trucks above wheel height. • meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors, and/or • ambient air quality conditions (that is, elevated short-term PM_{10} concentrations).	Within 3 months of approval and ongoing
WCL will implement a range of air quality mitigation measures and controls during operation of the Revised Preferred Project: • Enclosure of conveyors and material transfer points • Enclosure of Coal Processing Plant	Ongoing

Commitment	Timing
• Water sprays on ROM stockpile • Water carts on unsealed haul routes • Water sprays on stockpiles and exposed areas triggered during periods of high winds • Water sprays on the bunds during construction • Trucks will be covered before leaving the site • Trucks will be washed before leaving the site • Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes • Revegetation/rehabilitation of exposed disturbed areas.	
Traffic	
WCL will review and update the existing Russell Vale Colliery Traffic Management Plan and Drivers Code of Conduct and implement the updated plan for the Revised Preferred Project.	Within 3 months of approval and ongoing
Coal transport will be restricted to an average rate of 16 laden trucks per hour leaving the site between 7.00 am to 6.00 pm Monday to Friday and between 8.00 am to 6.00 pm Saturday, with no haulage on Sunday or Public Holiday; Coal transport may occasionally be required until 10.00pm Monday to Friday as a result of unexpected Port closures or interruptions. If this is the case, outbound laden truck movements will be further limited to an average of 12 trucks per hour between 6.00pm and 10.00pm, Monday to Friday only.	Ongoing
Trucks arriving between 6.00am and 7.00am (Mondays to Fridays) or 7.00am and 8.00am (Saturdays) will park in the dedicated truck parking provided on site and switch off engines.	Ongoing
WCL will maintain, monitor and enforce the voluntary speed limit along Bellambi Lane of 50km/hr for all trucks accessing the Colliery, with the continued aim of achieving 95% compliance with the voluntary speed restriction.	Ongoing
WCL will seek to reach agreement with Wollongong City Council for a road maintenance contribution for the maintenance of Bellambi Lane.	Within 12 months of project approval
Visual Amenity	
WCL will implement the following measures to improve the visual amenity of the site and minimise the visual impact of the Revised Preferred Project: • Bunds surrounding the Pit Top will be progressively rehabilitated, spread with topsoil and planted with a selection of native species as soon as practical once final bund height is achieved • Existing vegetation outside the Pit Top disturbance area will be regularly maintained and supplemented or replaced if necessary to maintain visual screening • Areas of disturbance will be kept to the minimum practicable and rehabilitated as soon as practical • Proposed coal handling infrastructure will be coloured in non-reflective natural tones to minimise contrast against the surrounding environment • All outdoor lighting will be installed and operated in accordance with Australian Standard AS4282 (INT) 1995 – Control of the Obtrusive Effects of Outdoor Lighting, including measures such as directing lighting downwards towards work areas and not toward	Ongoing

Commitment	Timing
private residences and roads, and where appropriate, using shields to limit the emission of light off site.	
Greenhouse Gas and Energy	
WCL will review and update the Greenhouse Gas Management Plan to consider both the construction and operational phase of the Revised Preferred Project.	Within 3 months of approval and ongoing
WCL will continue to seek operational energy use efficiencies where commercially feasible and will review renewable energy opportunities as new technology is developed and becomes viable.	Ongoing
Rehabilitation and Mine Closure	
WCL will review and update the existing Russell Vale Colliery Rehabilitation Management Plan for the Revised Preferred Project in consultation with the relevant key stakeholders and government agencies.	Within 3 months of approval and ongoing
WCL will progressively rehabilitate the site as soon as reasonably practicable following disturbance to the satisfaction of the Executive Director Mineral Resources.	Ongoing and upon mine closure
If WCL does not have a future approval for ongoing mining within the Russell Vale Colliery lease holding by the end of year 4 of the Revised Preferred Project, WCL will commence consultation with the Resources Regulator and DPIE regarding detailed closure planning.	End of Year 4 of the Revised Preferred Project (if no future approval for ongoing mining obtained)

Part B – Response to PAC Second Review Report

7.0 Background

Part B of this report provides a response to the issues raised in the PAC Second Review Report released in March 2016. The PAC Second Review Report outlined the PAC's findings based on its review of the UEP Preferred Project, which included a second public hearing (held on 8 December 2015) and written submissions from the public and State and Commonwealth agencies.

Based on its review of the information provided, the PAC formed the view that the social and economic benefits of the project as it was then proposed were most likely outweighed by the magnitude of impacts to the environment. The key considerations driving this finding include:

- Concerns from government agencies regarding risk of water loss, risk to upland swamps, noise impacts on nearby residents and along Bellambi Lane, potential hydrological impacts and loss of ecosystem functions. The PAC was of the opinion these concerns were not satisfactorily resolved.
- Residual uncertainty identified by groundwater and subsidence experts regarding the potential for and degree of loss of surface water flow due to subsidence and cracking.
- The project's substantial reliance on mitigation strategies to deal with residual impacts, however there remained uncertainty about the type and effectiveness of mitigation measures proposed.
- Short term benefits associated with jobs, royalties, capital investment, other direct and indirect flow on effects, continuation of coal production in the Southern Coalfields and utilisation of the PKCT. However, the PAC noted some external costs had not been accounted for in the economic assessment.
- Potential noise impacts on residents adjacent to the Pit Top and along Bellambi Lane were considered to be underestimated.

The PAC was not satisfied that the project was consistent with *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2001* that it would have a neutral or beneficial effect on water quality in the catchment area, particularly in so far as the magnitude of water loss remained uncertain.

The PAC recommended that any further consideration of the UEP should have regard to these issues raised by the PAC.

WCL and its technical specialists have considered the findings of the PAC Second Review Report and a response is provided to each of the issues in the following sections.

In addition to the specific PAC recommendations, this report addresses the concerns raised by State and Commonwealth agencies as summarised in the PAC Second Review Report:

> *"Concerns were raised by WaterNSW, Office of Environment and Heritage, Department of Primary Industries, Environment Protection Authority and the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development. Their concerns include risk of water loss, risk to upland swamps, noise impacts on nearby residents along Bellambi Lane, potential hydrological impacts and loss of ecosystem functions. The Commission is of the opinion that from the information presented to it, these issues have not been satisfactorily resolved."*

8.0 Mining SEPP as amended

8.1 Compatibility with Other Land Uses (Clause 12)

- **The Commission is not convinced that the project is not likely to result in unacceptable impacts to surrounding land uses in general.**
- **The Commission finds potential noise impacts on adjacent residences would not be negligible or beneficial, if reasonable benchmarks for existing noise were used for the assessment instead of using the "modelled maximum noise levels for 1 Mtpa." Similarly, traffic noise impact on residences along Bellambi Lane requires reassessment.**
- **The Commission is not satisfied that the project will have a neutral or beneficial effect on water quality, as is required for consent to be granted under the objectives of the Sydney Drinking Water Catchment SEPP.**

Response

Mining at the Russell Vale Colliery site has been undertaken since 1887. Over time, urban development has encroached on the pit-top facilities at Russell Vale and these facilities are now bordered by residential land uses. Russell Vale Colliery has coexisted with these neighbouring land uses over an extended period with a degree of impact on the amenity of these residential land uses.

Key elements of the Revised Preferred Project have been designed to minimise amenity impacts on surrounding residential land uses, including substantial noise mitigation works around the Pit Top to reduce noise impacts on surrounding residents, modifications to surface water management system to improve the quality of water flowing off site and reduce downstream flood impacts, and controls on the speed and timing of trucks entering and leaving the site. The proposed additional noise mitigation measures are discussed in **Section 8.1.1** below.

Further, in order to address residual uncertainty regarding potential subsidence and water impacts of the project, longwall mining is no longer proposed. Instead, a stable first workings mine plan has been developed to address this uncertainty and enable the project to demonstrate it will have a neutral or beneficial effect on water quality, as discussed in **Section 8.1.2**.

8.1.1 Noise Impacts

As discussed in **Section 5.6**, a range of additional feasible and reasonable noise control measures were investigated to minimise, control or manage the noise impacts from the project. These measures were tested through an iterative design process to determine their effectiveness at reducing noise impacts.

The noise mitigation measures identified through this process to be reasonable, feasible and effective at mitigating noise impacts from surface operations have been adopted and include:

- Repositioning infrastructure to provide maximum topographical shielding from surrounding residences, for example relocating the surge bin and secondary sizer building from an exposed location to the toe of a batter.
- Acoustic treatment of new plant and equipment, including enclosing the Coal Processing Plant and Secondary Sizer in an acoustically treated building, acoustic treatments to the Surge bin and conveyors and attenuation pack and grouser treatment of the dozer.

- extension and increase in the height of existing berms in strategic locations surrounding the Pit Top to shield trucks and equipment.
- construction of a 4 m high noise barrier along the northern side of the site access road between the site entrance and turn off to the truck parking area to mitigate impacts of trucks accessing the site. Construction of the access road noise barrier will be completed prior to the commencement of 'phase-in' operations.
- establishing a temporary stockpile of ROM coal as early as possible in 'phase-in' operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile.
- voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane.
- 40 km/hr speed limit on site.
- operational noise mitigation measures such as:
  - restricting the operation of the dozer, rejects front-end loader, rejects truck, and underground loader to daytime only use
  - generally restricting the operation of the reclaim conveyor system, Secondary Sizer, Surge Bin, Coal Processing Plant and truck loading bins to daytime use only, however noise impacts of operation of these items during the evening period has been considered in this NIA to cater for unexpected Port closures or interruptions
  - Dozer movements restricted to near ground level during 'phase-in' operation to maximise shielding provided by temporary ROM coal stockpile.

As discussed in **Section 5.6**, the effects of these noise mitigation measures have been assessed as part of an updated noise impact assessment undertaken in accordance with the NSW Noise Policy for Industry (NPfI) (EPA 2017). Results indicate that at full operation, no exceedances of the NPfI criteria are expected during the day, evening or early morning shoulder periods at any of the identified representative receivers. Under adverse weather conditions, a 1-2 decibel (dB) exceedance is anticipated at some residences close to the site during a small percentage (less than 10%) of Winter nights. It is noted that due to restricting operating hours associated with the Revised Preferred Project, the only noise generating activity occurring on the surface during the night time period is the running of ROM coal onto the ROM stockpile.

The NPfI and Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) defines a 1-2 dB exceedance as a negligible residual noise impact indiscernible by the average listener.

These changes therefore significantly reduce the predicted noise levels of the Revised Preferred Project in comparison to both historical operations, and to the previously proposed site configuration, which predicted exceedances (of the then Industrial Noise Policy criterion) of up to 11dB, 13dB and 9dB during the day, evening and night respectively.

The NIA prepared for the Revised Preferred Project includes an updated traffic noise assessment in accordance with the EPA's *NSW Road Noise Policy* (RNP) (EPA 2011). The assessment concludes that road traffic noise associated with the Revised Preferred Project resulted in an acceptable relative traffic noise increase to residents along Bellambi Lane and surrounds under the RNP.

8.1.2 Neutral or Beneficial Effect on Water Quality

As discussed in **Sections 5.2**, **5.3** and **5.4**, the Revised Preferred Project has been specifically designed to be long term stable with minimal risk of subsidence, thereby also minimising potential subsidence related impacts on groundwater and surface water resources within the Cataract Reservoir catchment area. The proposed first workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs (including the Illawarra Escarpment), steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir (refer to **Sections 5.2** and **5.3**).

An assessment of the Revised Preferred Project against the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* neutral or beneficial effect on water quality (NorBE) test has been completed and included in **Section 5.3.7** and **Appendix 2**. The Revised Preferred Project is considered to satisfy the NorBE Test as applied under clause 11A of the Drinking Water SEPP (refer to **Section 5.3.7**).

8.2 Voluntary Land Acquisition and Mitigation Policy (Clause 12A)

- **The Commission considers the potential noise increase on nearby residences would be significant, not beneficial or negligible, if assessment is based on criteria derived from the Industrial Noise Policy.**

Response

As discussed in **Section 5.6.1** and **7.1**, a substantial re-design of the Russell Vale Pit Top has been undertaken as part of the Revised Preferred Project design phase in order to reduce noise impacts associated with the UEP. These changes, in conjunction with a range of additional reasonable and feasible noise mitigation measures, significantly reduce the predicted noise levels of the Revised Preferred Project in comparison to the both historical operations and to previously proposed site configuration.

An updated noise impact assessment (NIA) has been completed which re-evaluates the operational and traffic noise impacts of the Revised Preferred Project in accordance with the NPfI, which has superseded the Industrial Noise Policy. The NIA is provided in full as **Appendix 5**, with the results summarised in **Section 5.6**.

Key outcomes of the NIA indicated that:

- with the additional noise controls, the site will generally comply with operational noise criteria at all surrounding residences
- under adverse weather conditions, there is the potential for minor exceedances (1-2dB) of the criteria during a small percentage (less than 10%) of winter nights at some residences close to the site; the NPfI and VLAMP considers a 1-2 dB exceedance a negligible impact that would not be discernible by the average listener
- predicted noise levels indicate that no residence or privately-owned land would be subject to voluntary mitigation or land acquisition rights in accordance with the Voluntary Land Acquisition and Mitigation Policy (VLAMP).

The Revised Preferred Project does therefore not trigger voluntary mitigation or acquisition rights established under the VLAMP.

8.3 Significance of the Resource (Clause 12AA)

- **Significance of the Project's coal resource lies mainly in its ability to maintain coal production from the Southern coalfield and utilisation of the PKCT, which is currently underutilised.**

Response

The Russell Vale Colliery produces high quality hard coking coal, a product that can help meet the expanding demand for metallurgical coal globally, where it is used for the production of steel.

The Russell Vale Colliery has a long history in the region and is well located close to coal export facilities at PKCT.

WCL is a 16% shareholder and has a representative on the Board of PKCT. Maximum approved throughput for the facility is 18 Mtpa and over the last 5 years PKCT have had an average throughput of 8.5 Mtpa. WCL advise that projected throughput for PKCT is 10-11 Mtpa for the next 4 years, which provides ample capacity for proposed WCL production.

9.0 Water and Subsidence

9.1 Potential loss of surface water due to subsidence related cracking

- **Experts remain concerned about the potential loss of surface water flow in Cataract Creek via subsidence related cracking.**
- **A reasonable degree of uncertainty still surrounds the potential for fracturing to extend all the way to the surface over portions of the application area and, if it did how it could be responded to by adaptive management or be remediated.**

Response

The proposed first workings mine plan has been designed to be long term stable with negligible risk of pillar failure. The small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

The groundwater assessment prepared for the Revised Preferred Project mine plan (refer to **Appendix 2**) concludes that due to the proposed mining method, the Revised Preferred Project is not expected to result in any strata deformation or cracking impacts which will affect surface flow and groundwater interactions (refer to **Appendix 2**).

The subsidence assessment prepared for the Revised Preferred Project mine plan (refer to **Appendix 1**) concludes that there is no significant potential for additional interaction between surface water, groundwater and the underground mining horizons above levels already experienced. The deformations associated with strata compression are small in magnitude and there is very limited potential to create additional zones where hydraulic conductivity would be increased (refer to **Appendix 1**).

As the Revised Preferred Project will not result in any strata deformation or cracking impacts which will affect surface flow and groundwater interactions, stream and groundwater system connectivity impacts associated with the proposed mining are largely limited to induced drawdown impacts. The groundwater assessment prepared by GeoTerra (refer to **Appendix 2**) quantifies potential losses in stream base flow for Cataract Creek associated with induced drawdown from the Revised Preferred Project alone and cumulative impacts from all proposed and previous mining at Russell Vale. Results indicate that no observable incremental effect will be caused due to extraction of the proposed first workings, and it will not cause an observable change in overall stream discharge into Cataract Reservoir (in addition to any prior longwall related effects).

The maximum stream flow loss as a consequence of only the proposed first workings is modelled to be 0.0006ML/day (0.22ML/yr) in Cataract Creek during 2073, which will be, for practical purposes, unobservable. Cumulative impacts on baseflow in Cataract Creek associated with all mining at Russell Vale are predicted to peak at 0.024ML/day (8.76 ML/year). Put in perspective, the average daily stream flow from Cataract Creek to Cataract Reservoir is 13ML/d of which 4.1ML/day is baseflow (with a median baseflow of 2.9ML/d) (refer to **Appendix 2**).

The predicted loss of base flow in Cataract Creek is considered unlikely to be observable.

Existing subsidence and water monitoring programs will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The ongoing collection and interpretation of the data will be used to update existing TARP trigger levels and the groundwater model as required. Adaptive management procedures will be reviewed and updated as part of the management plan review process in order to ensure a systematic process for continually detecting impacts that deviate from predictions, validating predictions and improving mining operations so that subsidence impacts creating a risk of negative environmental consequences do not occur (refer to **Appendix 2**).

9.2 Integrated Risk Assessment (IRA)

- **Independence of the IRA is questioned. A risk assessment by oneself of one's own work, even if a recognised expert in the field, does not constitute a truly independent or high level risk assessment.**
- **The context of the IRA did not extend to the effects of water quantity and quality on fauna and on water dependent species along watercourses.**
- **Levels of consequences were defined in qualitative terms, as opposed to quantitative, hence the risk outcomes lack objectivity for those not involved in the risk assessment process.**

Response

As discussed in **Section 5.1.1**, an IRA was undertaken as part of the Response to Planning Assessment Commission Review Report Part 2 (Hansen Bailey 2015b) by Broadleaf Capital International Pty Ltd (Broadleaf, 2015), and assessed risks associated with the previously proposed Preferred Project.

The IRA identified a series of pathways from mining activities that could lead to impacts to water quantity, water quality and environmental effects. These pathways were used as the starting point for identifying risks, which were then analysed and evaluated under a formal risk assessment framework.

The pathways identified by the IRA as having the potential to lead to impacts to water quantity, water quality and environmental effects were all associated with subsidence caused by mining activities. Specifically, the identified risk pathways relate to subsidence movements that have the potential to result in surface fracturing, fracturing of deeper strata, changes to stream or swamp water regimes, changes to groundwater regimes or valley closure on Cataract Creek.

The proposed change to the mine design for the Revised Preferred Project to a stable first workings mine plan effectively addresses all of the identified pathways for impacts on water quantity, water quality and environmental effects assessed by the IRA. The subsidence assessment prepared for the Revised Preferred Project by SCT (2019) (refer to **Appendix 1**) concludes:

> *The small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.*
>
> *Proposed mining is not expected to increase interactions between the mine and surface water or impact surface water dependent ecosystems or groundwater at levels above those currently experienced.*
>
> *There is considered to be no significant potential for additional interaction between surface water, groundwater and the underground mining horizons. The deformations associated with strata compression are small in magnitude. There is very limited potential to create additional zones where hydraulic conductivity would be increased.*

It is noted that the Independent Expert Panel for Mining in the Catchment has recommended that all future applications to extract coal within Catchment Special Areas should be supported by independently facilitated and robust risk assessments that conform to ISO 31000. Given that the proposed change to the mine design has effectively addressed all of the identified pathways for impacts on water quantity, water quality and environmental effects assessed by the previous IRA, and has significantly increased certainty regarding impact predictions, an updated IRA is not considered warranted

9.3 Sealing of Mine Adit to Management Water Inflow

- **If sealing of an adit constitutes a control for managing water inflow, then this control should be risk assessed to determine its likely practicality and effectiveness and hence residual risk.**
- **Consideration of sealing is inconsistent with earlier documentation which indicated that the adits would remain open with water outflows being managed by a water treatment system. If this is the case then the ongoing costs of management and maintenance of the treatment system should be included as part of the mine closure plan.**
- **The flow loss pathway appears to have been considered only in the context of adaptive management in the risk assessment. Experts questioned how the adaptive management regime would be invoked and considered that this raised significant concerns based on experiences at other locations in the Southern Coalfields which suggest that remediation would prove difficult if not impossible.**

Response

The above comments relate to the management of risks should connectivity between the underground workings and surface water features result in increased water inflow. Due to the proposed change in mining method, the Revised Preferred Project is not expected to result in any strata deformation or cracking impacts which will affect surface flow and groundwater interactions and there is very limited potential to create additional zones where hydraulic conductivity would be increased (refer to **Appendix 1** and **Appendix 2**).

As with existing (approved) mine workings, following the completion of mining, groundwater inflows associated with past and proposed workings will recover to the level of the Wongawilli Seam adit (GeoTerra, 2019). The modelled adit drainage rate of up to 0.3ML/day is capable of being managed by water treatment systems. Appropriately treated, this water would be capable of reuse for residential or industrial purposes or discharge into local creek systems.

As part of the mine closure process, a suitable funding arrangement will be negotiated with the relevant stakeholders to fund the ongoing monitoring and treatment of future water outflows from the adit, if required. The funding arrangement will consider appropriate water quality targets based on an agreed potential end use at the time of closure and will be sufficient for 10 years of monitoring and treatment.

9.4 Barrier to Stored Waters of Cataract Reservoir

- **LW 7 bord and pillar workings and limited pillar extraction workings occur within the protective pillar. The stability assessment did not address the angle of draw associated with this subsidence event, which is likely to result in some (minor) subsidence of the base of the reservoir.**

Response

Longwall mining is no longer proposed as part of the UEP. Instead, a first workings mine plan is proposed with large width to height ratio pillars that are designed to be long term stable. The subsidence assessment prepared for the Revised Preferred Project concludes that the proposed first workings mine plan is not considered to have any potential to perceptibly impact on Cataract Reservoir (refer to **Appendix 1**).

It is recognised that the Revised Preferred Project mining plan involves mining within the Dams Safety Committee (DSC) Notification Area for Cataract Storage Reservoir (**Figure 3.2**). The proposed mining plan has minimum width/height pillar within the 1.2 times depth Restricted Zone, the 0.7 times depth (35^0 angle of draw) Marginal Zone and up to the full supply level of the Reservoir. This mining will therefore require the consent of the DSC.

The subsidence assessment (refer to **Appendix 2**) has also given consideration to the potential impacts of the proposed first working mine plan on the Corrimal Fault and Dyke D8, and any risk this may post to the stored waters of Cataract Reservoir. The assessment concludes that no significant subsidence impacts or environmental consequences are expected from mining through or in the vicinity of the Corrimal Fault and Dyke D8 by the proposed first workings layout and no credible risk of inflow between the stored waters of Cataract Reservoir and the mining horizons through either the Corrimal Fault or Dyke D8 exists as a result of the Revised Preferred Project.

The subsidence assessment is detailed further in **Section 5.2** of **Part A.**

9.5 Trigger Levels for Responding to Future Subsidence

- **Cumulative effects and impacts of subsidence in the area are not known with certainty and present a challenge to setting trigger levels for responding to future subsidence.**
- **The proposal by Water NSW that any consent should only permit mining up to a point where the valley closure is predicted to be 200mm needs to be assessed with caution as predictions of valley closure can be unreliable; and it is not known how much valley closure has already occurred and therefore what tolerance there is to further valley closure without resulting in unacceptable impacts.**
- **More emphasis may need to be given to trigger levels based on observed and measured impacts of valley closure such as surface cracking and horizontal shear planes.**

Response

Longwall mining is no longer proposed as part of the UEP. Instead, a first workings mine plan is proposed with large width to height ratio pillars that are designed to be long term stable. There is the potential for low-level subsidence movements (less than 100mm and generally less than 30mm) associated with strata compression above pillars to occur, however these movements are expected to be generally imperceptible and at, or below, survey monitoring tolerance.

The low-level subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

It is noted that large areas within the UEP Application Area are currently in limiting equilibrium (on the verge of moving) because of previous mining of LW4, 5 and 6. This ongoing subsidence may result in further minor impacts to the to the pavement of Mount Ousley Road and small additional valley closure movements across Cataract Creek. These movements would continue regardless of any future mining and may be triggered by effects such as increased groundwater levels following periods of high rainfall and seasonal temperature variations. The mining proposed by the Revised Preferred Project is not expected to increase or otherwise change the potential for these effects to cause additional, perceptible impacts.

The existing subsidence monitoring program will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The monitoring program will be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mining below subsidence sensitive infrastructure.

Trigger levels for existing operations will initially be maintained for the Revised Preferred Project, having regard to existing observed impacts and the potential for low-level subsidence movements associated with the proposed mine plan. These triggers (and TARP more broadly) will be reviewed in the development of updated water management plan.

The subsidence assessment is detailed further in **Section 5.2** of **Part A.**

9.6 PAC's Considerations and Findings

- **Uncertainty of potential impact to the catchment area remains unresolved, particularly when the cumulative impacts are considered.**

Response

The revised mine plan and mining method proposed for the Revised Preferred Project has been specifically designed to reduce the uncertainty associated with subsidence related impacts on groundwater and surface water systems.

The Revised Preferred Project, using first workings only, is not expected to cause perceptible surface subsidence, significant interaction with the overlying seams or significant interaction with existing groundwater systems (SCT, 2019). The mine plan is designed to retain pillars which are long term stable. Some low level deformation is however expected due to elastic compression of the strata above and below these pillars. This strata compression has potential to result in low level subsidence movements (less than 100 mm and generally less than 30mm) with corresponding low levels of tilt and strain. Any such subsidence is likely to occur gradually. These subsidence movements are expected to be generally imperceptible and insignificant for all practical purposes (SCT, 2019).

The subsidence and groundwater assessments are detailed further in **Sections 5.2** and **5.3** of **Part A.**

- **If flow loss does occur, there is no clear indication of what the adaptive management measures are, how they could be implemented or their effectiveness in remediation.**

Response

The Revised Preferred Project has been specifically re-designed to avoid any secondary extraction beneath Cataract and Bellambi Creeks or Cataract River and their associated swamps, as well as Cataract reservoir. The proposed mine layout and mining method has been designed to reduce uncertainty regarding potential impacts.

The small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir (SCT, 2019). Due to the small magnitude of subsidence effects expected from the proposed mining layout, there is a high level of confidence in the reliability of the subsidence impacts forecast.

The existing Russell Vale groundwater monitoring network will continue to be utilised to monitor impacts associated with the Revised Preferred Project. The existing groundwater monitoring program will be reviewed and updated to reflect the Revised Preferred Project as part of an update to the existing Russell Vale Water Management Plan. The groundwater monitoring program will include monitoring of groundwater levels, water quality, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model as required. Adaptive management procedures will be reviewed and updated as part of the management plan review process in order to ensure a systematic process for continually detecting impacts that deviate from predictions, validating predictions and improving mining operations so that subsidence impacts creating a risk of negative environmental consequences do not occur (refer to **Appendix 2**).

- **Potential loss of 10% flow in Cataract Catchment would be a significant loss.**

Response

The proposed mine plan will have no observable impact on surface flows.

The groundwater assessment for the Revised Preferred Project (refer to **Appendix 2**) quantifies potential losses in stream base flow within the Cataract catchment (Cataract Creek, Cataract River and Bellambi Creek) associated with induced drawdown from the Revised Preferred Project alone and cumulative impacts from all mining at Russell Vale.

The assessment indicates that the stream base flow losses in Cataract Creek, Cataract River and Bellambi Creek due to the proposed mine plan alone are in the order of 1.3 kL/day or 0.47 ML/year and peak in approximately 45-60 years post mining (GeoTerra, 2019). Put in perspective, the average daily stream flow from Cataract Creek to Cataract Reservoir is 13ML/d of which 4.1ML/day is baseflow (with a median baseflow of 2.9ML/d (WRM Water & Environment, 2015). This additional predicted loss of base flow is unlikely to be observable.

Total predicted cumulative stream base flow losses in Cataract Creek, Cataract River and Bellambi Creek due to all mining at Russell Vale Colliery (proposed and historical) are in the order of 27 kL/day or 9.91 ML/year (GeoTerra, 2019). The predicted cumulative daily reductions in base flow represent less than 0.2% of the average daily inflows to the Cataract Reservoir from Cataract Creek alone.

The groundwater model also considered potential leakages from Cataract Reservoir associated with regional depressurisation of the underlying aquifers. Leakage of stored water within Cataract Reservoir to the underlying groundwater system due to depressurisation of the regional groundwater system in the vicinity of the reservoir was found not to be measurable at the end of the proposed first workings extraction (refer to **Appendix 2**).

The subsidence and groundwater assessments are detailed further in **Sections 5.2** and **5.3** of **Part A**.

- **Financial compensation for water loss – Payment could be one-off but loss will be permanent and irreversible and will also have an associated impact on water quality due to the damage to upland swamps and other vegetation that relies on surface and shallow groundwater.**

- **If water loss is negligible, the water licence system could be employed to compensate the loss, however the estimated potential loss ranges between 15 ML/year and 2.6 GL/year, so at what point does a water licence as a compensatory mechanism become unacceptable?**

Response

The predicted reductions in baseflows associated with the Revised Preferred Project are considered to be negligible (less than 0.5 ML/year). Under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources, which encompasses the UEP Application Area and is contained within the Sydney Basin Nepean Groundwater Source Area, WCL will require a WAL for the annual take of up to 10.04 ML/yr of stream baseflow resulting from depressurisation of deeper aquifers (refer to **Appendix 2**).

- **Ongoing costs of management and maintenance of the water treatment system, if required, to treat water outflows from the adit after the mine closes. Not clear whether the proponent or community will bear long term management and operational cost of the treatment system as it will have significant impact on economic assessment of the project**

Response

Irrespective of whether or not the Revised Preferred Project is approved, once mining ceases groundwater inflows to the underground workings will gradually fill the mine and re-pressurise the overburden until the recovery reaches the 117.5m AHD elevation of the escarpment adit, at which point the water would discharge from the adit. The Revised Preferred Project is unlikely to have any significant impact on the volume of water discharged from the adit however the additional void space associated with the additional coal extracted from the Project will delay the time in which the water levels recovers to the level of the adit. The management of this water and maintenance of the water treatment system if required, therefore applies under both the Project and no Project Scenario.

As part of the mine closure process, WCL will negotiate a suitable funding arrangement with the relevant stakeholders to fund the ongoing monitoring and treatment of future water outflows from the adit, if required. The funding arrangement will consider appropriate water quality targets based on an agreed potential end use at the time of closure and will be sufficient for 10 years of monitoring and treatment.

10.0 Impact on Upland Swamps

- **The uncertainty in predicting subsidence and the environmental outcomes for upland swamps and the sensitive nature of the area warrants a cautious approach.**
- **There is significant doubt as to what mitigation measures could be applied to remedy the cracking of bedrock beneath the swamps, apart from offset**

Response

In response to the PAC's concerns regarding uncertainty in predicting subsidence and the environmental outcomes for sensitive environments such as upland swamps, longwall mining is no longer proposed as part of the UEP. Instead, a first workings mine plan is proposed with large width to height ratio pillars that are designed to be long term stable. The subsidence assessment prepared for the Revised Preferred Project concludes that the proposed first workings mine plan is not considered to have any potential to perceptibly impact on any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

The groundwater assessment prepared for the Revised Preferred Project mine plan (refer to **Appendix 2**) concludes that due to the proposed mining method, the Revised Preferred Project is not expected to result in any strata deformation or cracking impacts which will affect surface flow and groundwater interactions (refer to **Appendix 2**).

Impacts on previously identified biodiversity values are predicted to be negligible. A revised impact assessment based on the findings of the updated subsidence and biodiversity assessments are provided in **Sections 5.2** and **5.5** of **Part A**.

Avoidance of longwall mining under swamps is a key guiding principle of the new upland swamp offset policy (OEH, 2016).

- **If the OEH's classification of risk is considered, the potential damage of 14 swamps with uncertain environmental consequences in a drinking water catchment area is a significant concern, if offset could not be found within the catchment area**

Response

In response to the PAC's concerns regarding uncertainty in predicting subsidence and the environmental outcomes for sensitive environments such as upland swamps, longwall mining is no longer proposed as part of the UEP. Instead, a first workings mine plan is proposed with large width to height ratio pillars that are designed to be long term stable. The subsidence assessment prepared for the Revised Preferred Project concludes that the proposed first workings mine plan is not considered to have any potential to perceptibly impact on any natural surface features including upland swamps (refer to **Appendix 2**).

As discussed in **Section 5.5**, a revised biodiversity impact assessment has been prepared for the Revised Preferred Project. As the revised mine plan will not result in any perceptible surface subsidence and is not considered to have any potential to perceptibly impact on upland swamps, potential impacts to upland swamps from the Revised Preferred project mine plan are predicted to be negligible. Consequently, threatened species occupying upland swamps are also considered at negligible risk of impact.

11.0 Socio-Economic Benefits and Impacts

- **Question over the quantum of economic benefits that would be generated from the project and the proponent's capacity to deliver the claimed benefits including employment, expected production rates and associated royalty payment**

Response

An economic impact assessment was undertaken which comprised a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA). The assessment estimates the net benefits of the Revised Preferred Project to the State and the local benefits to the Wollongong region. A summary of the key outcomes of the economic assessment is set out in **Section 5.14**, with the full report provided in **Appendix 10**.

As summarised in **Section 5.14.1**, the estimated net benefit to NSW is $174.3 million in NPV terms (how much a future sum of money is worth today) with the direct benefits of the Revised Preferred Project estimated to be $116.9 million in NPV terms. The Revised Preferred Project is also expected to generate total indirect benefits of $57.4 million in NPV terms, comprised of $43.6 million of worker benefits and $13.8 million of supplier benefits.

Further, the Revised Preferred Project is expected to generate modest incremental indirect costs on the NSW community of about $19,158, which is the cost of water licensing and greenhouse gas attributable to NSW. Most of the mitigation and monitoring costs associated with environmental impacts relating to the UEP are incorporated in the capital and operating costs of the Revised Preferred Project.

In terms of local effects, the assessment predicts a total estimated net benefit of $17.0 million in NPV terms to local suppliers and employees in the Wollongong local area. This is driven largely by:

- Benefits to local workers of $8.7 million in NPV terms based on the assumption that 20% of the mine's direct employees continue to be drawn from the region; and,
- Benefits to local suppliers of $5.5 million in NPV terms based on the assumption that 20% of the inputs to production are suppled from the region.

The revenue, expenditure and employment associated with the operation of the Revised Preferred Project will stimulate economic activity in the Wollongong local economy as well as the broader NSW economy.

- **The economic assessment requires updating to take into consideration that additional mitigation measures are required to reduce noise impact from the pit top site to private residences and truck traffic noise impact to residents along Bellambi Lane when the benchmark existing noise levels are updated to reflect actual noise.**

Response

The updated economic assessment for the Revised Preferred Project (**Appendix 10** and **Section 5.14**) takes account of the costs associated with the noise mitigation measures (set out in **Section 5.6.1**). These are incorporated in the capital and operating costs of the Revised Preferred Project.

- **How does the $22m cost of water loss estimated by WaterNSW compare with the CIE estimate of $430,000 present value? The Commission's concern is that any payment could be a one-off payment. However, the loss will be permanent and irreversible. The loss will also have its associated impact on water quality due to the damage of upland swamps and other vegetation that rely on surface and shallow groundwater, which play a significant role in water quality control.**

<u>*Response*</u>

As discussed in **Section 5.3**, updated groundwater modelling has been used to quantify predicted losses in stream base flow within the Cataract catchment as a result of the Revised Preferred Project mine plan. The predicted reductions in baseflows associated with the Revised Preferred Project are considered to be negligible (less than 0.5 ML/year), significantly less than those previously predicted under the Preferred Project longwall mine plan.

A Water Access Licence under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (Surface Water WSP), Sydney Basin Nepean Groundwater Source Area, will be sought to account for these losses.

The economic cost attributed to these losses is estimated in the Economic Impact Assessment (refer to **Appendix 10**) as $36.66 per annum or $515.20 in NPV terms in total.

- **Who should bear the potential long term management and operational cost of the water treatment system, if require to control water outflows from the adit following mine closure assuming it is part of the operating cost while the mine is in operation?**

- **Timeframe factored in the estimated $62,000 (present value) to WaterNSW for on-going monitoring requirements as monitoring will continue to be required after mine closure.**

Response

As part of the mine closure process, WCL will negotiate a suitable funding arrangement with the relevant stakeholders to fund the ongoing monitoring and treatment of future water outflows from the adit, if required. The funding arrangement will consider appropriate water quality targets based on an agreed potential end use at the time of closure and will be sufficient for 10 years of monitoring and treatment.

- **The key issue is balancing the short-term immediate economic benefits with the uncertain long-term costs and environmental consequences.**

<u>*Response*</u>

The economic assessment concludes that the Revised Preferred Project is estimated to contribute a total net economic benefit for the NSW community of approximately $174.3 million in NPV terms consisting of $116.9 million in direct benefits to the State, $57.4 million indirect benefits. In addition, the Revised Preferred Project will also provide a net benefit of approximately $17.0 million in NPV terms to the Wollongong local area consisting mainly as economic benefits of $8.7 million to employees and $5.5 million to suppliers in the local area.

The Revised Preferred Project is expected to generate modest incremental indirect costs on the NSW community of about $19,158, which is the cost of water licensing and greenhouse gas attributable to NSW. Most of the mitigation and monitoring costs associated with environmental impacts relating to the UEP are incorporated in the capital and operating costs of the Revised Preferred Project.

Therefore, it is concluded that the revenue, expenditure and employment associated with the operation of the Revised Preferred Project will stimulate economic activity in the Wollongong local economy as well as the broader NSW economy.

12.0 Noise

- **The Department's adoption of the modelled noise levels as existing noise levels is not reasonable or sufficiently justified.**

Response

An updated Noise Impact Assessment has been prepared for the Revised Preferred Project in accordance with the NSW Noise policy for Industry (NPfI) (EPA 2017) and is provided in **Appendix 5**. The existing acoustic environment surrounding the site has been established using a combination of:

- long-term noise monitoring data collected at two on-site monitoring stations over the entire 2016 year period, and
- the results from a previous survey conducted by Wilkinson Murray over a 12 day period in 2014.

Continuous 15-minute interval noise monitoring data collected by the two on-site monitoring stations over the entire 2016 period was processed in accordance with NPfI methodology. Russell Vale Colliery went into care and maintenance in late 2015 and was not operational throughout the whole of 2016. This long-term data is therefore considered to provide the most accurate representation of the existing background noise environment for receivers in the vicinity of the monitoring locations, that is, to the north and south of the site.

For receivers to the east of the site that are likely to be more affected by traffic noise from the Princes Highway, noise survey data collected by Wilkinson Murray over a 12 day period in 2014 in the absence of operational mine noise was used to establish background noise levels at these locations.

- **The setting of benchmarks should have regard to the 2011 approved noise limits, the 2012 noise audit results and the Industrial Noise Policy.**

Response – 2011 approved noise limits

The 2011 approved noise limits are inappropriate as they are the outcome of an assessment approach that was not undertaken in full accordance with the then applicable *NSW Industrial Noise Policy* (now superseded by the NPfI).

As previously reported to the PAC, Wilkinson Murray has found a general inconsistency with the approved limits, the Project Specific Noise Levels (PSNLs) (determined by the ERM 2010 assessment) and the predicted noise levels (determined by the ERM 2010 assessment). It has been noted that the limits developed from the predicted levels are based on "under-predictions" that seemingly did not incorporate the appropriate meteorological conditions and sound power levels. Additionally, based on these under-predicted levels some of the approved limits are lower than the determined PSNLs.

Due to these inconsistencies, it is considered appropriate that the approved limits are reconsidered based on the findings of the Revised Preferred Project noise assessment.

Response – 2012 noise audit

As previously noted, the 2012 audit results indicated that the site complied with its limits during the brief period of the audit. Whilst this may provide a benchmark in terms of the site's compliance status for the period of the audit, Wilkinson Murray considers that due to the temporal variations in site noise emissions, the most appropriate assessment would consider the site emissions at full capacity and under relevant meteorological conditions. The noise assessment prepared by Wilkinson Murray for the Revised Preferred Project (refer to **Appendix 5**) considers site noise sources operating at full production capacity and under the relevant meteorological conditions established in accordance with the NPfI.

The 2012 noise audit (Pacific Environment, 2012, Section 7, Table 7.1) provided an action plan of recommendations and associated time scales for implementation. These recommendations are provided below, along with current status and responses (where required) regarding the Revised Preferred Project:

Noise Audit Recommendations (Pacific Environment, 2012)	Status / WCL Response
Restrict Heavy Truck activities on the Project site outside day and evening periods to achieve noise limits defined in Project Approval.	Truck loading and coal transport will typically be limited to daytime hours only between 7.00 am - 6.00 pm Monday to Friday and 8.00 am - 6.00 pm Saturday. No truck loading or coal transport will occur on Sundays or Public Holidays. Truck loading and coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closure or supply interruption, however such circumstances would be rare and as a result of unexpected events.
Schedule 3, Condition 14(a) of Project Approval to be modified to state 'the existing Bulli Conveyor is decommissioned when the Wonga Mains drivage is complete'.	The "existing Bulli Conveyor" referred to by Pacific Environment will not be used for the Revised Preferred Project and has been decommissioned.
Any large scale construction activity include a noise management plan in accordance with DECCW's Interim Construction Noise Guidelines	A noise management plan for construction activity associated with the Revised Preferred Project will be prepared as part of the proposed Construction Environmental Management Plan.
Retrofit existing mobile plant with non-tonal reversing alarms (quacking alarms).	Undertaken by WCL.
Implement Real Time Monitoring Program	WCL has a real time noise monitoring program in place using two real time continuous monitors.
When possible, coordinate quarterly attended noise surveys with high levels of site activity. Quarterly attended noise survey should include 1/3 octave band measurement.	Quarterly attended noise surveys were undertaken by WCL prior to the site going into care-and-maintenance status.

Noise Audit Recommendations (Pacific Environment, 2012)	Status / WCL Response
Retrofit CAT988 Loader, D11 Dozer with noise mitigation	The D11 Dozer will be downsized to a D8 fitted with an attenuation pack for the Revised Preferred Project. The use of the FEL is now required significantly less frequently than previously due to the proposed installation of truck loading bins. Previously the FEL was used to load most of the product trucks leaving the site. As it will now be used less frequently (approximately 2 hours per day) its contribution to noise impacts is significantly reduced as a noise source, and attenuation is not proposed for the Revised Preferred Project.
Based on noise source levels of mitigated Dozer and Front loaders, quarterly compliance measurements, and operational modelling predictions determine additional administrative controls required to achieve medium term intrusive noise limits of the Project Approval.	Quarterly compliance monitoring will continue for the Revised Preferred Project.

<u>Response – Industrial Noise Policy</u>

It is noted that the Industrial Noise Policy has now been superseded by the NPfI and following consultation with DPIE, the noise assessment has been updated to take account of the contemporary provisions of the NPfI in the setting of noise criteria. The Revised Preferred Project noise assessment has drawn on long-term background noise monitoring data collected on-site over the full 2016 year and over a 12-day period in June 2014, whilst the site was not operational. It is considered that this long-term site-specific data provides the best estimation of the background noise environment around the site and new Project noise trigger levels have been re-evaluated on this basis.

- **If the PSNLs are accepted as the benchmark for assessment of impact, the proposed project would have significant residual noise impact on certain nearby residences, notwithstanding the already implemented and proposed on site mitigation measures.**

<u>Response</u>

The Revised Preferred Project noise assessment has re-evaluated impacts, with consideration of a significant site reconfiguration, substantial changes to operational processes and the adoption of extensive noise mitigation measures as detailed in **Section 5.6.1**. Additionally, project noise trigger levels have been re-evaluated in accordance with the new NPfI and based on long-term site-specific background noise data, collected on-site over the full 2016 year and over a 12-day period in June 2014, whilst the site was not operational. It is considered that this long-term data provides the best estimation of the background noise environment around the site and new Project noise trigger levels are justified on this basis.

With these proposed changes, significantly reduced operational noise levels are predicted, in comparison with the pre-existing operation of the site and when compared with the recently proposed site arrangement

Despite the implementation of feasible and reasonable mitigation, some residual exceedances of the operational criteria are predicted to remain:

Night time noise levels during phase-in and full operations are predicted to exceed the Project noise trigger levels by up to 1 dB at representative receivers R1, R2 and R3 and by up to 2 dB at representative receivers R9 and R10.

It should be noted that the extent of these exceedances is significantly less than previously assessed by Wilkinson Murray, indicating a marked environmental noise reduction (i.e. according to the previous UEP assessment, residual noise impact with upgrades in place would have ranged up to 11 dB, 13 dB and 9 dB during the day, evening and night periods, respectively).

Additionally, whilst some residual exceedances are predicted, they are considered negligible and indiscernible by the average listener. No noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.

The reduction in predicted impacts are due to a number of additional and improved noise mitigation measures including:

- Repositioning infrastructure to provide maximum topographical shielding from surrounding residences, for example relocating the surge bin and secondary sizer building from an exposed location to the toe of a batter
- Acoustic treatment of new plant and equipment, including enclosing the Coal Processing Plant and Secondary Sizer in an acoustically treated building, acoustic treatments to the Surge bin and conveyors and attenuation pack and grouser treatment of the dozer
- extension and increase in the height of existing berms in strategic locations surrounding the Pit Top to shield trucks and equipment.
- construction of a 4 m high noise barrier along the northern side of the site access road between the site entrance and turn off to the truck parking area to mitigate impacts of trucks accessing the site. Construction of the access road noise barrier will be completed prior to the commencement of ‘phase-in’ operations
- establishing a temporary stockpile of ROM coal as early as possible in ‘phase-in’ operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile
- voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane
- 40 km/hr speed limit on site
- operational noise mitigation measures such as:
    - restricting the operation of the dozer, rejects front-end loader, rejects truck, and underground loader to daytime only use
    - generally restricting the operation of the reclaim conveyor system, Secondary Sizer, Surge Bin, Processing Plant and truck loading bins to daytime use only, however noise impacts of operation of these items during the evening period has been considered in the noise impact assessment to cater for unexpected Port closures or interruptions
    - Dozer movements restricted to near ground level during ‘phase-in’ operation to maximise shielding provided by temporary ROM coal stockpile.

- **The draft recommended noise criteria for the identified receivers are not reasonable, particularly the criteria for "all other privately-owned land" especially to those who are neighbours to the identified receivers.**

Response

As outlined in Section 3 of **Appendix 5**, the sensitive receivers considered by the Noise Impact Assessment are deemed representative of the potentially most impacted receivers surrounding the site.

The Noise Impact Assessment identifies noise catchment areas to represent areas of similar background noise levels. As illustrated in the noise contour figures presented in **Appendix 5**, those noise catchment areas are in turn used to define project noise trigger level applicability areas. All receivers located within the same project noise trigger level applicability area are subject to the same project noise trigger levels.

The project noise trigger levels derived for this assessment have been established in accordance with contemporary policy, being NPfI, and are based on long-term site-specific background noise data collected over the full 2016 year and survey data collected over a 12-day period in June 2014 whilst the site was not operational. It is considered that this data provides the best estimation of the background noise environment around the site and new project noise trigger levels are justified on this basis. The project noise trigger levels are considered appropriate in the current land use context, with the primarily residential areas close to the site subject to criteria ranging from 39 dB to 44 dB, and areas to the east that are increasingly affected by noise from the Princes Highway, Memorial Drive and commercial land uses, subject to slightly higher criteria ranging from 42 dB to 48dB.

- **Additional mitigation measures are required to reduce noise impact from the pit top site to private residences and truck traffic noise impact to residents along Bellambi Lane when the benchmark existing noise levels are updated to reflect actual noise**

Response

A key objective of the Revised Preferred Project design has been to develop comprehensive mitigation and management strategies to reduce environmental and social impacts associated with the UEP in order to meet relevant criteria where-ever practicable and feasible. This has included redesigning the Russell Vale Pit Top and identifying further noise mitigation measures to reduce the acoustic impact of surface operations on the surrounding community. Further detail of the proposed noise mitigation measures is provided in **Section 5.6.1**.

As discussed in **Section 5.6**, the effects of these noise mitigation measures have been assessed as part of an updated Noise Impact Assessment undertaken in accordance with the NPfI (EPA 2017). Results indicate that at full operation, no exceedances of the NPfI criteria are expected during the day, evening or early morning shoulder periods at any of the identified representative receivers. Under adverse weather conditions, a 1-2 decibel (dB) exceedance is anticipated at some residences close to the site during a small percentage (less than 10%) of Winter nights. It is noted that due to restricting operating hours associated with the Revised Preferred Project, the only noise generating activity occurring on the surface during the night time period is the running of ROM coal onto the ROM stockpile.

The NPfI and Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) defines a 1-2 dB exceedance as a negligible residual noise impact indiscernible by the average listener.

These changes therefore significantly reduce the predicted noise levels of the Revised Preferred Project in comparison to both historical operations, and to the previously proposed site configuration, which predicted exceedances (of the then Industrial Noise Policy criterion) of up to 11dB, 13dB and 9dB during the day, evening and night respectively.

The NIA prepared for the Revised Preferred Project includes an updated traffic noise assessment in accordance with the EPA's *NSW Road Noise Policy* (RNP) (EPA 2011). The assessment concludes that road traffic noise associated with the Revised Preferred Project resulted in an acceptable relative traffic noise increase to residents along Bellambi Lane and surrounds under the RNP.

13.0 Air Quality

- **A strong real time monitoring and pro-active management regime is of critical importance to minimise potential impact on residents and annual reporting should be available on the proponent's website.**

Response

WCL operates two real time TEOM air quality monitors recording PM_{10} and $PM_{2.5}$ concentrations. As discussed in **Section 5.7.7,** WCL will review and update the existing Russell Vale Colliery Air Quality and Greenhouse Gas Management Plan for the Revised Preferred Project. In addition to the range of dust control measures outlined in **Section 5.7.7**, the plan will be updated to incorporate a range of proactive and reactive dust control strategies.

Proactive air quality management would involve the planning of activities in advance of potentially adverse conditions. Specifically, the proactive air quality management approach will include:

- implementation of a system to provide the operation with a daily forecast of expected dust conditions in the vicinity of the operation
- discussion of the weather conditions and dust considerations at daily pre-shift meetings
- modifying or suspend the planned activities, as appropriate, to minimise dust impacts.

Reactive air quality management will include the modification or suspension of activities in response to the following triggers:

- visual conditions, such as visible dust from trucks above wheel height.
- meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors, and/or
- ambient air quality conditions (that is, elevated short-term PM_{10} concentrations).

WCL currently has annual environmental monitoring reports available on its website, consistent with the recommendation of the PAC.

- **A review of the draft conditions of approval in relation to timeframes for implementation of the various proposed mitigation measures is required, particularly when production rate is unlikely to reach 2.7mtpa.**

Response

The proposed production rate for the Revised Preferred Project is a maximum of 1 Mtpa product coal.

As discussed in **Section 5.7.7**, a range of air quality mitigation measures and controls have been included in the Revised Preferred Project design and will be implemented by WCL in the ongoing operation of the Revised Preferred Project. These include:

- Enclosure of conveyors and material transfer points
- Enclosure of Processing Plant

- Water sprays on ROM stockpile
- Water carts on unsealed haul routes
- Water sprays on stockpiles and exposed areas triggered during periods of high winds
- Water sprays on the noise berms during construction
- Trucks will be covered before leaving the site
- Trucks will be washed before leaving the site
- Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes
- Revegetation/rehabilitation of exposed disturbed areas.

These controls will be implemented upon commencement of the relevant activity and continue to be implemented over the life of the project.

- **A prohibition condition may be required to disallow the transport of materials from the site to the RVEA without the agreement of the Wollongong City Council.**

Response

The RVEA operates under a development consent issued by WCC on the 11 April 1990, granting approval for the emplacement of reject material only (from the coal washery plant and the underground workings) which is uncontaminated by oil or any other form of waste.

As described in **Section 2.1.6**, reject material generated by the Revised Preferred Project will be sold for use as fill inert material, alternatively rejects will be used in site rehabilitation or hauled back to the mine portal for emplacement underground. Reject material will not be emplaced on the RVEA.

- **A clear description of the stockpiles' dimensions (height, length and width) would assist the understanding of the visual relationship of the stockpiles and the surrounding land uses.**

Response

The dimensions of the stockpile areas proposed for the Revised Preferred Project are described in **Section 2.1.7**.

Mining has been undertaken at the Russell Vale Colliery site since the 1880s. As such mining related infrastructure has been a feature of the visual landscape surrounding the site for over 130 years. An assessment of the potential visual impacts of the Revised Preferred Project has been undertaken and is presented in **Section 5.10**. A range of visual mitigation measures are also set out in **Section 5.10.4** to improve the visual amenity of the site and minimise visual impact.

14.0 Bellambi Creek – Flood Management

- **If project were to be approved, PAC supports the inclusion of a condition of consent that requires the implementation of flood mitigation measures recommended in the Cardno 2015 Report within 12 months of date of approval.**

- **PAC supports the draft recommended condition requiring the installation of a swale alongside the stockpile access road, which should improve water management on the site.**

<u>*Response*</u>

Following the PAC Second Review Report in March 2016, WCL applied through a separate modification application (MP10_0046) (Modification 4) to implement the works identified in the Cardno 2015 Bellambi Gully Flood Study consistent with the above recommendations from the PAC Second Review Report in the absence of the impending UEP approval. Through this process, the Cardno 2015 design has been further refined by using further detailed flood modelling in the Bellambi Gully Flood Assessment (Engeny, 2018).

The environmental assessment (EA) for the modification application (MP 10_0046 MOD 4) (Mod 4) was placed on public exhibition in March 2018. A total of 41 submissions were received which included eight government agency submissions and 33 submissions from community members and interest groups. In response to the submissions, WCL commissioned further investigations, including updated flood modelling and further pipeline assessments in order to refine the proposed stormwater management strategy. These revised studies have been peer reviewed.

Engeny (2018) indicated that the proposed refinements to the Cardno 2015 flood control strategy will have improved flood management outcomes compared to the 2015 Cardno solution. These refinements include:

- **Separation of clean and dirty water systems:**
  - Construction of upstream levee to detain and divert upslope catchment runoff through the Bellambi Gully Diversion Pipeline.
  - Construct self-cleaning debris control structures at the inlets to both the 1800 mm and 600 mm pipes.
- **Control of flows through dirty water areas:**
  - Regrade eastern laydown area to form a dry detention basin. This basin will enable management of runoff within the laydown areas and minimise spills to Bellambi Lane. The basin would have an effective capacity in the order of 2.1 ML.
  - Construct channel from laydown area to SWCD to manage and divert flows in excess of the capacity of Dam 1 and Dam 2 and the new dry detention basin in the laydown area to the SWCD.
- **Maintenance**
  - The above structures and existing controls will be included on regular maintenance schedules.

In overview, the key differences in the management of flood/stormwater flows in the Engeny (2018) proposed flood mitigation measures when compared to Cardno (2015) are, in summary:

- Use of a flood levee upslope of the stockpile area. This is changed from a swale alongside the stockpile access road as proposed in Cardno (2015) as the updated modelling results from Engeny (2018) indicated that the swale would increase flood impacts at the Princes Highway. The Engeny (2018) proposed flood levee provides additional separation of clean and dirty water systems (i.e. upstream runoff and runoff from the stockpile area) for up to and including the 100 year ARI event (Engeny, 2018).

- Controls to divert dirty water runoff to the SWCD via the proposed dry detention basin. Conveyance of dirty water through an additional dry detention basin located on the eastern end of the existing laydown area, which is considered to provide additional water quality treatment, and minimisation of dirty water flows down the access road and Bellambi Lane. The measures proposed in Cardno (2015) resulted in more dirty water flows from the site being conveyed to Bellambi Gully without passing through either the dry detention basin or the Stormwater Control Dam when compared to Engeny (2018).

- The modelling results of the changes to the proposed flood mitigation measures indicated improved separation of clean and dirty water flows, as well as, additional reduction of peak flow rates down the access road (and Bellambi Lane) and reductions in peak flows at the Bellambi Gully Culverts under the Princes Highway when compared to Cardno (2015). In particular,

  - Engeny's flood modelling results for the Cardno preferred solution (including the refined dry detention basin) show a 55% reduction in 100 year ARI peak flow rates down Bellambi Lane (9.4 to 4.2 m^3/s), as well as a 26% reduction in peak flows overtopping the Princes Highway (10.0 to 7.4 m^3/s).

  - Engeny's flood modelling for the updated stormwater management strategy (Engeny, 2018a) shows a 57% reduction in 100 year ARI peak flow rates down Bellambi Lane (9.4 to 4.0 m3/s), as well as a 36% reduction in peak flows overtopping the Princes Highway (10.0 to 6.4 m3/s).

Engeny (2018) recommended further monitoring and contingency measures, including management measures related to stockpile management and heavy vehicle movements over the Bellambi Gully Diversion Pipe which are aspects of the Revised Preferred Project for the UEP.

To optimise performance of all mitigation measures, regular/programmed inspection and clearing of debris control structures is proposed. These measures will be incorporated in the Surface Facilities Water Management Plan for Russell Vale Colliery. This will include trigger action response plans (TARPs) for each aspect of the monitoring, management and contingency measures.

A Response to Submissions (RTS) was prepared to address the issues raised in the agency and community submissions received during the public exhibition period. The revised stormwater management strategy and recommended stormwater management and control measures were also further described and assessed in Section 5.3 of the RTS. The RTS was lodged with the DPIE on 21 December 2018.

In a further round of submissions, three agencies (Council, OEH and EPA), in addition to the DPIE, had additional concerns and comments for further consideration. Detailed and comprehensive technical responses were prepared to address concerns and were collated into a Response to RTS. The Response to RTS was lodged with the DPIE on 19 June 2019.

15.0 Traffic and Transport

- **The predicted traffic noise increase of 1.7dBA is not credible and should be reassessed having regard to the then existing truck movements not modelled movements.**

Response

Coal from the Revised Preferred Project will be transported by truck to PKCT using road registered semi-trailer trucks and may in the future utilise B-double trucks. The proposed transport route is via Bellambi Lane and Memorial Drive, consistent with previously approved operations. Traffic generation of the Revised Preferred Project will be similar to the previous traffic generation of Russell Vale Colliery when it was operational.

An updated assessment of road traffic noise has been completed for the Revised Preferred Project in accordance with EPA's *NSW Road Noise Policy* (RNP) (EPA 2011). The assessment is provided in **Appendix 5**. Under the RNP, Bellambi Lane is identified as a 'principal haulage route', and therefore the criteria for arterial/sub arterial roads apply. The assessment considered the increase in noise levels from the existing traffic volumes and takes into consideration an average 1.5% per year background traffic growth rate for Bellambi Lane. As per the RNP, an increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

The analysis indicated that the Revised Preferred Project traffic may be expected to result in relative noise level increases of:

- 2.0 dB during the day (associated with light and heavy vehicles accessing the site), and
- 0.5 dB at night (associated with light vehicles accessing the site).

This indicates an acceptable relative traffic noise increase to residents along Bellambi Lane and surrounds under the RNP.

WCL has sought to limit traffic noise impacts to residents along Bellambi Lane by restricting haulage to the RNP day period only and mandating a reduced speed limit for coal trucks along Bellambi Lane, which is monitored via GPS tracking.

- **The proposed truck parking area is in close proximity to a number of residences near the entrance to the pit top site. The review of the need for the construction of a noise barrier and/or mitigation measures on private residences should have regard to the noise impact arising from truck queuing.**

Response

An alternative parking area is proposed as a component of the Revised Preferred Project and is further discussed in **Section 2.1** and shown in **Figure 2.2**. The proposed truck parking area is well shielded from neighbouring residences as it is surrounded on three sides by an existing bund that will be extended in height as part of the Revised Preferred Project. Trucks entering the site prior to the commencement of loading operations will be required to proceed to the truck parking area and turn off their engines while parked. Adequate parking will be available on site to avoid trucks queuing on the road outside of the Colliery.

In addition, a 4 m high noise barrier will be constructed along the northern side of the site access road between the site entrance and turn off to the truck parking area to mitigate noise impacts of trucks accessing the site. Construction of the access road noise barrier will be completed prior to the commencement of 'phase-in' operations.

- **The proponent's offer to make a contribution to the RMS for pavement upgrade along Bellambi Lane is reasonable and should be accepted as a condition of approval, if the project were to be approved. However, the contribution should be made to the relevant roads authority.**

Response

WCL will seek to reach agreement with WCC for a road maintenance contribution for the maintenance of Bellambi Lane within 12 months of project approval.

- **There is insufficient justification to increase production level to 3Mtpa based on the predicted production levels provided by the proponent.**

Response

The Revised Preferred Project has a production rate of up to 1 million tonnes of product coal per year.

16.0 Conclusion

This section provides a conclusion discussing the justification for the Revised Preferred Project, taking into consideration the environmental, social and economic impacts of the proposal and the suitability of the site, to assist the consent authority to determine whether or not the Revised Preferred Project is in the public interest.

16.1 Environmental, Social and Economic Impacts

As detailed in **Section 5.0**, the environmental, social and economic impacts of the Revised Preferred Project have been identified and subject to a detailed environmental assessment based on:

- assessment of the site characteristics (existing environment)
- historical/actual knowledge and data from the existing mining operations and surrounds
- consultation with relevant government agencies
- engagement with local community and other stakeholders
- environmental and social risk analysis
- application of the principles of ESD, including the precautionary principle, intergenerational equity, conservation of biological diversity and valuation and pricing of resources
- expert technical assessment.

The key issues identified were subject to comprehensive specialist assessment to identify and assess the potential impacts of the Revised Preferred Project on the existing environment and community. These results of these assessments are detailed in **Section 5.0**.

The detailed impact assessment undertaken for the Revised Preferred Project concludes that with the implementation of feasible and reasonable mitigation measures, the proposal can proceed within acceptable environmental standards. This is largely driven by the proposed change in mine design to a stable first workings mine plan and the proposed reconfiguration and additional noise mitigation measures proposed in relation to the Pit Top facilities.

16.2 Suitability of the Site

The site has a long established history of mining activity, with mining having been undertaken at the Russell Vale Colliery since 1887. Over time, urban development has encroached on the Russell Vale Pit Top and these facilities are now bordered by residential land uses. Russell Vale Colliery has therefore coexisted with these neighbouring land uses over an extended period with a degree of impact on the amenity of these residential land uses. Key elements of the Revised Preferred Project have been designed to minimise impacts on these surrounding land uses, including substantial noise mitigation works around the Pit Top to reduce noise impacts on surrounding residents and controls on the speed and timing of trucks entering and leaving the site.

The proposed first workings mine plan is not considered to have any potential to perceptibly impact on natural surface features and is therefore unlikely to result in any adverse impacts to the surface feature present within the UEP Application Area, including upland swamps, cliffs (including the Illawarra Escarpment), steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

Russell Vale Colliery produces high quality hard coking coal, a product that can help meet the expanding demand for metallurgical coal globally.

The site is well located close to coal export facilities at Port Kembla, resulting in reduced transport related fuel use, greenhouse gas emissions, particular emissions and transport costs.

16.3 Ecologically Sustainable Development

Ecologically Sustainable Development (ESD) is one of a number of objectives of the EP&A Act. ESD requires the integration of economic and environmental considerations in decision making processes.

To justify the Revised Preferred Project with regard to the principles of ESD, the benefits of the Revised Preferred Project in an environmental and socio-economic context should outweigh any negative impacts. The principles of ESD encompass the following:

- the precautionary principle
- intergenerational equity
- conservation of biological diversity
- valuation and pricing of resources.

These principles are discussed further in **Sections 16.3.1** to **16.3.4**.

16.3.1 The Precautionary Principle

Environmental assessment involves the prediction of potential environmental outcomes of a development. The precautionary principle reinforces the need to take risk and uncertainty into account, especially in relation to threats of irreversible environmental damage.

A preliminary environmental risk analysis was undertaken for the Revised Preferred Project to identify key areas for further impact assessment. The results of the risk assessment are summarised in **Section 5.1**. A review of appropriate mitigation measures and strategies was also undertaken as a part of the detailed impact assessment process. The Precautionary Principle has therefore been applied to the assessment of the Revised Preferred Project through:

- careful project design aimed at reducing uncertainty in impact predictions
- identification of the potential impacts and the likelihood and consequences of these impacts
- identification of management and mitigation measures that are designed to address the potential environmental impacts of the Revised Preferred Project
- implementation of monitoring and reporting mechanisms for the project.

Existing monitoring programs will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The ongoing collection and interpretation of the data will be used to update existing TARP trigger levels as required. Adaptive management procedures will be reviewed and updated as part of the management plan review process in order to ensure a systematic process for continually detecting impacts that deviate from predictions, validating predictions and improving mining operations so that subsidence impacts creating a risk of negative environmental consequences do not occur.

16.3.2 Intergenerational Equity

Intergenerational equity is based on the principle that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. The principles of intergenerational equity are addressed by the Revised Preferred Project most fundamentally via the revised mine design that significantly limits subsidence related impacts and secondly through the development and implementation of management and mitigation measures that are designed to address any residual potential environmental impacts.

The EP&A Act requires the consent authority to consider matters of relevance to the public interest. Matters of public interest have been held to include intergenerational equity. Greenhouse gas emissions associated with coal combustion, and the established links to climate change, are likely to generate environmental impacts across generations with the predicted impacts associated with greenhouse gas emissions further discussed in **Section 5.12**.

16.3.3 Conservation of Biological Diversity

The Revised Preferred Project is not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. As a result, impacts to the biodiversity values of the UEP Application Area are predicted to be negligible.

The proposed upgrades to Pit Top will occur within existing disturbed areas, and no direct or indirect impact on biodiversity is anticipated as a result of these works.

16.3.4 Valuation and Pricing of Resources

In response to community and agency concerns regarding the potential adverse impacts of longwall mining associated with the original UEP proposal, the Revised Preferred Project proposes the use of non-caving first working techniques to significantly limit the potential adverse impacts of mining. The Revised Preferred Project is considered to strike an appropriate balance between maximising resource recovery within the environmental and community constraints of the site.

16.4 Conclusion

A key issue for the PAC in its consideration and review of the UEP Preferred Project was the uncertainty associated with subsidence and groundwater impacts as a result of the proposed longwall mining in the multi-seam mining environment present at Russell Vale.

In order to address residual uncertainty regarding the impacts of longwall mining raised by the PAC Second Review Report, a revised mine design has been developed based on a non-caving first workings mining system. The revised mine plan has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

Changes to the Russell Vale Pit Top are also proposed to address concerns regarding potential amenity impacts to surrounding residential areas.

The detailed impact assessments undertaken for the Revised Preferred Project and outlined in **Section 5.0** conclude that the proposed mining is not expected to cause significant surface subsidence, significant interaction with the overlying seams or significant interaction with existing groundwater systems. Importantly, the proposed mine plan is not considered to have any potential to perceptibly impact natural surface features including upland swamps, cliffs including the Illawarra

Escarpment, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. This is primarily due to the proposed first workings mining method that has been designed to be long-term stable. Additionally, due to the small magnitude of subsidence effects expected from the proposed mining layout, there is a high level of confidence in the reliability of the subsidence impacts forecast.

Substantial improvements to the Pit Top layout and adoption of a range of additional feasible and reasonable noise control measures, including restricting hours of operation, have been proposed to reduce the noise impact of the Pit Top facilities and trucks accessing the site. The noise impact assessment demonstrates that the proposed changes are effective at reducing noise levels from the site to within acceptable levels for the majority of the time the site is operational, with only negligible (1-2dB) exceedances predicted at surrounding residences during a small percentage (less than 10%) of Winter nights.

A cost benefit analysis was undertaken for the Revised Preferred Project which assessed the net benefit of the Revised Preferred Project when all external and internal costs were considered, including environmental and social externality costs. The cost benefit analysis determined that the Revised Preferred Project would result in a net economic benefit of approximately $174.3 million in NPV terms for the NSW community, approximately $17.0 million in NPV terms to the Wollongong local area through employment and expenditure in the local area, and indirect costs of $19,158.

This environmental assessment demonstrates that with the implementation of existing and proposed management and mitigation measures, the Revised Preferred Project can proceed within acceptable environmental standards and would result in a net benefit to the NSW community.

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APPENDIX 1

Subsidence Assessment

Strata Control Technology

UMWELT (AUSTRALIA) PTY LTD

Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East

UMW4609

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REPORT NO	UMW4609
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SUMMARY

Wollongong Coal Limited (WCL) is proposing to mine the Wongawilli Seam at Russell Vale Colliery in an area of the mine known as Russell Vale East located approximately 9km north-northwest of Wollongong. After consideration of the findings of two Planning Assessment Commission (PAC) reviews, WCL revised the proposed mining plan by removing secondary extraction by longwall method and to instead form first workings only with large width to height ratio pillars that are designed to be long-term stable. Umwelt Australia Pty Ltd (Umwelt), the lead consultant responsible for managing the Underground Expansion Project (UEP) approval process, commissioned SCT Operations Pty Ltd (SCT) to undertake a subsidence assessment for the revised mine plan layout. This report presents the results of our assessment. Our assessment indicates:

The proposed mining layout based on pillars with a width to height ratio of 8 and 10 is long-term stable. The mining of these pillars is not expected to cause significant surface subsidence, significant interaction with the overlying seams or significant interaction with existing groundwater systems.

The proposed layout is not considered to have any potential to perceptibly impact natural surface features including upland swamps, cliffs including the Illawarra Escarpment, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. Assuming the overlying workings are not required to be drained for mining in the Wongawilli Seam, any impacts on groundwater are expected to be limited only to the immediate vicinity of the Wongawilli Seam and only in the area of the proposed mining.

Some ongoing low-level ground movement, mainly horizontal movement associated with previous mining including the Wongawilli Seam longwalls, may not yet have ceased completely. This low-level movement has potential to continue to cause low-level impacts to Mount Ousley Road and valley closure across Cataract Creek that may be perceptible. This movement is a legacy of previous mining and is not expected to be influenced by the proposed mining. Movement may continue irrespective of any further mining in the Wongawilli Seam.

Two power transmission lines, a 330kV line and a 132kV line both supported on steel truss pylons, traverse the surface to the east of Mount Ousley Road. The pylons are very sensitive to differential ground movements that may occur if any marginally stable Bulli Seam pillars are destabilised. Uncertainty remains as to the extent of marginally stable pillars in the vicinity of these pylons. An engineered solution is expected to be required by regulatory authorities to manage the very low-likelihood, very high consequence risk to the power transmission pylons within the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 given the uncertain nature of the Bulli Seam layout and the limited options to reduce this uncertainty.

Existing management plans for management of subsidence impacts and the monitoring included in them are focussed on longwall mining. A review of these is recommended based on the significantly lower levels of surface subsidence anticipated for the proposed system of mining compared to longwall mining. There may be potential to modify the frequency and nature of monitoring to achieve more effective outcomes.

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1. INTRODUCTION

Wollongong Coal Limited (WCL) is proposing to mine the Wongawilli Seam at the Russell Vale Colliery in an area known as Russell Vale East located approximately 9km north-northwest of Wollongong. After consideration of the findings of two Planning Assessment Commission (PAC) reviews, WCL revised the proposed mining plan by removing secondary extraction by the longwall method and to instead form first workings only with large width to height ratio pillars that are designed to be long-term stable. Umwelt Australia Pty Ltd (Umwelt), the lead consultant responsible for managing the Underground Expansion Project (UEP) approval process, commissioned SCT Operations Pty Ltd (SCT) to undertake a subsidence assessment for the revised mine plan layout. This report presents the results of our assessment.

The report is structured to provide:

- conclusions and recommendations
- overview and background, including a description of the site and the proposed first workings mining geometry
- a summary of the deformation characteristics of coal pillars and expectation of the stability of the proposed pillars under the range of loading conditions likely below extracted workings in the overlying seams
- an assessment of the ground movements expected from the proposed first workings geometry with consideration of the potential for greater than expected ground movements including from seam interaction effects
- an impact assessment for surface features and surface infrastructure based on the magnitude of ground movements expected.

A review of previous mining activity in the Russell Vale East area and the associated subsidence effects and subsidence impacts is presented in Appendix 1 as context. The estimations and measured results in Appendix 1 are largely reproduced from SCT Report WCRV4263 "Update of Subsidence Assessment for Wollongong Coal Preferred Project Report Russell Vale No 1 Colliery" (SCT 2014). This report was prepared in support of the previous Underground Expansion Project – Preferred Project Report (UEP – PPR) longwall mining application.

2. CONCLUSIONS AND RECOMMENDATIONS

The proposed layout for Russell Vale East is likely to result in very low levels of subsidence with only minor impacts additional to those caused by previous mining activities in this area.

The mining geometry proposed comprises pillars that are large enough, at a width to height ratio of 8 and 10, to be long-term stable.

Some low-level deformation of the first workings pillars is expected with elastic compression of the strata above and below these pillars.

This strata compression has potential to result in some low magnitude subsidence movements with correspondingly low levels of tilt and strain.

Any such subsidence is likely to occur gradually. These movements are expected to be generally imperceptible and insignificant for all practical purposes. Interaction with the overlying seams is expected to be negligible, but there are known to be areas of Bulli Seam pillars that are marginally stable.

So, while there is considered to be some potential for additional subsidence movements if these areas of pillars are destabilised for any reason, this potential generally exists irrespective of the proposed mining.

The proposed workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs including the Illawarra Escarpment, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir. Assuming the overlying workings are not required to be drained for mining in the Wongawilli Seam, any impacts of the proposed workings on groundwater are expected to be limited only to the immediate vicinity of the Wongawilli Seam and only in the area of the proposed mining. If the overlying workings in the Balgownie and Bulli Seams are required to be drained as an inrush control measure then this may alter the current groundwater flow paths underground. Any changes to flow paths are not expected to increase the overall quantity of groundwater entering the mine.

The proposed mining plan involves first workings within the DSC Notification Area for Cataract Storage Reservoir. This mining will require the consent of the Dams Safety Committee.

Some ongoing low-level ground movement, mainly horizontal movement associated with previous mining, including the Wongawilli Seam longwalls, may still be ongoing. This low-level movement has potential to continue to cause perceptible cracking on Mount Ousley Road at the top of the ridge to the south of Cataract Creek and some compression on the road at Cataract Creek that may also be perceptible. This movement is a legacy of previous mining and is not expected to be influenced by the proposed mining. Movement is expected to continue irrespective of any further first workings that are developed in the Wongawilli Seam.

Two power transmission lines, a 330kV line and a 132kV line traverse the surface to the east of Mount Ousley Road. Both lines are supported on steel truss pylons. The pylons are sensitive to differential ground movements. Such movements may occur if any marginally stable Bulli Seam pillars are destabilised.

The Bulli Seam in the general area of the proposed mining was mined at a time when there was no legal requirement to keep 'accurate' mine records. A small area of marginally stable standing pillars in the Bulli Seam is known to exist to the east of Mount Ousley Road. Although this area is shown on the mine plans, there is uncertainty about whether there may be other areas of marginally stable pillars elsewhere across the area given that most of these workings are now inaccessible.

The proposed mining is not expected to result in destabilisation of the pylons, however due to the very high consequence of the risk, an engineered solution is likely to be required by regulatory authorities to manage the very low-likelihood risk to the power transmission pylons within the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 because of the uncertain nature of the Bulli Seam layout and the limited options to reduce this uncertainty.

Engineered controls include construction of cruciforms at the base of the existing pylons, replacing the towers with single pole structures, filling the Bulli Seam voids with cement stabilised material and leaving coal barriers with only a minimum three entries within a radius of 0.7 times depth (35° angle of draw) of the pylons.

Exploration drilling that demonstrates full subsidence has occurred in areas below the pylons may confirm that the risk of further subsidence has been eliminated.

Ongoing use of existing management plans is recommended, in particular the Built Features Management Plans for Mount Ousley Road (and Picton Road interchange) and the adjacent electricity transmission lines. A program of subsidence monitoring in areas not sensitive to surface movements is also recommended. This program would be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mine below subsidence sensitive infrastructure.

3. OVERVIEW AND BACKGROUND

This section provides a general context for the assessment. The section is structured to provide an overview of the site, the background to the mining application, a summary of surface ownership, surface features, the geological setting, previous mining and a description of the major surface features. More detail on specific aspects of the project is presented in other specialist reports associated with the project.

3.1 Site Overview

Figure 1 shows the location of existing and proposed workings in the Russell Vale East Area, including the main headings access and services roadways, superimposed onto a 1:25,000 topographic series map of the area.

Figure 1: Plan showing location of Application Area with existing and proposed Wongawilli Seam proposed workings superimposed onto a 1:25,000 topographic series map with creek alignments update based on LiDAR imaging of the ground surface.

After recovery of the existing longwall equipment, WCL propose to continue development of the Wongawilli Seam. Outside of the main headings roadways, the mining system proposed has replaced longwall mining with first workings only. These first workings form square pillars in generally rectangular panels. Each panel typically has five headings and is separated from adjacent panels by solid coal barriers. The proposed layout is designed to dovetail with previous mining in the Wongawilli Seam and to fit within the footprint of previous mining in the overlying seams so that there are more than five headings in some areas and irregular shapes in others. This design is intended to improve roadway conditions and reduce the potential for surface subsidence.

Palaris Mining Pty Ltd (Palaris), in consultation with the WCL, identified an optimum cutting height of 2.4m in the lower section of the Wongawilli Seam. Pillars in the Wongawilli Seam located below longwall panels in the overlying Balgownie Seam are designed to be 25m wide measured centre to centre. The width to height ratio for the pillars is therefore approximately 8 for nominal 5.5m wide roadways. Pillars outside the Balgownie Seam longwall panels are designed to be square at 30m centres. These pillars have a width to height ratio of approximately 10 for nominal 5.5m wide roadways.

The Application Area for the project provides an area within which the influence of proposed mining is considered. The Application Area is defined by a distance equal to one times the overburden depth to the Wongawilli Seam around the proposed first workings. Features within the Application Area and major features just outside are considered in this assessment.

The Application Area is located entirely within the headwaters of Cataract River and the Cataract Reservoir and predominantly within the catchment of Cataract Creek. The surface is mainly undeveloped bushland. Surface features include sections of rainforest in the valleys, a variety of upland swamps located mainly on the valley sides and numerous sandstone rock formations associated with the Hawkesbury Sandstone outcrop on the upper slopes. The surface is traversed by the Mount Ousley Road and four high-voltage power transmission lines, two of which are supported on steel truss pylons and the other two on single pole structures.

The location of surface watercourses, particularly Cataract Creek, has been refined using surface contours available from LIDAR (Laser Interferometric Detection and Ranging) imagery flown since the 1:25,000 series topographic series map was produced. The watercourses are ranked on the basis of their stream order using the approach described in the Strategic Review into Impacts of Underground Coal Mining on Natural Features in the Southern Coalfields (NSW Department of Planning 2008). First and second order streams are located across the Application Area. Two short sections of third order streams on Cataract Creek to the east of Mount Ousley Road join to form a fourth order stream downstream of Mount Ousley Road.

Surface features outside the Application Area that may nevertheless be sensitive to subsidence impacts include the Hawkesbury Sandstone outcrop on the Illawarra Escarpment forming Brokers Nose, a telecommunications facility on Brokers Nose and a bridge on the Picton Road interchange.

3.2 Project Background

Russell Vale Colliery is located near Russell Vale in the Illawarra region of New South Wales. The mine has had several names since it commenced in the late nineteenth century. The mine was known as South Bulli Colliery for most of its life, more recently as NRE No1 Colliery after being purchased by Gujarat NRE and for the last four years, the mine has been known as Russell Vale Colliery.

The colliery holding covers a total area of approximately 6,973 hectares (ha). The holding includes multiple sub leases held between WCL and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 157.

Underground mining within the colliery holdings is extensive, particularly in the Bulli Seam where bord and pillar mining, pillar extraction and numerous longwall panels have largely exhausted the Bulli Seam resource in the eastern part of the mine. Eleven longwall panels have been mined in the Balgownie Seam and three short panels have been mined in the Wongawilli Seam. Nevertheless, substantial high quality coking and thermal coal resources remain.

Originally, Gujarat NRE intended to expand its Wongawilli Seam operations in two stages. Stage 1 plans were detailed in the Preliminary Works Project Part 3A application that was approved in October 2011, allowing main headings first workings with gateroad panel development roadways for Longwalls 4 and 5, and upgrades to surface facilities. In December 2012, the Preliminary Works Project Part 3A was modified to allow the secondary extraction of Longwalls 4 and 5 and the development of Maingate 6.

The original Stage 2 application known as the Underground Expansion Project Part3A (UEP) was lodged with the Department of Planning and Infrastructure (DPI now Department of Planning and Environment DP&E) in August 2009 detailing an application to extract eleven longwalls in the Wonga East area (as it was known at the time) and seven longwalls in the Wonga West area together with surface facilities upgrades to allow production of up to 3Mtpa for up to 20 years.

After consideration of the submissions received for the application, NRE made the decision to substantially revise the UEP Application to facilitate the approval process and allow continuity of operations. Due to the scope of the changes, the then DPI requested NRE to prepare a Preferred Project Report (PPR) for the revised UEP Application based on only eight longwalls in the Wonga East area and upgrading of surface facilities to manage an extraction rate of up to 3Mtpa ROM coal per annum.

In February 2014, Gujarat NRE formally changed its name to Wollongong Coal Ltd (WCL) following a change in shareholder ownership. WCL subsequently changed the name of the mine to Russell Vale Colliery and the eastern mining area from Wonga East to Russell Vale East.

A further modification to the Preliminary Works Project Part 3A approval was granted in November 2014 allowing the first 365m of Longwall 6 panel in the Wongawilli Seam to be mined.

The PPR application was assessed by the Planning Assessment Commission (PAC) and after holding public submissions, a report was released in April 2015. The PAC concluded that further information was required. After responses to submissions were provided by WCL in 2015, a second PAC review was commissioned. After further public hearings, a report released in March 2016 declined to recommend approval for the project based on a range of issues relating to subsidence impacts on water and upland swamps and noise.

In December 2016, WCL engaged Palaris Mining Pty Ltd to design a mining plan layout for the Russell Vale East area suitable to address the concerns of the PAC. An initial layout design with limited secondary extraction at the edges was reviewed by SCT in March 2017 and the plan was subsequently modified by Palaris to exclude secondary extraction. This final plan forms the basis of the assessment presented in this report.

Figure 2 shows a comparison between the proposed UEP-PPR longwall mining plan and the proposed first workings only mine plan for the Wongawilli Seam at Russell Vale East.

3.3 Surface Ownership

Figure 3 shows the surface ownership within the Application Area. Most of the area is within the Metropolitan Special Area for Cataract Water Supply Reservoir. The surface area in the catchment is administered by WaterNSW. The stored waters of Cataract Reservoir are also administered by the Dams Safety Committee (DSC).

A large part of the area to the east of Mount Ousley Road and small areas to the west are owned by WCL. The easement for the Mount Ousley Road and an area northeast of the Picton Interchange within the Application Area is owned and administered by the Roads and Maritime Services (RMS).

3.4 Surface Infrastructure

Major infrastructure within the Application Area includes the Mount Ousley Road and four high voltage power lines to the east that cross the area. The location of this infrastructure is shown on the topographic map in Figure 1.

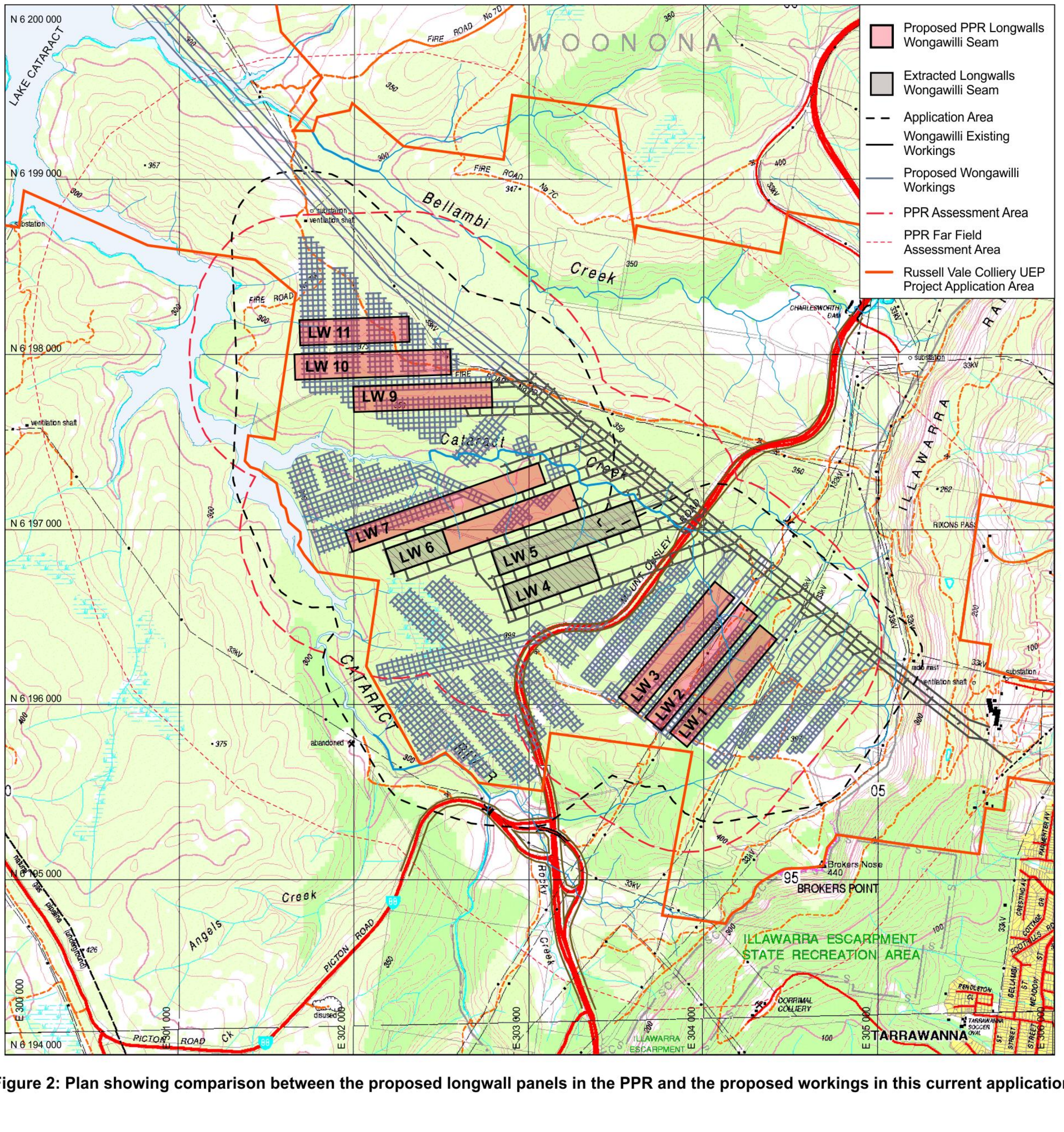

Figure 2: Plan showing comparison between the proposed longwall panels in the PPR and the proposed workings in this current application

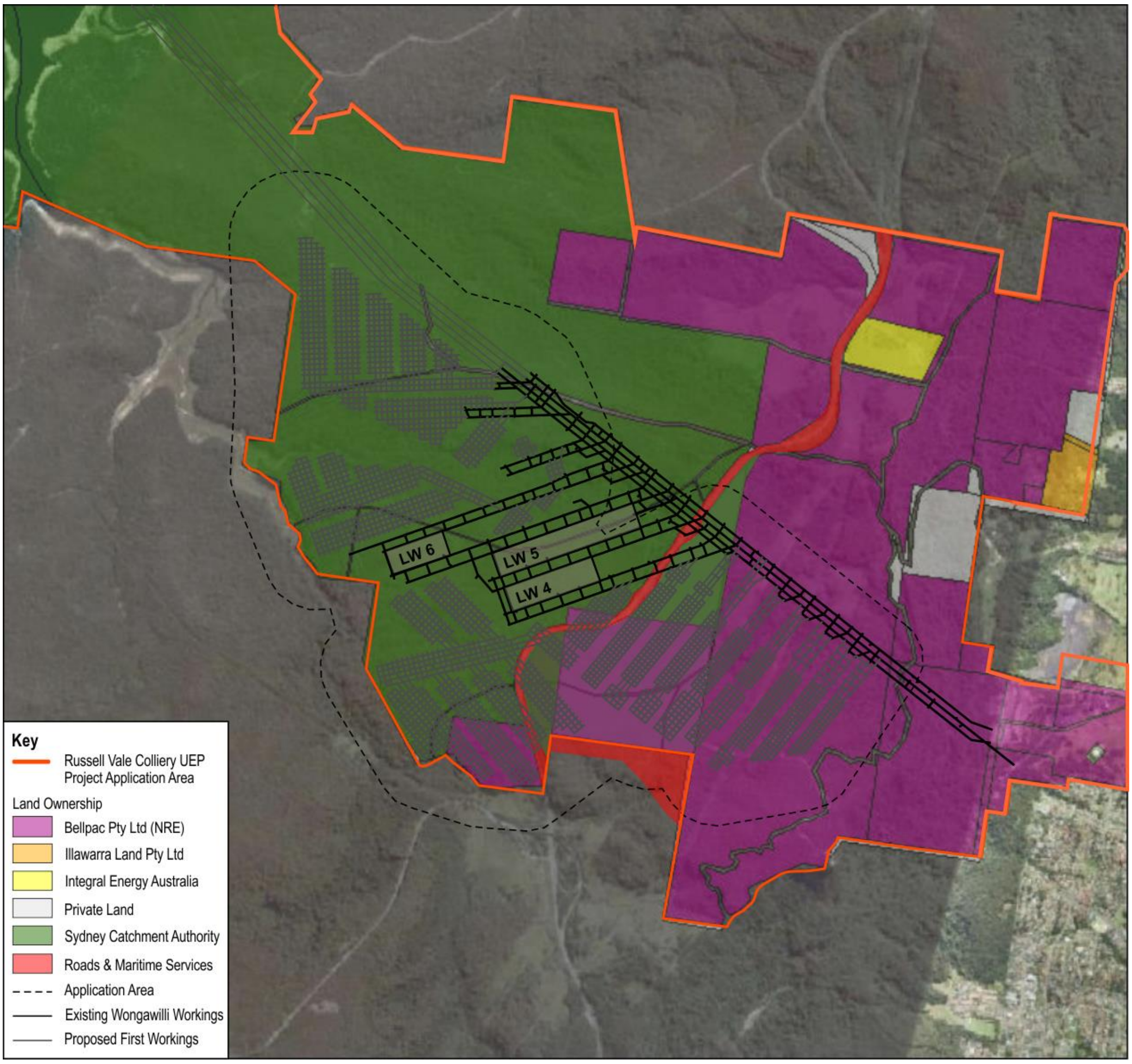

Figure 3: Plan showing land ownership within Application Area. (Diagram modified from Environmental Resources Management Drawing Number 0079383s_EA_GIS013_RO.mxd dated 22/9/10).

Mount Ousley Road (recently renamed the M1 Princes Motorway) is a major four lane highway connecting New South Wales largest and third largest cities. This road is administered by Roads and Maritime Services (RMS). The interchange with the Picton Road is located to the south at the boundary of the Application Area. This interchange includes a concrete bridge and several drainage culverts.

Mount Ousley Road was constructed as a defence route during 1942 with duplication of the highway commencing in 1965 reaching Picton Road from the south in 1979 (OzRoads 2012). A major deviation at Cataract Creek was opened in 1980. The northbound carriageway on Mount Ousley Road at Cataract Creek was last resurfaced in 2009 with the surface expected to last 10-12 years (Vecovski 2012). The southbound carriageway was last resurfaced in 2003 and resurfacing of this section is expected within 5-6 years.

A major upgrade and realignment of the Mount Ousley Road is planned over the next few years. This realignment is expected to involve widening the road to three lanes in each direction across the Application Area and softening of bends at the top of the ridge to the south of Cataract Creek.

There are four power transmission lines located within the Application Area, a 330kV transmission line owned and maintained by Transgrid, a 132kV transmission line located alongside that is owned and maintained by Endeavour Energy and two 33kV transmission lines and associated infrastructure owned and maintained by Endeavour Energy. There are also two more 33kV lines and located at the north east corner of the Application Area. One of these line services mine owned infrastructure.

There is a telecommunications installation located adjacent to the Illawarra Escarpment at Brokers Nose. This facility is approximately 600m from the nearest panel of first workings.

3.5 Natural Features

Major natural features and natural resources in the area include the Illawarra Escarpment and the upper parts of Lake Cataract that forms part of Sydney's water supply catchment. The Illawarra Escarpment is located 400m east of the nearest panel of proposed workings. Approximately half of the Application Area is located within the DSC Cataract Notification Area (revised in 2013).

There are numerous natural swamps identified within the Application Area. The nature and distribution of these swamps are described in detail in associated specialist reports.
There are numerous sandstone cliff formations located within the Hawkesbury Sandstone outcrop in the Application Area. Most of these are less than 5m high. Multiple rock falls are evident across the site. Some were caused by previous mining and others have occurred naturally.

There are several locations where drainage lines and first order creeks flow over sandstone outcrops to form waterfalls following periods of heavy rain. Two of these features are approximately 7m high.

However, only the feature at the downstream edge of swamp CCUS4 is regarded as a semi-permanent waterfall on a first order watercourse. The others are either located on drainage lines that have no permanent flow or have been impacted by previous mining so that water emerges from the base of the rock formation during periods of low flow rather than flowing over the rock as a waterfall.

3.6 Heritage Features

Several Aboriginal heritage sites have been identified within the Application Area. These sites are mainly associated with rock shelters in sandstone cliff formations and grinding groove sites on upland sandstone outcrops.

One of the shelter sites appears to have been impacted by instability to the associated sandstone overhang, either as a result of previous mining in the Bulli Seam or as a result of tree root invasion and natural erosion processes.

3.7 Geological Setting

The geological setting is described in detail in Clark (2013) but it is helpful to understand the geological setting as context for the subsidence assessment.

Figure 4 shows a plan of the geological formations that outcrop at the surface and the geological structure that exists at the Wongawilli Seam level and at the surface. The existing and proposed workings in the Wongawilli Seam are also shown.

Within the Application Area, the strata dips at between 1 in 25 and 1 in 30 to the west-north-west from its outcrop on the Illawarra Escarpment.

Hawkesbury Sandstone is present on the surface over most of the Application Area. The Bald Hill Claystone that underlies the Hawkesbury Sandstone outcrops in Cataract Creek and its tributaries. The Bulgo Sandstone that underlies the Bald Hill Claystone outcrops along the main channel of Cataract Creek on both sides of Mount Ousley Road.

Figure 5 shows cross-sections drawn at natural scale through the Application Area extending from west to east and from south to north. These sections are located in the vicinity of Mount Ousley Road and Cataract Creek. The sections show how Cataract Creek has cut down through the stratigraphy near the top of the anticlinal structure that exists in this area. This anticlinal structure is an arch shaped fold in the geological strata.

3.7.1 Coal Seams

The three coal seams mined at the colliery are all located within the Illawarra Coal Measures.

The Bulli Seam is the uppermost of the three seams and averages about 2.2m in thickness across the Application Area. Figure 6 shows the layout of the Bulli Seam workings and the geological structure in the Bulli Seam (reproduced from Clark 2013).

The Balgownie Seam is located on average about 10m below the floor of the Bulli Seam ranging from 5m to 14m across the Application Area. Figure 7 shows the layout of the Balgownie Seam workings and the geological structure in the Balgownie Seam (reproduced from Clark 2013). The Balgownie Seam is approximately 1.2m thick, but mine plan detail, anecdotal evidence from miners who worked the seam and subsidence monitoring indicates that the mining height may have been up to 1.5m on the longwall faces to accommodate the mining equipment. It is understood the additional height was gained by mining the immediate floor strata.

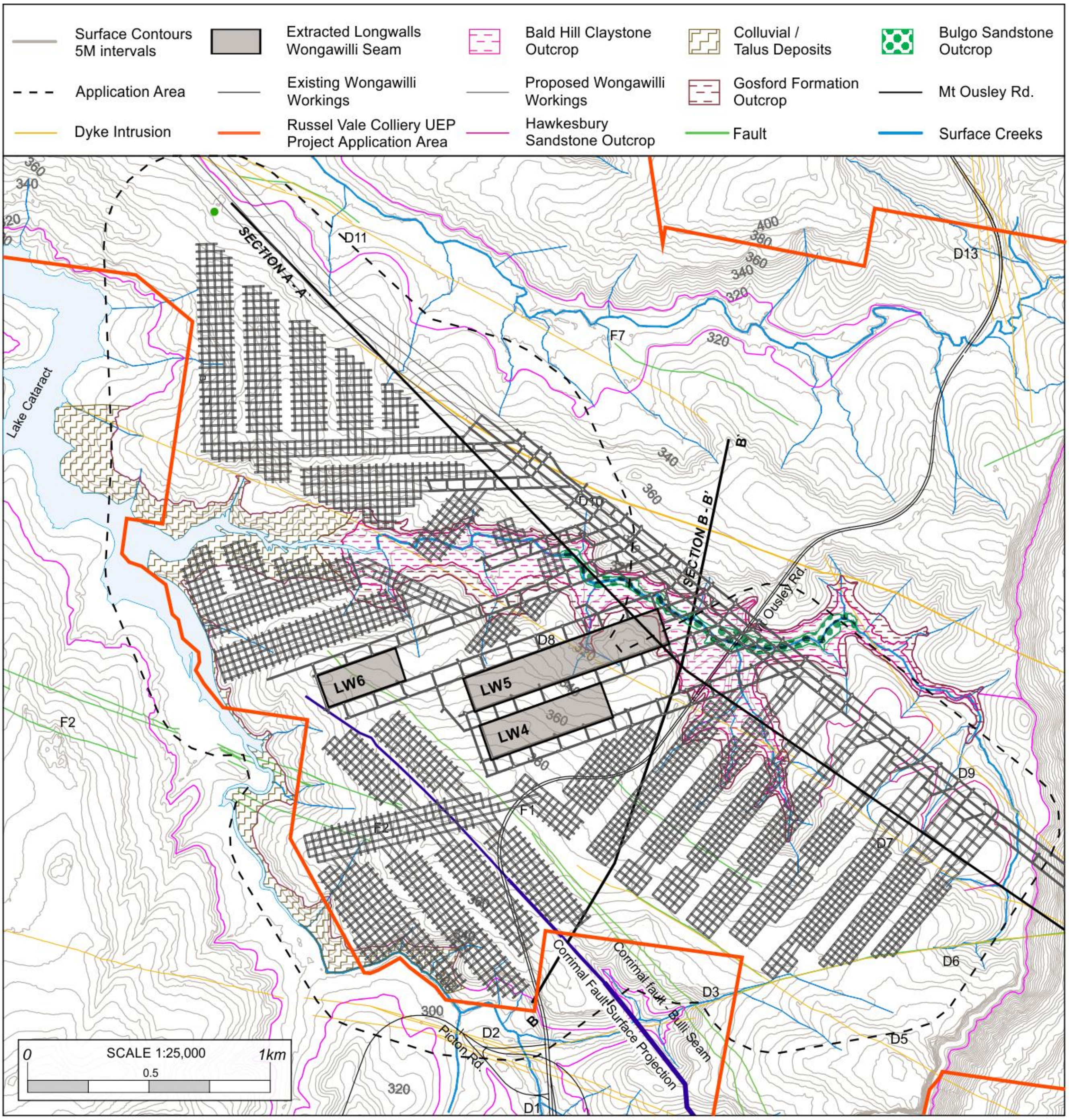

Figure 4: Plan showing geological outcrop at the surface and the location of major geological structures. (reproduced from Clark 2013).

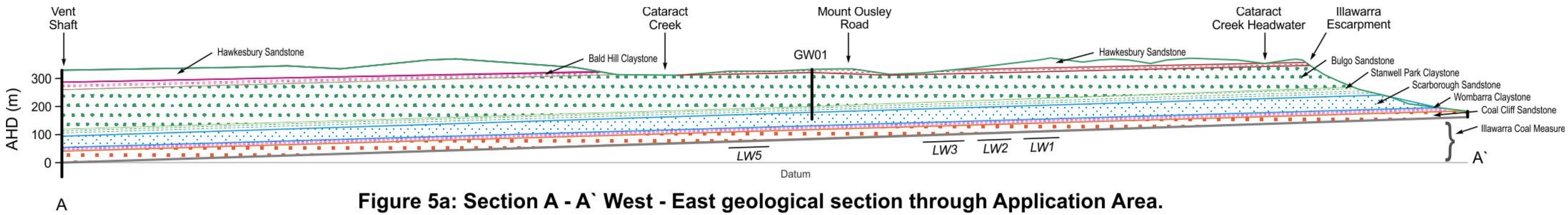

Figure 5a: Section A - A` West - East geological section through Application Area.

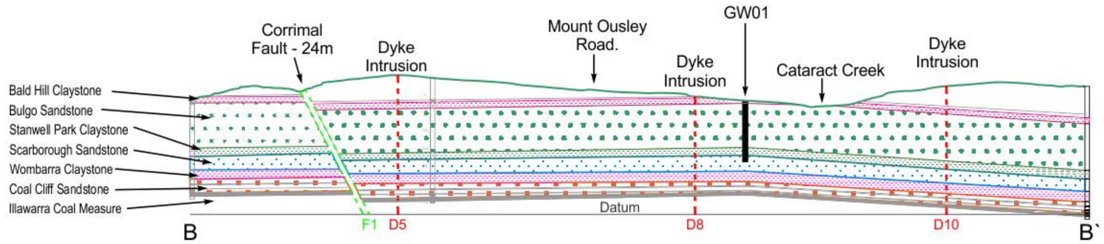

Figure 5b: Section B - B` South-North geological section through Application Area. (reproduced from Clark 2013).

Note: Vertical scale is the same as the horizontal scale.
Refer to Figure 4 for section locations.

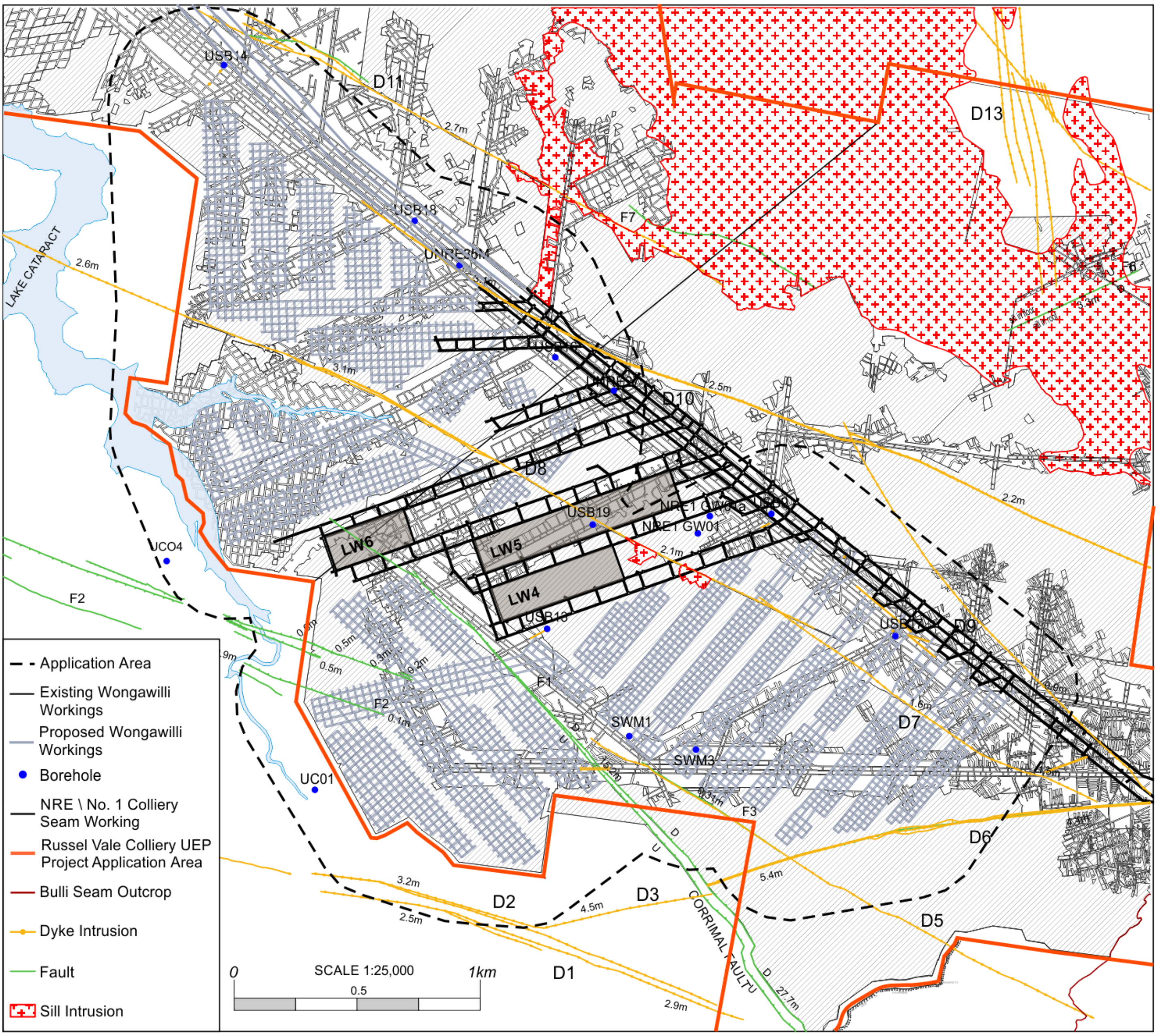

Figure 6: Plan showing geological structures and the extent of mining in the Bulli Seam level. (reproduced from Clark 2013).

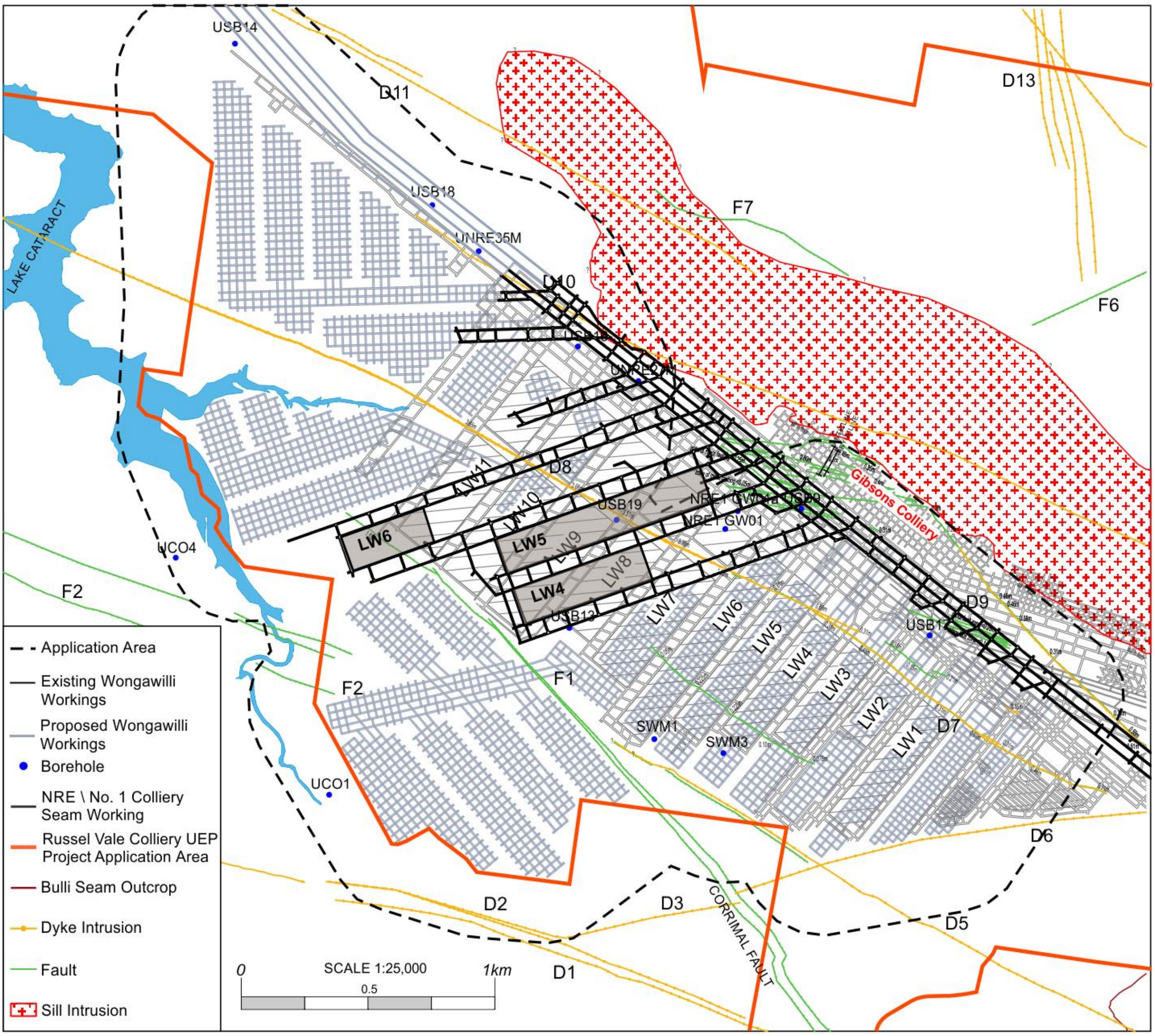

Figure 7: Plan showing geological structures and the extent of mining in the Balgownie Seam level. (reproduced from Clark 2013).

The Wongawilli Seam is located approximately 20m below the Balgownie Seam and ranges in thickness from about 8m to 12m. The lower section contains the best quality and bottom 2.4m of the seam section is the target height of the proposed mining.

Figure 8 shows a plan of the geological structure at the Wongawilli Seam level (reproduced from Clark 2013) and modified to include the Wongawilli Seam floor contours and up to date workings. The floor of the Wongawilli Seam ranges in elevation across the Application Area from approximately RL 85mAHD in the east to approximately RL-25mAHD in the west. The dip of the seam between these two points is, for practical purposes, constant.

3.7.2 Geological Structures

The proposed mining system is not expected to mobilise ground movements on any of these structures, but it is nevertheless helpful to have an understanding of the geological structure as a basis to understand their potential for subsidence impacts. The proposed workings avoid interaction with geological structures where possible and the limited interaction is not expected to extend beyond the immediate vicinity of individual roadways.

The major geological structures of interest in the area are the Corrimal Fault, several other minor faults, a sill (horizontal igneous intrusion) and several dykes (vertical igneous intrusions). The vertically continuous structures are evident in the Bulli and Balgownie Seam and in the geomorphology on the surface. The positions of these features are considered to be well defined because of the underground exposures. The geological structures in each seam are shown in Figures 6-8.

The Corrimal Fault (F1) is the only major geological fault within the Application Area extending in a north-west south-east orientation across the southern part of the Application Area. The Corrimal Fault is apparent in the surface geomorphology and at seam level in the Bulli and Wongawilli Seams so its location and characteristics are well defined. The fault diminishes to the northwest and has become insignificant as a series of minor features with total displacement of about 1.0m where it is intersected by the gateroads for Longwall 6 in the Wongawilli Seam (Cartwright 2014). The first 340m of Longwall 6 in the Wongawilli Seam mined through disturbed ground associated with the tail end of the Corrimal Fault without undue difficulty.

Other faults in the general area include the F2 faulting, Rixons Pass Fault and the Woonona Fault. Fault F2 is a series of minor displacements intersected in the Bulli Seam workings of both South Bulli (Russell Vale) Colliery and the adjacent Corrimal Colliery. This faulting is more prominent in Corrimal Colliery. The throws of these faults are recorded as less than 1.0m and general around 0.5m in the area of the proposed mining plan layout. This faulting is not expected to significantly impact the proposed mining or have any influence on subsidence.

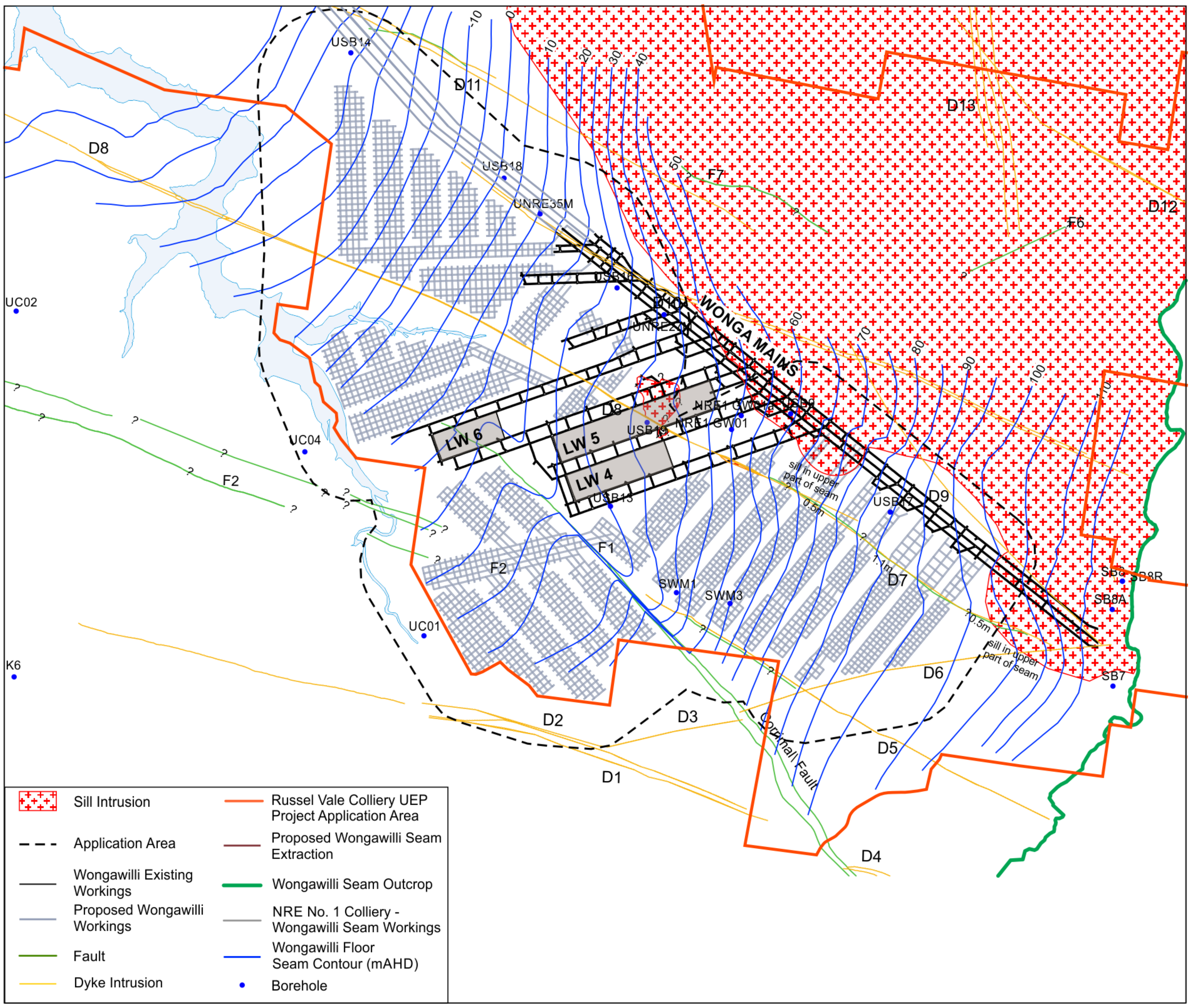

Figure 8: Plan showing geological structures in the Wongawilli Seam (reproduced from Clark 2013) and floor contours of the Wongawilli Seam based on floor contours in the Bulli Seam.

The Rixons Pass Fault identified to the east of the escarpment is not apparent in the mine workings. Dyke D10 may be an extension of this fault feature. Similarly, the Woonona Fault may align with a series of dykes and minor faulting reported in the workings of the Bulli Seam. Both of these regional geological features are remote from the proposed mining and are not considered likely to affect mining or to be affected in any significant way by the proposed mining.

An igneous sill has intruded into the Wongawilli Seam to the north of the main headings. The coal in this area is cindered and unsuitable to mine.

Several dykes exist within the Application Area with most having a west-north-west east-south-east orientation. Dykes are the vertical equivalent of sills and often form an intrusion that is vertically and laterally continuous for many kilometres in length. The dykes that have formed in the Southern Coalfield are generally less than a few tens of centimetres thick in the general strata but often increase in thickness at coal seam level. Dykes are usually hard to mine, dilute the coal product, cause damage to the mining equipment, and tend to be avoided where possible.

The site constraints within the Application Area mean that several of the proposed panels will need to mine access roadways through Dyke D8. This dyke has been previously encountered in the Bulli Seam, Balgownie Seam and existing Wongawilli Seam workings and its trace is apparent in the geomorphology on the surface indicating that it is vertically continuous to the surface. Longwall panels have potential to cause movements on dykes; individual roadways such as those proposed do not.

Dyke D5 and associated faulting has been intersected at numerous locations in the Bulli Seam. This structure forms part of the south east limit of Balgownie Seam workings.

3.7.3 Overburden Depth

Figure 9 shows a plan of the overburden depth to the Wongawilli Seam. The overburden depth ranges from a maximum of approximately 380m in the northwest to a minimum of about 250m in the east along the line of Cataract Creek.

3.8 Previous Mining

Figure 10 shows the location of the proposed workings in the Wongawilli Seam relative to existing workings in the Bulli, Balgownie and Wongawilli Seams. Bulli Seam mining extends over almost all the proposed mining area in the Wongawilli Seam. There are large areas of pillar extraction separated by large main heading barrier pillars and some smaller areas of standing pillars. Balgownie Seam longwall panels extend over approximately half the proposed mining area.

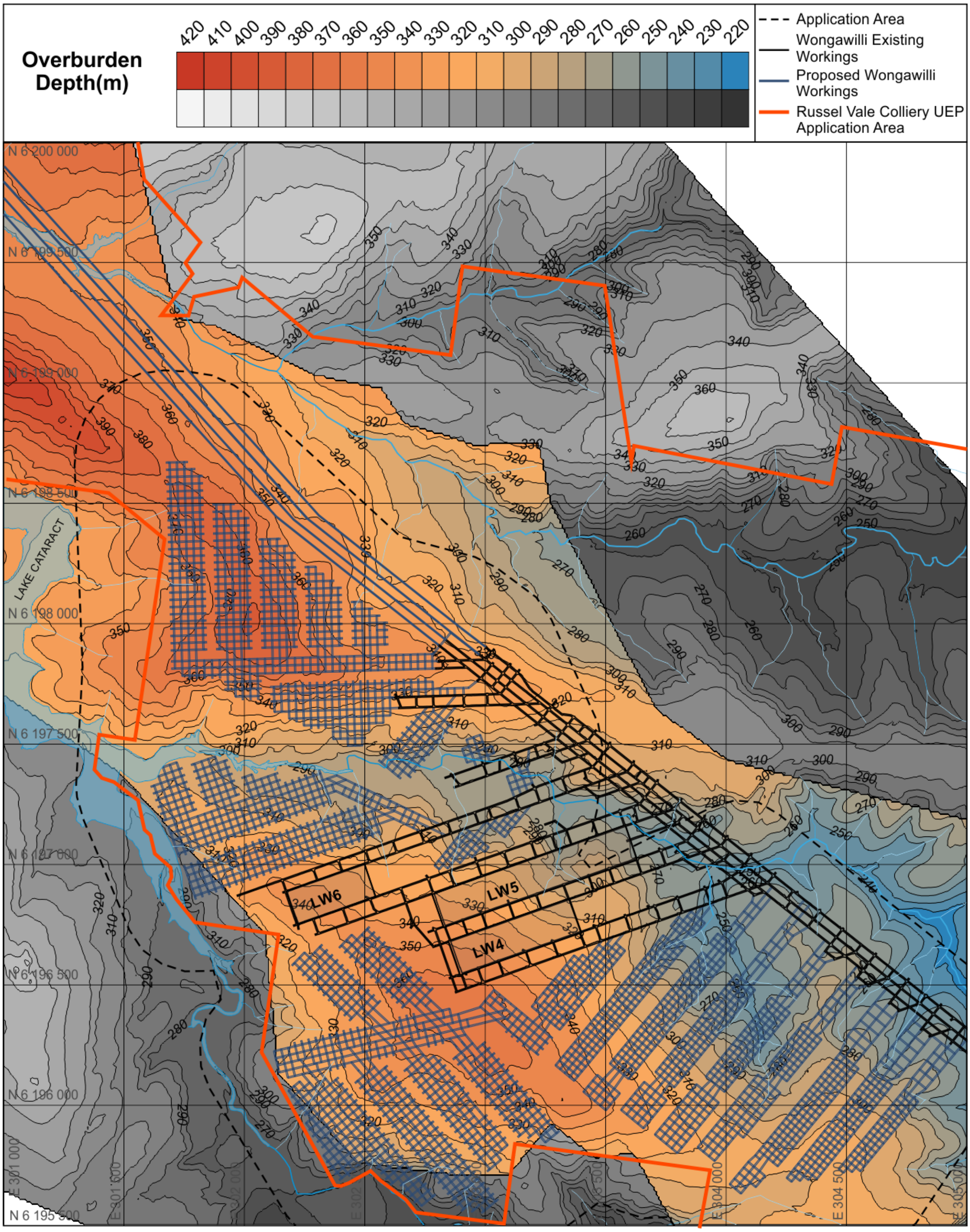

Figure 9: Depth of Overburden to the Wongawilli Seam.

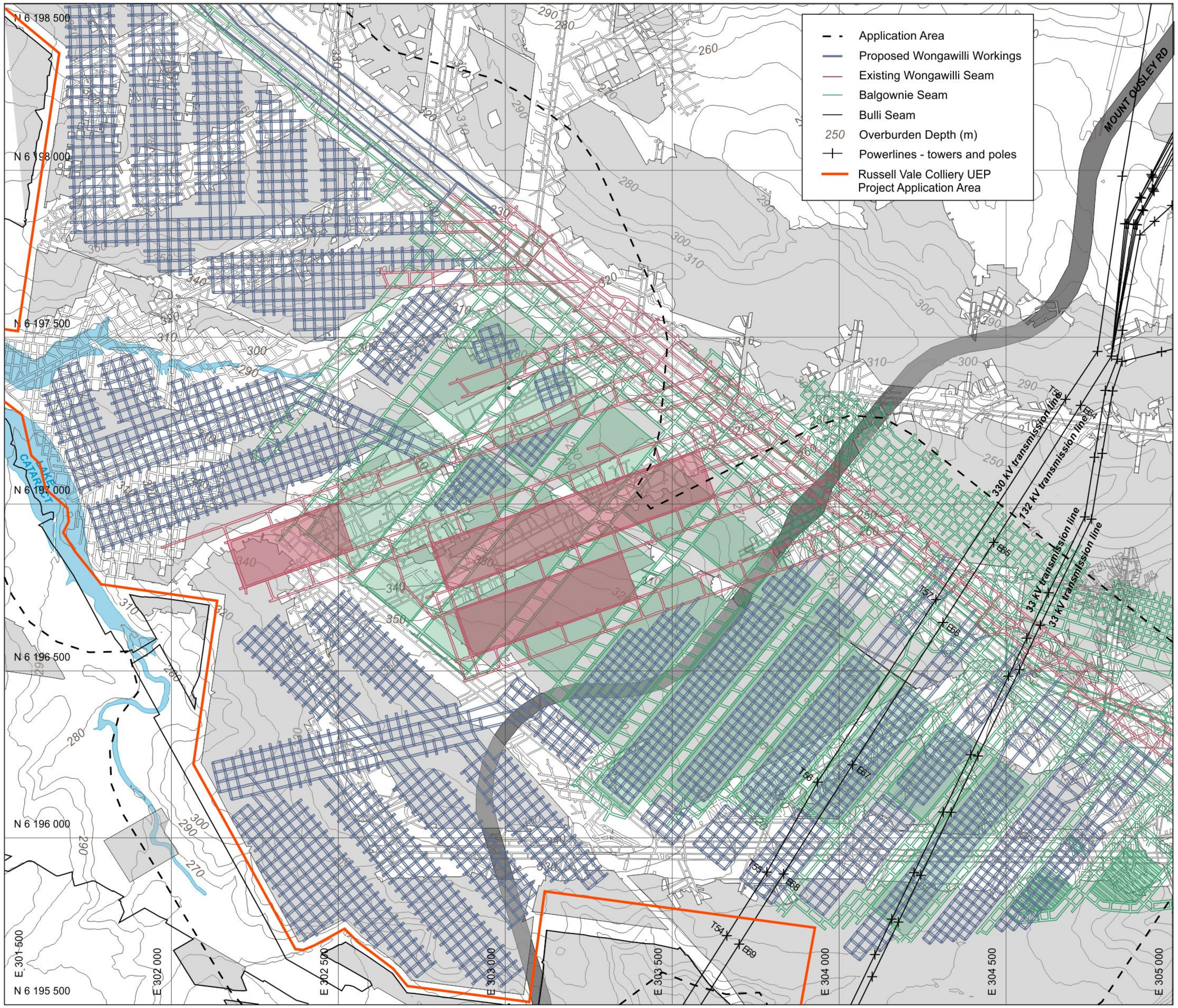

Figure 10: Existing Bulli, Balgownie and Wongawilli Seam workings and the proposed workings in this current application.

The proposed panels in the eastern area are aligned to fit directly below the extracted longwall panels in the Balgownie Seam so as to minimise interaction with the Balgownie Seam chain pillars. These chain pillars are supporting the weight of overburden strata across almost half the Application Area. By not mining directly below these chain pillars, the load bearing characteristics of the chain pillars are maintained, surface subsidence is reduced, and mining conditions are improved.

4. PILLAR STABILITY

4.1 Deformation Characteristics of Pillars

The strength and deformation characteristics of coal pillars are described in this section. The discussion presented shows how pillars of the size of those proposed to be formed at Russell Vale East continue to gain strength as they deform so there is no potential for sudden collapse or load shedding at failure; characteristics that are observed in smaller pillars. These pillars are also only relatively lightly loaded. The proposed mining is not expected to cause any perceptible subsidence at the surface.

Coal pillars derive their strength from two independent sources: cohesion and friction (AMIRA 1995).

- Cohesive strength can be thought of as the strength that is derived from the chemical bonds that hold the fabric of the coal together. These bonds are variable in strength averaging about 6MPa for most Australian coals. The cohesive strength of the bonds does not change significantly with external confinement. Once the bonds are broken, the material strength is lost and cannot be regained.

- Frictional strength can be thought of as the strength that is derived from confinement, much like the strength developed in sand. Frictional strength is zero without confinement but increases quickly with confinement at a rate of about 3-5MPa for every 1MPa of confinement. Frictional strength is effectively independent of cohesive strength and is retained even when the chemical bonds that generate cohesive strength have been broken. Frictional strength is much less variable than cohesive strength but its reliance on confinement means that it is sensitive to the geometry of the pillar and the strength characteristics of the roof and floor strata through which confinement is generated.

These two components contribute significantly to the different pillar behaviour observed for different sized pillars in different geological settings.

- Small pillars with a width to height of less than about three have a slender geometry that is unable to generate any significant confinement within the core of the pillar until all the cohesive strength has been exhausted and the pillar has collapsed. Their strength is clearly apparent as the point at which cohesive strength is lost and this strength varies with the variability of cohesive strength. Estimating pillar strength is a process that involves characterising the variability of cohesive strength. Probabilistic approaches have been found to be effective, provided there is sufficient margin between the average strength and the applied load.

- Larger pillars with a width to height ratio of greater than about eight in strong roof and floor conditions develop most of their strength from confinement provided to the core of the pillar. The variability in strength associated with the variability of cohesive strength is not a significant component of the strength of large pillars. Instead their strength is a function of the geological setting and the confinement that this setting is able to provide to the core of the pillar.

- Larger pillars in low strength roof and floor conditions are not able to generate confinement at the same rate and their deformation behaviour becomes more dependent on cohesive strength when confinement cannot be effectively generated.

- Pillars with a width to height ratio between three and eight in strong roof and floor conditions show pillar deformation behaviour that is transitional between pillars that initially increase in strength and then lose strength as they deform, to pillars that maintain the same strength after they have reached peak load and on to pillars that, continue to increase in strength and load carrying capacity as they deform.

Figure 11 shows the pillar stress/strain relationship for pillars with width to height ratios from 1 to 10 (AMIRA 1995).

Despite Wongawilli Seam workings being categorised as having a weak coal/shale roof in a thick seam environment, stress change pillar monitoring has indicated that Wongawilli Seam pillars display similar strength and deformation characteristics to Bulli Seam pillars in strong roof and floor conditions. This behaviour is contrary to the variable laboratory strength measurements for Wongawilli Seam coal and confirms the effect of frictional strength derived from confinement in larger pillars.

4.2 Pillar Loading

In multi-seam workings where, overlying seams have been partially or fully extracted, the vertical loads are not necessarily uniform and may become locally concentrated as a result of the overlying mining.

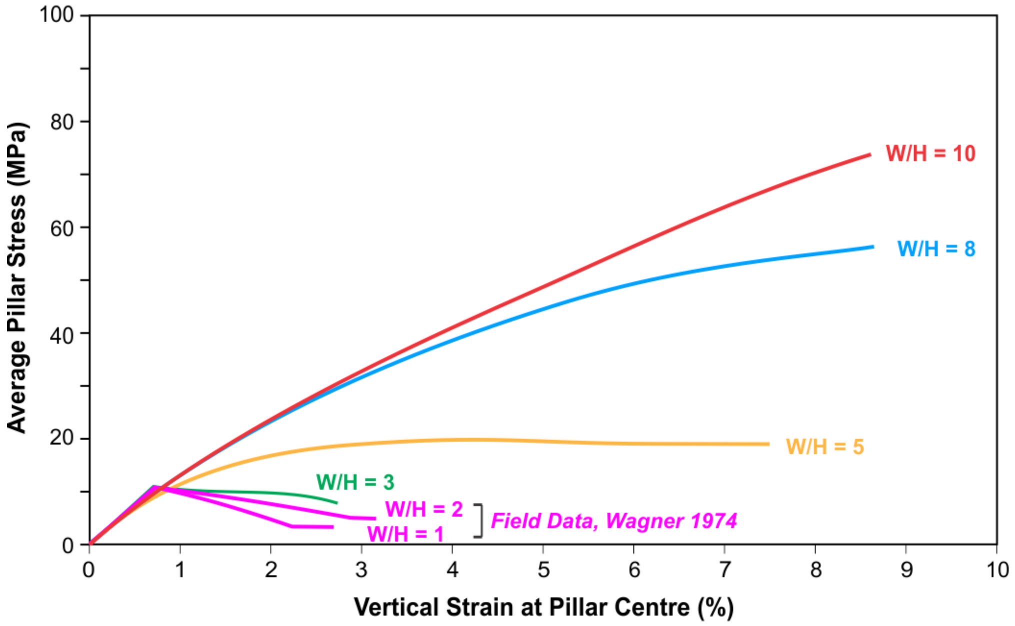

Figure 11: Pillar load/deformation characteristics for varying width/height ratios.

The loading conditions for the proposed pillars are expected to be variable due to the extraction geometries in the overlying seams. The variations could change from reduced loads under sections of goaf areas, to full tributary area loading below areas of reasonably sized first workings pillars, to elevated loading under chain pillars between the extracted Balgownie Seam longwall panels, or under abutment pillars and barrier pillars in both the Balgownie and Bulli Seams. These loading scenarios have been observed previously in Wongawilli Seam workings at Russell Vale East.

Areas of concentrated vertical stress are generally localised and easily identifiable on the mine plans. Unmined coal in these areas is effectively controlling the current subsidence levels from the previous mining.

Smaller pillars in the proposed layout for the Wongawilli Seam have minimum width to height ratios in the range of 8-10. These pillars are large enough to remain stable in the long term under the range of loading conditions anticipated, including in areas of elevated vertical load where the panel and adjacent barrier pillar geometries planned are able to share any increased load due to the stiffness and bridging capacity of the intact interburden strata.

4.3 Pillars in Flooded Overlying Workings

Figure 12 shows the location of potential water lodgements in both the Bulli and Balgownie Seams relative to the existing workings and proposed mining layout in the Wongawilli Seam.

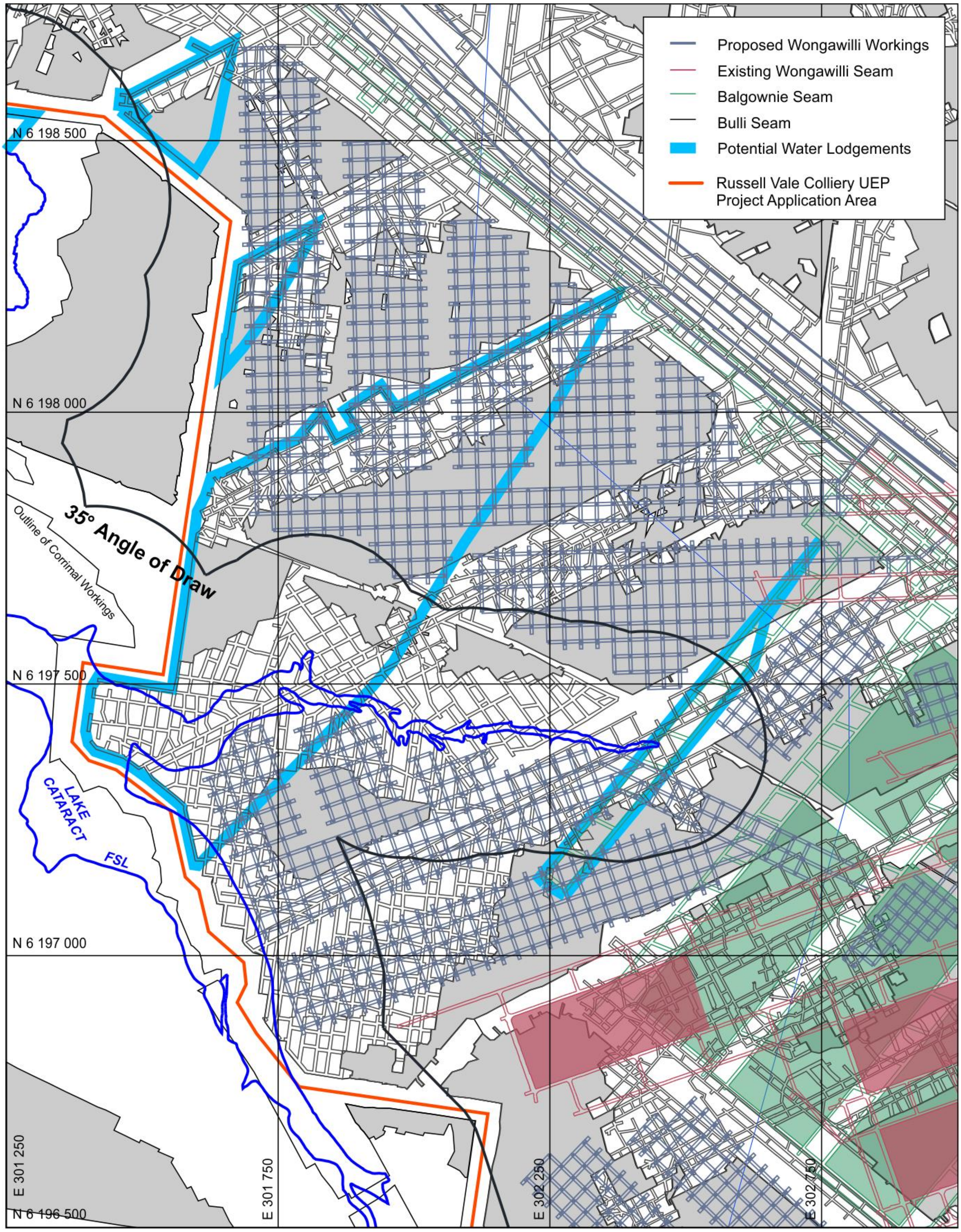

Figure 12: Potential water lodgements relative to existing workings and proposed mining.

The largest of these potential water lodgements in the Bulli Seam is below the Full Supply Level (FSL) of and the 35^0 Angle of Draw offset to Cataract Reservoir in an area directly above the proposed Wongawilli Seam mining layout. In this section, this area is referred to as the subject area. The maximum water head in the subject area would be 13m. The maximum water head in the lodgement further to the west would be 17m.

Proposed mining in the Wongawilli Seam in the subject area includes two panels each comprising five headings. One of these panels extends approximately 120m horizontally below the edge of the potential lodgement within the subject area. The water here is estimated to be up to 6m deep.

The issue of pillar stability of the Bulli Seam workings in the subject area, if water is drained as part of inrush control measures for the proposed Wongawilli Seam mining, has been considered. The effect of draining the lodgement would be to reduce the buoyancy effect of the water and slightly increase the pillar loads. The effect is finite, but negligible.

Our assessment of pillar stability indicates that the Bulli and Balgownie Seam pillars in the subject area are large enough to be long-term stable without any buoyancy effect.

4.3.1 Pillar Stability Assessment

Proposed first workings in the underlying Wongawilli Seam are not expected to have any significant effect on pillar loading in the overlying seams. The Bulli Seam is approximately 30m to 35m above the Wongawilli Seam. The formation of 5.5m wide roadways in the Wongawilli Seam is not expected to cause any significant change in loading in Bulli Seam pillars. Considerations of pillar stability in the Bulli Seam relate to the pre-existing stability of the pillar geometry and any effects associated with potentially draining the Bulli Seam.

Inspection of the Bulli Seam mine working plans and mine record tracings in the subject area indicate that the first workings were mined between 1931 and 1942 with the secondary extraction of pillars from 1945 to 1947. The plans are consistent and are considered more reliable than plans for other pre-1931 areas and mining layouts in the Bulli Seam workings.

The bord and pillar layout mined in the Bulli Seam in the subject area generally consisted of two heading panels and sub-panels. The two parallel headings are separated by long, narrow pillars ranging in width from 12m to 15m. The pillars are typically rectangular in shape with the length being more than 1.5-2.0 times greater than width. Flanking the narrow two heading panels are wider pillars, generally 20m to 30m wide. Some irregular shaped pillars, including triangular pillars, were formed where the sub-panels intersect the two parallel headings.

The Bulli Seam pillars range in size from 12m by 24m up to 24m by 48m with many formed at 20m by 20m in size.

The overburden depth to the Bulli Seam in the subject area ranges from 270m to 300m and is 270m where the proposed Wongawilli Seam panels extend below the lodgement. The seam thickness and assumed mining height is 2.2m.

These pillars have a nominal width to height ratio in the range 5 to 11, but generally greater than 9. Pillars in this width to height range located in strong roof and floor conditions such as those typical of the Bulli Seam tend to build strength as they become loaded. They are therefore not subject to becoming overloaded and losing strength.

Experience of monitoring pillar behaviour in the Bulli Seam reported in Mills and Gale (1994) indicates that pillar strength can be estimated using Bieniawski's pillar design formula:

$$Q_p = K\ (0.64+0.36\ W/H)$$

where Q_p is the nominal pillar strength, W is the pillar width, H is the pillar height and K is a constant to reflect the pillar geometry and the geological characteristics of the roof and floor conditions.
A value of K = 6MPa provides a conservative estimate of the strength of square pillars in strong roof and floor conditions considered appropriate for the Bulli Seam at this location.

At an overburden depth of 270m, the Bulli Seam pillars across the subject area have a nominal strength of typically more than twice the load they are expected to carry under tributary area loading assuming roadway widths of 6m. The ratio of nominal strength to loading ranges from greater than 1 to about 2.6 and is more typically 2.1 for the 20m by 20m pillars. These Bulli Seam pillars are expected to remain stable in dry conditions without any buoyancy effects associated with flooding.

For a maximum depth of water of 13m, the buoyancy effects are negligible for all practical purposes and wouldn't normally be considered in a pillar stability assessment. A maximum depth of 13m is estimated to reduce the vertical loading from 6.75MPa to 6.68MPa, a reduction of 1.1%. For the 12m, 20m and 24m square pillar geometries assessed this vertical stress reduction would increase the strength to load ratio of these pillars by about 4.0%.

A water lodgement is also thought to remain in the last gateroad development panel in the Balgownie Seam within the subject area. The maximum water depth in this panel is estimated to be 6m. The pillars in this panel are 40m wide with lengths ranging from approximately 40m to 70m. The seam thickness is around 1.3m and the mining height believed to be 1.5m. The nominal width to height ratio for these pillars is greater than 30 and as such are long-term stable. Removing the water from this panel is not expected to have significant impact on the stability of these pillars or those above in the Bulli Seam.

5. FORECAST GROUND MOVEMENTS FOR THE PROPOSED WORKINGS

Irrespective of the strength, load and behaviour of the proposed pillars, some low-level deformation is expected with elastic compression of the strata above and below these pillars. This strata compression has potential to result in low-level subsidence movements (less than 100mm and generally less than 30mm) with corresponding low levels of tilt and strain. Any such subsidence is likely to occur gradually. These movements are expected to be generally at or below survey monitoring tolerance particularly in areas where surface surveying techniques are constrained by environmental considerations. These subsidence movements are expected to be generally imperceptible and insignificant for all practical purposes.

The exception to this is ongoing horizontal movements; a legacy of previous mining. Any ongoing movements are likely to be small but nevertheless potentially noticeable along the section of Mount Ousley Road from near the topographic high point (ridge line south of Cataract Creek) down to areas adjacent to Cataract Creek.

Proposed mining in the Wongawilli Seam is not expected to cause any significant instability of pillars in the overlying seams. Stress concentrations from pillars in the overlying seam may cause locally higher deformation and instability around first workings roadways at the Wongawilli Seam mining horizon. Geological features such as the Corrimal Fault and Dyke D8 are expected to locally concentrate stresses nearby, but increased deformations are likely to be generally limited to within a few metres of these features.
The proposed mining is not expected to contribute to significantly increased loading in the overlying Bulli Seam and therefore, in general, there is very limited potential for the proposed mining to lead to additional pillar instability in the Bulli Seam.

During recent longwall mining in the Wongawilli Seam, pillar instability in the overlying Bulli Seam has only been observed directly above extracted longwall panels. This pillar instability is a result of the significant ground disturbance caused by full extraction. Subsidence monitoring experience from longwall mining in the Balgownie Seam and the recent Wongawilli Seam longwalls indicates that the extent of any instability of remnant pillars in the Bulli Seam is likely to be limited to a few small areas where the Bulli Seam pillars are narrow and the voids between them wide enough that stability appears marginal irrespective of any further mining.

In these areas, there is some potential for pillar instability to lead to additional subsidence, potentially of the order of 1m to 2m should the pillars collapse over a large enough area. These areas of marginally stable pillars are located outside of areas of full extraction in the Bulli Seam, the Balgownie Seam and the Wongawilli Seam.

Remnant pillars in the thinner Balgownie Seam are generally larger in plan area and are expected to display greater stability due to their higher width/height ratios.

Targeted surface to seam drilling for groundwater monitoring (permeability testing and piezometer installation) in 2014 confirmed one area of Bulli Seam goaf to the east of Mount Ousley Road to be totally collapsed as expected. This borehole drilled down through the Bulli Seam goaf confirming it had collapsed as shown on the mine plan, through the Balgownie Seam chain pillar between Longwalls 5 and 6 and into the virgin Wongawilli Seam below. The area of Bulli Seam goaf was sufficiently large and the collapsed ground sufficiently tight that a column of water more than 200m high was able to be maintained in the borehole.

6. IMPACT ASSESSMENT OF FORECAST GROUND MOVEMENTS

The subsidence movements forecast for the proposed layout are not expected to cause any significant impacts to natural surface features within the Application Area. Any additional impacts to the natural and built surface features from the proposed first workings would be difficult to distinguish from those associated with previous mining activities.

It is recognised that the proposed mining plan involves mining within the DSC Notification Area for Cataract Storage Reservoir. The proposed mining plan has minimum width/height pillars within the 1.2 times depth Restricted Zone, the 0.7 times depth (35^0 angle of draw) Marginal Zone and up to the FSL of the Reservoir. This mining will therefore require the consent of the Dams Safety Committee.

SCT Report WCRV4466A “Assessment of Corrimal Fault and Dyke D8 at Russell Vale East as Risks to the Stored Waters of Cataract Reservoir” (SCT 2015) concludes that there is no credible risk of inflow between the stored waters of Cataract Reservoir and the mining horizons through either the Corrimal Fault or Dyke D8 as a result of the proposed UEP-PPR mining layout for longwall extraction. Any effects from mining first workings roadways in the Wongawilli Seam are expected to be generally limited to a few metres around the proposed roadways. No significant subsidence impacts or environmental consequences are expected from mining through or in the vicinity of the Corrimal Fault and Dyke D8 by the proposed first workings layout. The likelihood of impacts to the Corrimal Fault is considered to be very low. The consequences of any impacts to the Corrimal fault are expected to be negligible. Any impacts on groundwater are expected to be limited to the immediate vicinity of the Wongawilli Seam and only in the area of the proposed mining.

Large areas of the surface within the Application Area are currently in limiting equilibrium (on the verge of moving) because of previous mining including Longwalls 4-6 in the Wongawilli Seam. Further narrow tension cracks and minor compression impacts to the Mount Ousley Road pavement are considered possible because of ongoing subsidence associated with this previous mining. Small additional valley closure movements across Cataract Creek may also continue regardless of any future mining. Effects such as increased groundwater levels following periods of high rainfall and seasonal temperature variations have potential to upset the equilibrium conditions and cause additional movements. The proposed mining is not expected to increase or otherwise change the potential for these effects to cause additional, perceptible impacts.
The small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

Proposed mining is not expected to increase interactions between the mine and surface water or impact surface water dependent ecosystems or groundwater at levels above those currently experienced.

There is considered to be no significant potential for additional interaction between surface water, groundwater and the underground mining horizons. The deformations associated with strata compression are small in magnitude. There is very limited potential to create additional zones where hydraulic conductivity would be increased.

The Illawarra Escarpment, in particular the section of Hawkesbury Sandstone outcrop at Brokers Nose, is not expected to be impacted by the proposed mining. It should be recognised that there is always potential for cliff falls to occur naturally as part of the ongoing erosion processes, but the proposed mining is not expected to increase this potential.

The telecommunications infrastructure at Brokers Nose and the bridge at the Picton Road Interchange are remote from the proposed mining. There is considered to be no potential for mining induced ground movements at this infrastructure from the proposed mining.

The 330kV and 132kV powerlines located east of Mount Ousley Road are both supported on steel truss pylons. These pylon structures are very sensitive to differential ground movements from subsidence, but the ground movements associated with the proposed mining are so low as to be well within the tolerance of these structures. The only potential for these structures to be impacted would be from subsidence movements associated with localised instability of marginally stable Bulli Seam pillars.

Inspection of the workings shown on mine plans below the eight pylon towers located within the Application Area indicate that the potential for additional subsidence from destabilised pillars in the upper seams is low. However, this potential cannot be eliminated. While the probability of additional subsidence is considered low, the consequences to this critical infrastructure from greater subsidence than forecast is likely to pose an unacceptable risk to asset owners and regulators. A strategy to protect the towers from the potential for subsidence impacts from pillar instability is likely to be required. This strategy is likely to involve the use of cruciforms, relocating towers to areas where pillar stability can be confirmed or stabilising the mine voids using some form of cement stabilised fill material.

The two 33kV powerlines located further to the east are not expected to be impacted by the low levels of subsidence movements forecast for the proposed first workings mining. These powerlines are supported on single and double pole structures. Such structures are generally tolerant of subsidence movements. The potential for additional subsidence at these pole locations from destabilised pillars in the upper seams is also considered to be low.

7. REFERENCES

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APPENDIX 1

Appendix 1 provides a review of the subsidence effects and subsidence impacts of previous mining activity in the Russell Vale East area as context for the imperceptibly low levels of ground movements expected from the proposed mining. This information was originally presented in SCT (2014) to support the UEP-PPR application. Sections of that report are presented together with additional monitoring or observations since the UEP-PPR application was lodged.

In the following sections the PPR Assessment Area is different to the Application Area for the current proposal. The PPR Assessment Areas included the 600m Study Area around the proposed longwall panels and the further 1.5km far-field effects zone.

A1. Review of Previous Mining Activity and Associated Impacts

An unusual characteristic of the PPR Application Area is the presence of previous mining activity in two other seams. Figure 13 shows the extent of previous secondary extraction in the Bulli, Balgownie and Wongawilli Seams within the PPR Application Area.

This previous mining provides a number of opportunities that are not usually available in single seam mining applications but also brings a number of differences as well. Geological structure and seam contour are much better known as a result of previous mining activity than would normally be possible for single seam mining.

Previous mining activity provides an opportunity to examine the mining impacts over timeframes of 50-100 years for the Bulli Seam and 30-40 year for the Balgownie Seam mining. The subsidence movements associated with the earlier mining have been estimated for the Bulli Seam and measured for the Balgownie Seam providing a baseline of impact experience and recovery that is not typically available.

The ongoing nature of the mining operation at Russell Vale Colliery provides the opportunity to inspect the mine workings in the Bulli Seam and the Balgownie Seam to better understand the nature of the potential interactions between seams and the potential for pillar instability, particularly in the Bulli Seam, to cause unexpected additional subsidence. For instance, a site visit was made by SCT on 21 June 2013 to inspect the workings in all three seams.

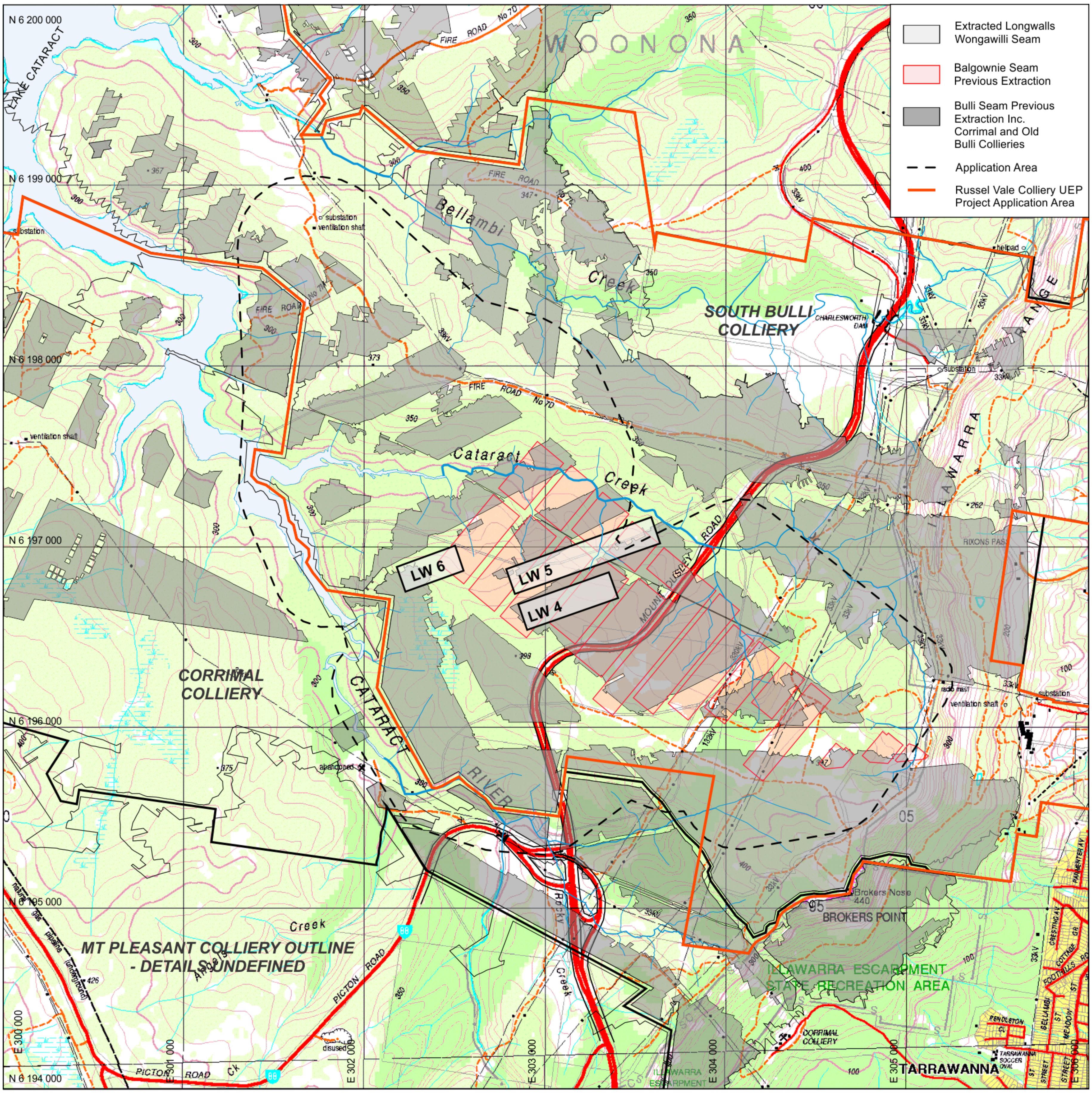


Figure 13: Plan showing extent of previous secondary extraction in Bulli Seam (black), Balgownie Seam (red) and Wongawilli Seam (grey) in the Application Area.

Subsidence monitoring data available from mining in the Balgownie Seam and more recently from three longwall panels in the Wongawilli Seam is available and this data provides a basis for confirming overburden behaviour and estimating the potential for further subsidence. This data indicates that while there are some significant differences in behaviour compared to single seam mining, the multi-seam behaviour is reasonably predictable and occurs predominantly within the bounds of the individual panels that were mined. This data and observations of previous ground movements indicate that the ground movements expected to result from the proposed mining are likely to be insignificant for all practical purposes.

A1.1 Bulli Seam Workings and Associated Subsidence

The Bulli Seam was mined initially using hand bord and pillar mining techniques from the 1890's through until pillar extraction became possible with improvements in mining technique and the arrival of mechanised mining. Some of the standing pillars associated with the main headings and original mining areas were extracted during the later stages of retreat. Mining in the Bulli Seam within the PPR Application Area had effectively finished by the 1950's. Areas of pillar extraction in Corrimal Colliery immediately to the south are also included in the estimation of subsidence from the Bulli Seam because they fall within the PPR Application Area.

There are no known records of subsidence monitoring for the period of mining in the Bulli Seam. However, it is possible to estimate the levels of subsidence that are likely to have occurred given the geometry of the panels mined and estimating the likely extraction percentages.

Figure 14 shows contours of the surface subsidence interpreted as being caused by pillar extraction operations in the Bulli Seam. This subsidence has been estimated based on subsidence monitoring results and subsidence profiles from mining in the Bulli Seam further to the west above the T and W (200 and 300 series) longwall panels at South Bulli and subsequent pillar extraction operations.

An underground site inspection conducted on 21 June 2013 showed that there are existing bord and pillar workings alongside the Bulli Seam main headings that may be destabilised if they were disturbed by further mining.

Similar workings were directly mined under by the Balgownie Seam longwall panels and it is clear from the underground inspection that these overlying pillars were destabilised in the area directly above the Balgownie Seam longwall goaf as shown in Figure 15. There did not appear to be any evidence that the footprint of instability extended significantly beyond the footprint of the underlying goaf, but it is considered possible that this potential may exist in some places where there are localised areas of standing pillars remaining.

The formation of isolated roadways in the Wongawilli Seam is not expected to have potential to cause instability in these Bulli Seam pillars. There is no known evidence of this effect at the Russell Vale site. However, the possibility cannot be ruled out completely.

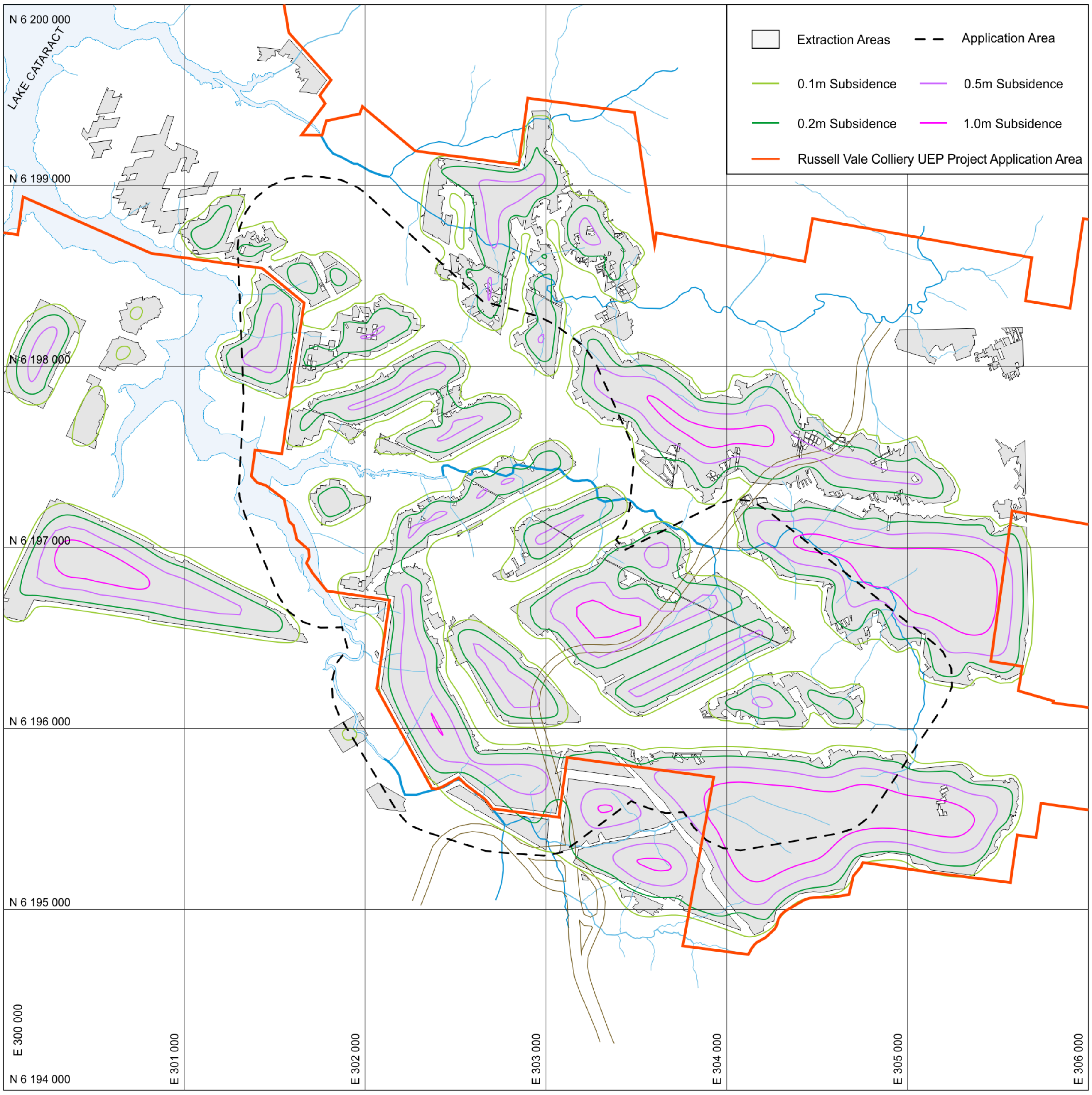


Figure 14: Plan showing estimated subsidence movements likely to have been associated with pillar extraction operations in the Bulli Seam.

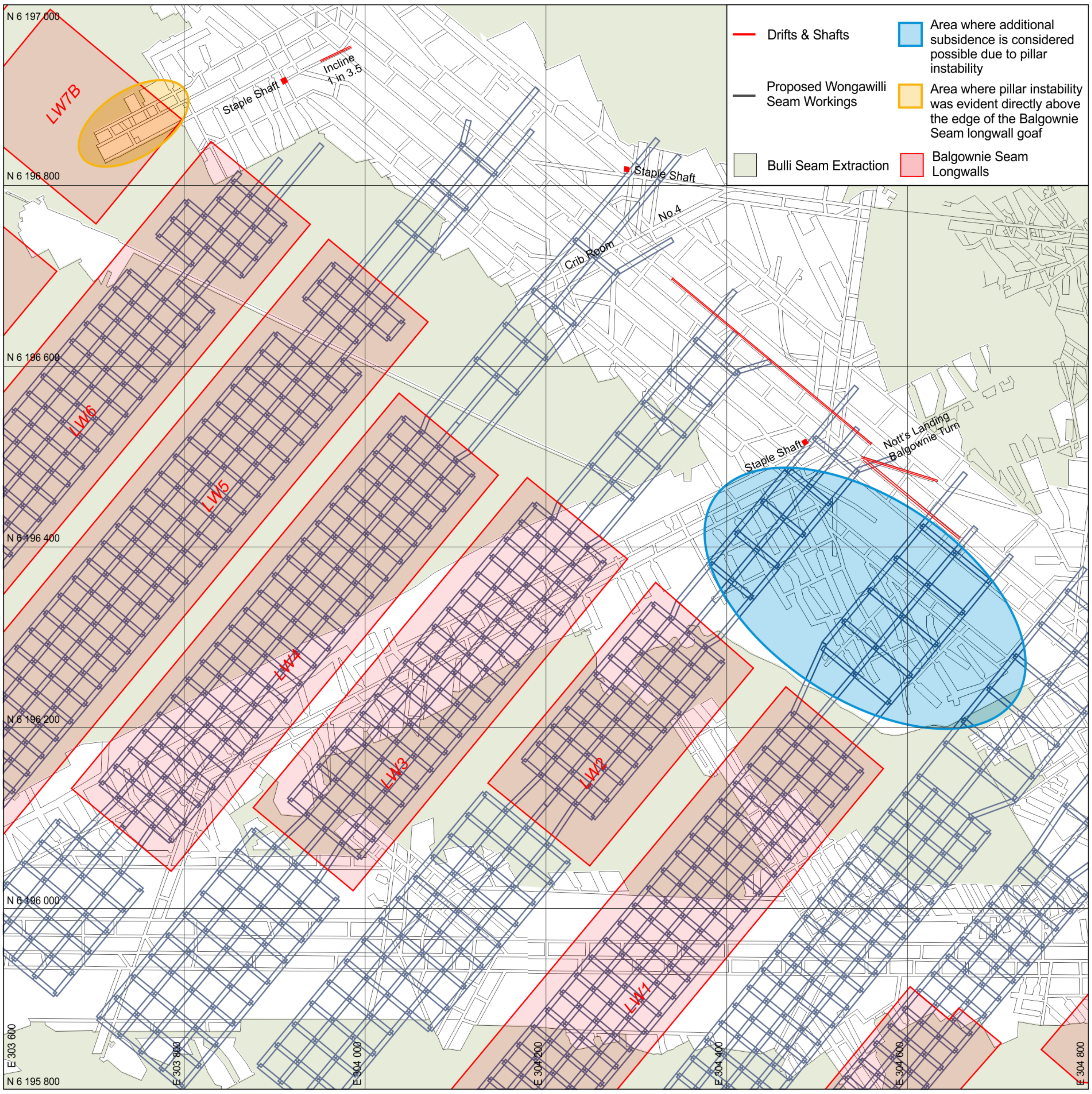


Figure 15: Plan showing areas of existing and potential pillar instability in overlaying Bulli Seam.

Where large areas have been shaded (refer to Figure 13) to represent the completion of mining, the detail of the Bulli Seam extraction is not available. These areas are likely to include different levels of mining ranging from solid coal, large standing pillars, standing pillars associated with Welsh bords, and goaf areas where there has been pillar extraction or the pillars have previously collapsed.

The downward movements that occurred during Balgownie Seam mining and were observed on the surface as subsidence provide a basis to differentiate these shaded areas where they have been directly mined under by the Balgownie Seam longwall panels. Small pillars that have been mined under by the Balgownie Seam longwall panels are considered likely to have been destabilised during the 1m to 1.5m downward movement in the Bulli Seam that would have occurred as these pillars were mined under.

Subsidence monitoring above the Balgownie Seam longwall panels is able to differentiate areas where there has been some additional subsidence consistent with pillar instability, areas where there has been additional consolidation of an existing Bulli Seam goaf, and areas where there has been either no mining in the Bulli Seam, or the Bulli Seam pillars are large enough to behave like solid coal.

Without having access to confirm, there is considered to be potential for some pillars in the Bulli Seam to remain standing just beyond the edges of the extracted Balgownie Seam longwall panels. The stability of these pillars is difficult to assess with confidence, particularly in areas in the Bulli Seam that are shaded to indicate pillar extraction but for which the detail is lacking. It is possible that these pillars are in a state of imminent instability that could lead to further subsidence in the future.

In the unlikely event of further subsidence due to pillar instability in the Bulli Seam without any further nearby mining activity in the Wongawilli Seam, any consequential impacts would be due to historic mining and any remediation costs would be covered by Subsidence Advisory NSW (formerly the Mine Subsidence Board). If, on the other hand, subsidence due to pillar instability in the Bulli Seam were to occur after mining in the Wongawilli Seam, even if only in the general vicinity, WCL would be in the position of needing to demonstrate the subsidence was not due to their recent mining activity to avoid being held responsible under the Work Health and Safety Act 2011 and specifically the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 for any impacts that may occur. This burden of proof may be difficult to support.

The Bulli Seam subsidence estimates shown in Figure 14 include refinements based on the ground behaviour observed during longwall mining in the Balgownie Seam. Although it is not possible to interpret the characteristics of some of the other large Bulli Seam goaf areas that have not been directly mined under in the Balgownie Seam, these other large goaf areas are remote from the areas where the PPR longwall panels are proposed.

The detail of the Bulli Seam pillars is available in some areas close to the main headings as shown in Figure 15. The site visit to this area indicated that additional subsidence due to pillar instability would be possible in this area if the pillars were to be destabilised for any reason although the surface subsidence that may result is likely to be relatively small given the narrowness of the panel at an overburden depth of 270m.

The issue of a "pillar run" in the Bulli Seam was raised in the Pt 3A submissions on the previous UEP mine plans. As indicated above, there is considered to be potential for a classical "pillar run" associated with pillar instability, but the geometries in the Bulli Seam and the evidence from previous mining in the Balgownie Seam make it unlikely that such an event would extend more than a few hundred metres from the goaf edge (i.e. the extent of the panel of standing pillars). The subsidence from such an event would be limited to low levels of less than a few hundred millimetres maximum due to the narrow panel width of standing pillars small enough to be destabilised and would be limited to only those areas where there are small standing pillars that have not previously been mined under in the Balgownie Seam.

The terms "pillar run" and "pillar creep" have been used in some of the submissions to describe the phenomenon that is perhaps better described as "stress redistribution" because of the relatively smaller ground movements involved, typically less than 100mm. As one area is subsided, pillars become more heavily loaded, and compress slightly causing lateral migration of low-level subsidence movements well beyond the limits of subsidence normally associated with single seam mining. This phenomenon is particularly common where panels are relatively narrow compared with overburden depth and surface subsidence is controlled mainly by elastic compression of the pillars between panels.

A similar process can also occur for horizontal movements as horizontal stresses are redistributed and dilation of subsiding strata causes horizontal movement in a downslope direction. Again, the ground movements tend to be small second order movements that may cause perceptible low-level cracking on hard surfaces such as sealed roads especially adjacent to topographic high points, but such movements are usually not significant because they tend to be of small magnitude and occur over large areas.

The proposed workings in the Wongawilli seam are not expected to cause any significant instability of pillars in the overlying seams.

A1.2 Balgownie Seam Workings and Associated Subsidence

Figure 7 shows the extent of the Balgownie Seam workings. There are eleven longwall panels extending to the south of the main headings. Apart from development headings, the remaining coal was recovered from three small panels of pillar extraction with continuous miners in the east and more recently as a panel of pillars formed up as first workings against the sill complex in the north.

Longwall mining in the Balgownie Seam started in September 1970 at Longwall 1 and finished in May 1982 at Longwall 11. The first six panels were located east of the current Mount Ousley Road alignment and ranged in width from 141m to 145m. The last five panels were located west of Mount Ousley Road and ranged in width from 185m to 189m. These later panels were split into two parts either side of the D8 Dyke. These longwalls mined directly below the road alignment.

A1.2.1 Vertical Subsidence

Surface subsidence was monitored along the centreline of each of the eleven longwall panels and on three cross-lines. The vertical subsidence was monitored at regular intervals during panel retreat above the initial panels and less frequently during mining of the last few panels. Surface strains were also measured during the last panel.

Figure 16 shows an example of the subsidence measured on the second cross-line that extends from the centre of Longwall 5 to the solid coal west of Longwall 11. The characteristics of the subsidence measured that are of relevance show:

- The chain pillars are clearly evident in the subsidence profile with 0.5m to 0.75m of subsidence directly over these pillars.
- Coal left in the Balgownie Seam around the dyke is clearly evident as reduced surface subsidence.
- The maximum sag subsidence in the centre of each panel is reduced in areas where the panels are narrower (0.2m in narrow panels compared to 0.5m above the wide panels).
- The sag subsidence is more in areas where the Bulli Seam has been extracted.
- The subsidence is greatest (1.42m) over Longwall 10 in an area on the fringe of Bulli Seam goaf where full subsidence during mining of the Bulli Seam was prevented by the presence of solid abutment coal or marginally stable pillars were destabilised.
- Surface subsidence occurred primarily within the geometry of the Balgownie Seam longwall panels.
- The goaf edge subsidence is greater and extends further when there is overlying Bulli goaf, but this effect is a second order effect.

These different characteristic behaviours have been considered for each of the subsidence lines and the maximum subsidence observed is able to be used to characterise the condition of the Bulli Seam goaf above.

Figure 17 shows the maximum subsidence observed for each of the longwall panels. The different areas can be divided up as shown in Table 1 based on where there are pillars and goaf in the two seams.

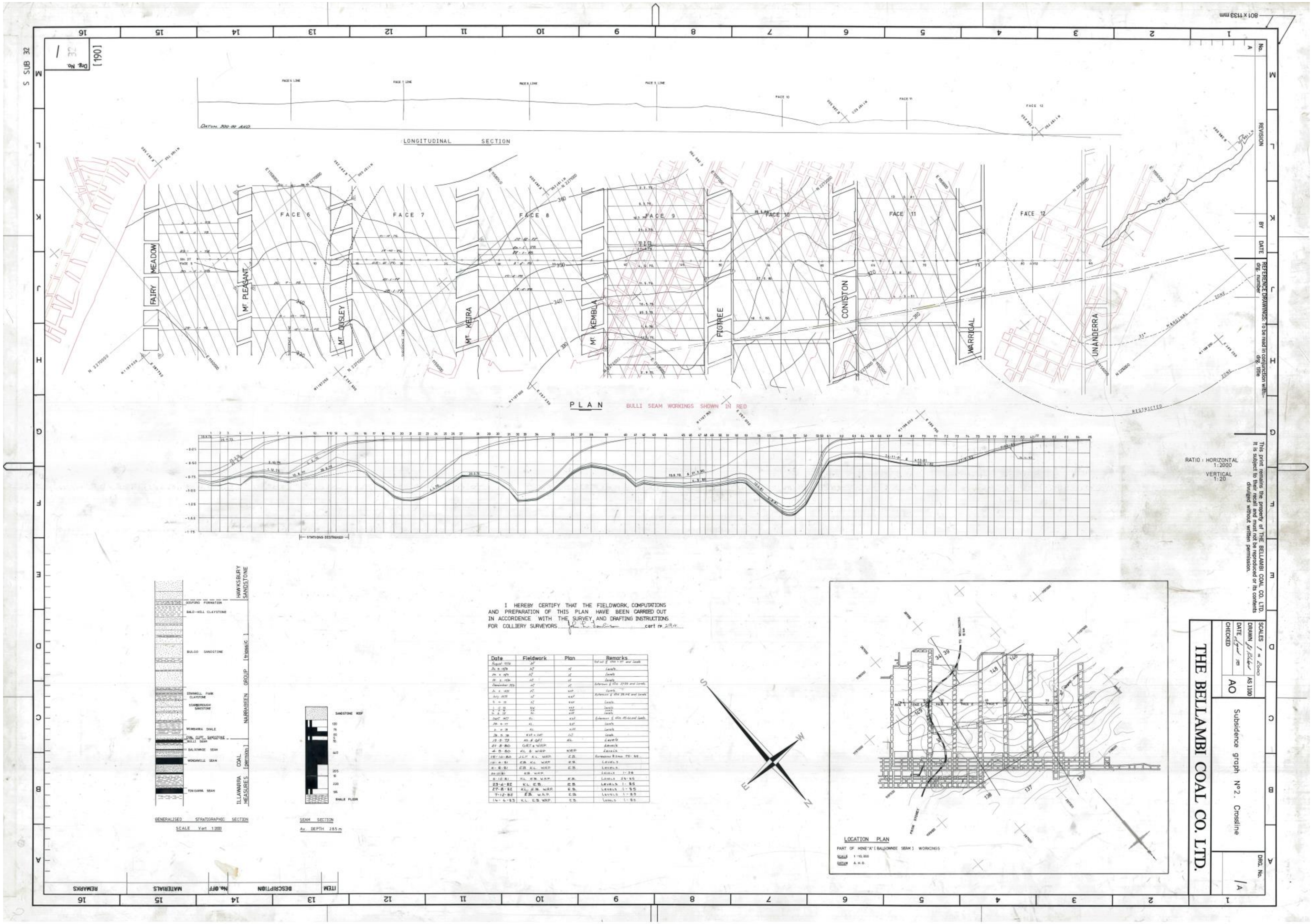


Figure 16: Example of subsidence monitoring of Balgownie Seam longwall panels.

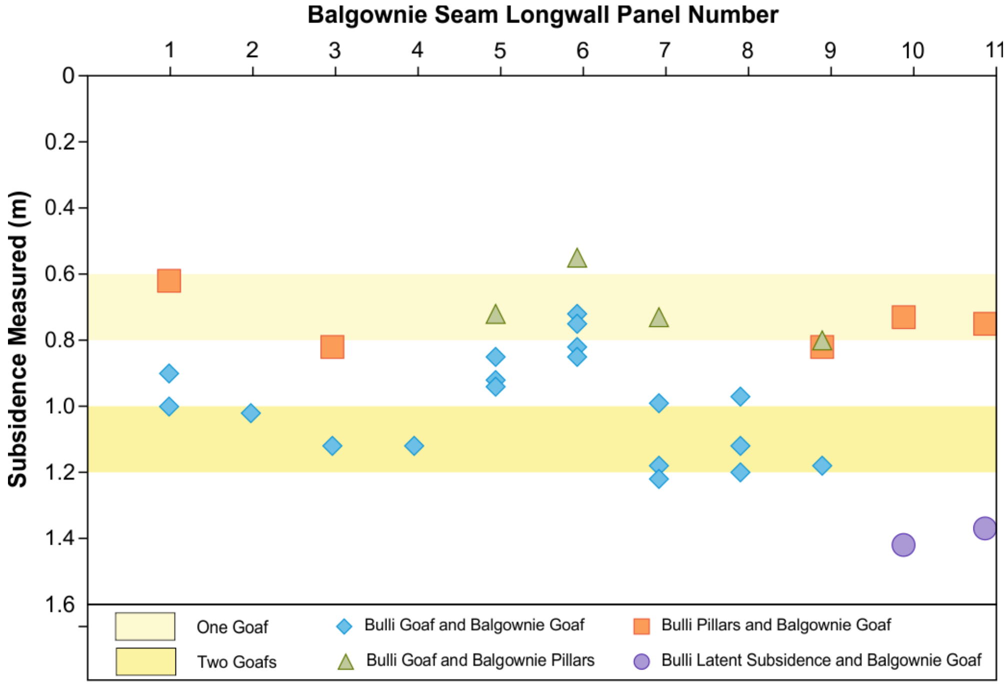


Figure 17: Maximum subsidence observed for each longwall panel in the Balgownie Seam.

Table 1: Subsidence Observed in Different Conditions

	Bulli Seam Pillars	Bulli Seam Goaf	Unstable Bulli Pillars
Balgownie Seam Pillars	Low-level subsidence (<0.2m)	0.6-0.8m	Low-level(<0.2m)
Balgownie Seam Goaf	0.6-0.8m	1.0-1.2m	1.4m

In areas where there are Balgownie chain pillars and pillars in the Bulli Seam, the subsidence directly over the chain pillars is less than 0.2m. In areas where there are pillars in one seam and extraction in the other seam, surface subsidence is between 0.6m and 0.8m. Where there has been extraction in both seams, the maximum incremental subsidence is in the range 1.0m to 1.2m – i.e. approaching 80% of the nominal mining height of the second seam mined.

In areas where there is clearly potential for either latent subsidence because the Bulli Seam goaf is narrow and bridging (such as the zone of high subsidence associated with mining Longwall 11 in the Balgownie Seam) or along a goaf edge where full subsidence has not been able to develop during mining the first seam (such as the high subsidence zone associated with mining Longwall 10 in the Balgownie Seam), the incremental subsidence reaches 1.4m and is of the order of 100% of the mining height of the second seam mined.

The 1.4m of subsidence observed in these circumstances is likely to have a component of destabilisation of standing pillars in the Bulli Seam caused by mining in the Balgownie Seam. Up to 0.7m of subsidence would be expected from mining below pillars in the Bulli Seam plus an additional 0.8m subsidence in the Bulli Seam of about 30% of the 2.2m mining height given an extraction ratio of about 30%. The total subsidence would therefore be about 1.5m and of the same magnitude as the subsidence observed.

Figure 18 shows the subsidence measured during mining the Balgownie Seam based on interpolation of the subsidence monitoring data. This data represents the incremental subsidence associated with mining the Balgownie Seam given that all the Bulli Seam subsidence had already occurred prior to the subsidence pegs being installed.

Maximum subsidence is 1.42m and 1.33m over Longwalls 10 and 11 respectively but in most of the areas, subsidence over the longwall goafs is in the range 0.6m to 1.2m.

A1.2.2 Horizontal Strains and Tilts

Maximum strains measured over Longwall 11 ranged from 3-4mm/m along the panel to peaks of 14mm/m in compression across the topographic low point of Cataract Creek and 9mm/m in tension on the slope beyond. For the maximum subsidence of 1.4m and an overburden depth to the Balgownie Seam of 260m at this location, the strain peaks measured indicate a relationship between maximum strain and maximum subsidence of:

$E_{max} = 500\ S_{max} / D$ for systematic strains and

$E_{max} = 1500\text{-}2500\ S_{max} / D$ for non-systematic strains associated with valley closure and steep topography.

These compare reasonably with the peak strain subsidence relationships presented by Holla and Barclay (2000) for the Southern Coalfield which indicate:

$$E_{max\ tensile} = 1500\ S_{max} / D$$
$$E_{max\ compressive} = 3000\ S_{max} / D$$
$$Tilt_{max} = 5000\ S_{max} / D$$

for peak strains and tilts that include non-systematic strains and tilts associated with valley closure and steep topography. The peak compressive strains tend to be apparent in topographic low points and the tensile strains tend to be more apparent at the start of panels in ground sloping in the same direction as mining, and along topographic high points such as ridges.

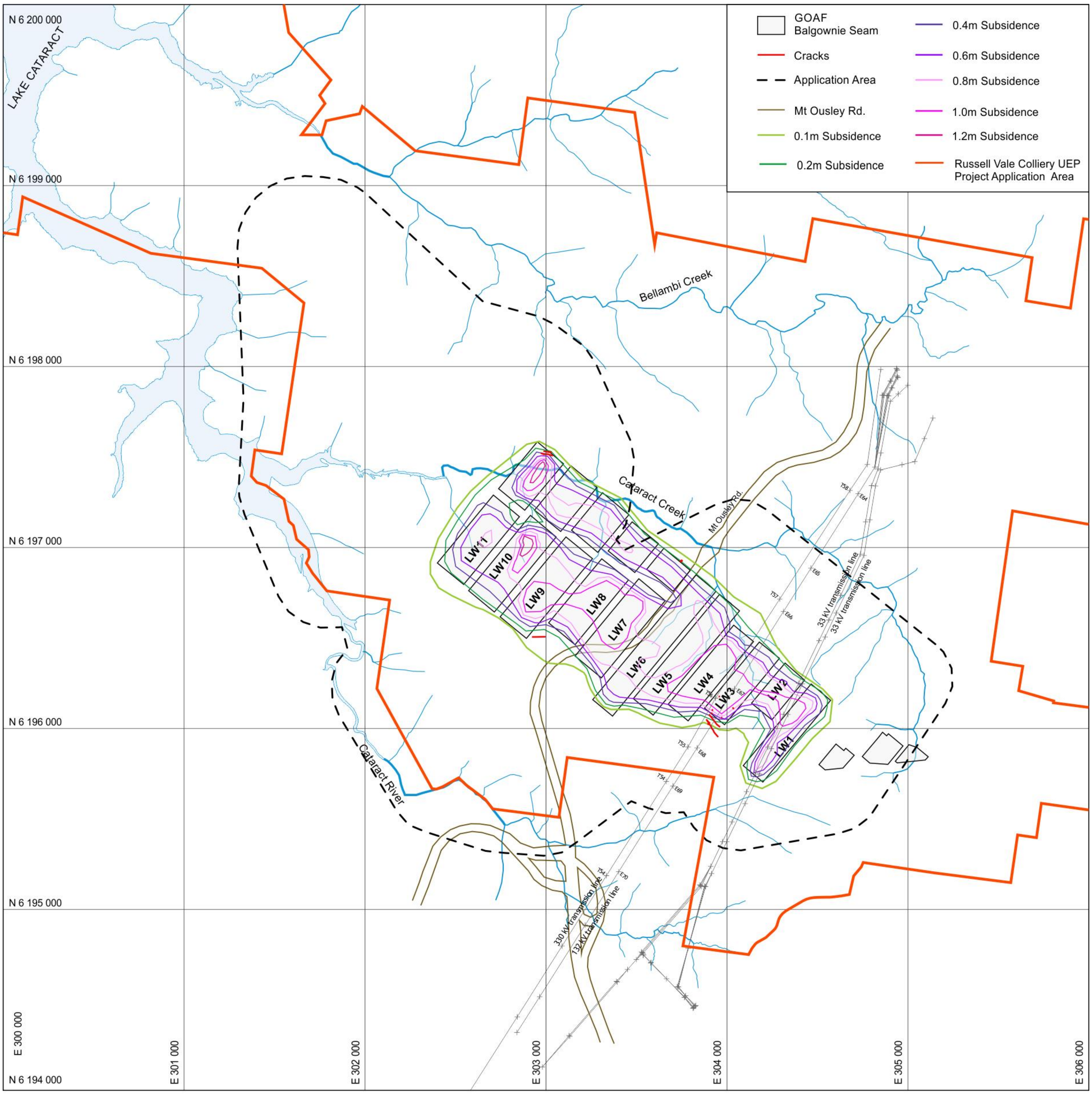


Figure 18: Contours of subsidence measured above the Balgownie Seam longwall panels.

A1.2.3 Valley Closure and Upsidence

The 14mm/m compressive strain peak measured across Cataract Creek on the centreline of Longwall 11 was measured between pegs spaced 18m apart. Compressive strain of 4mm/m was measured between the next two pegs spaced 15m apart. These measurements imply a total closure across the creek of about 310mm.

The ACARP method for estimating valley closure developed by Waddington and Kay (2002) indicates the incremental valley closure for Longwall 11 as being of the order of 200-300mm and is therefore consistent with the closure measured during mining of Longwall 11. The agreement is relatively close between measured and calculated even though the geometry associated with the short longwall panels is irregular and well outside the database of experience on which the ACARP method is based.

Valley closure at other locations is also evident as upsidence in the subsidence profiles that extend across Cataract Creek. Table 2 summarises the upsidence measured as well as the incremental upsidence calculated for each longwall panel to allow direct comparison with the upsidence measured for each longwall panel during mining of that panel.

Table 2: Comparison of Measured and Calculated Upsidence

Balgownie Longwall Panel	Distance from End of Panel (m) (positive over goaf)	Incremental Upsidence Indicated (mm) (not necessarily peak)	Overburden Depth (m)	Maximum Subsidence (m)	Calculated Upsidence for each panel individually (mm)
3	170	130	230	1.1	70
4	30	210	230	1.1	100
5	0	80	230	0.8	100
6	-75	30	240	0.8	120
8	-106	80	240	0.9	130
9	-30	120	250	0.9	110
10	20	100	260	0.9	100
11	116	100	260	1.4	90

Upsidence measurements shown in Table 2 are made at the peg locations. The pegs are 15m to 20m apart while the upsidence tends to peak over a distance of only a few metres. The location of the pegs may not necessarily coincide with the peak upsidence, so the measured upsidence is considered to be a lower bound estimate of the maximum upsidence that occurred. The measurements made during mining of the Balgownie Seam longwall panels indicate that Cataract Creek has already sustained upsidence in the range 100mm to 200mm from this mining with some additional upsidence likely to have occurred during mining in the Bulli Seam.

The ACARP method for estimating upsidence for single seam mining operations indicates upsidence and valley closure that are consistent with the values measured. This method appears likely to still be relevant for estimating upper bound upsidence and valley closure for future mining activity in the Wongawilli Seam even in a multi-seam mining environment

A1.2.4 Total Cumulative Subsidence

Figure 19 shows the total cumulative subsidence estimated by adding together the estimated subsidence from the Bulli Seam and the measured subsidence from the Balgownie Seam using Surfer and a 10m by 10m grid spacing. The locations of surface features that have or may have been impacted by subsidence from this previous mining are also shown.

The total cumulative subsidence associated with mining both the Bulli Seam and Balgownie Seam is an estimate because the Bulli Seam subsidence was not measured. The total subsidence is nevertheless useful as an indicator of maximum subsidence when interpreting subsidence impacts from previous mining activity.

Maximum cumulative subsidence is approximately 1.9m in the area above Longwalls 7 and 8 in the Balgownie Seam just to the west of the Mount Ousley alignment on the slope to the south of Cataract Creek. More generally the cumulative subsidence is in the range 0.3m to 1.3m.

A1.3 Wongawilli Seam Longwall Mining

In this section, the results of subsidence monitoring in Longwalls 4 and 5 are reviewed.

Three short longwall panels were mined in the Wongawilli Seam between 2012 and 2015 creating voids at the mining horizon that are 150m wide. Longwall 4 was extracted between 21 April and 21 September 2012. Longwall 5 was extracted between 15 January 2013 and early January 2014 although the panel was substantially complete by 18 December 2013. The first 340m of Longwall 6 was extracted between 5 May 2015 and 7 July 2015.

The subsidence from mining the first 340m of Longwall 6 has occurred in a separate small area. Although there has only been limited extraction whereby subsidence and disturbance of the overburden strata is yet to fully develop the measurements of subsidence effects and impacts observed are within expectation. This data set includes the observation of angle of draw and the extent of destabilisation of previous workings in the upper seams. SCT understands WCL intends to mine the remaining 25m of the approved length of Longwall 6 to facilitate the recovery of the longwall equipment. The equipment will then be removed and brought out of the mine.

It is convenient to discuss the surface subsidence as comprising two components. These two components are described in detail in Mills (1998).

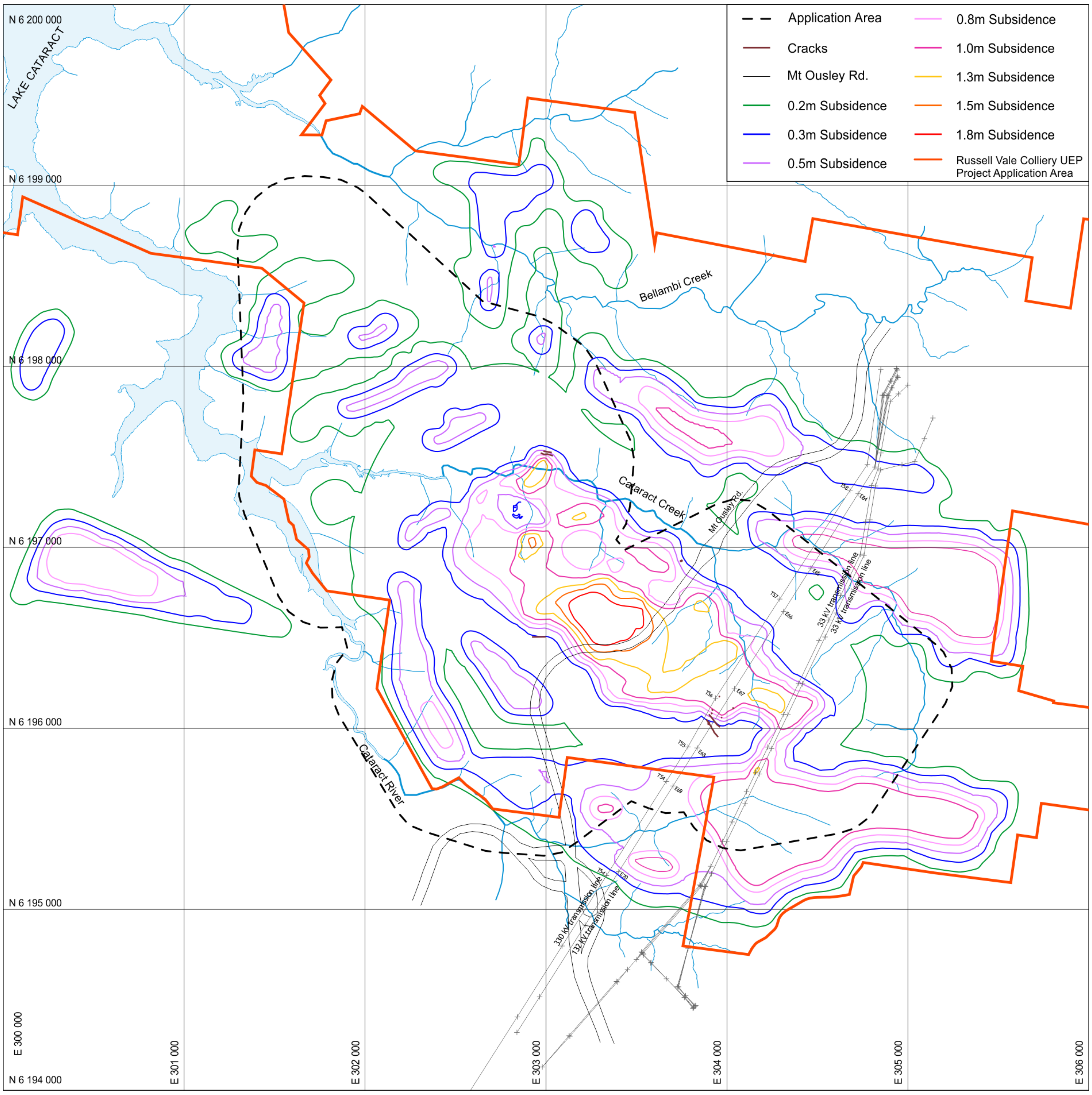


Figure 19: Contours of estimated cumulative subsidence for the Bulli Seam and the Balgownie Seam mining.

The first component, called sag subsidence, is the subsidence that results from the overburden strata draping down into the void created by each longwall panel. Sag subsidence increases with increasing panel width up to a maximum at a distance referred to as critical width. Sag subsidence also increases as the overburden depth reduces, as the thickness of the coal seam mined increases, and with the presence of previous mining activity in the overlying seams.

Sag subsidence is a measure of the capacity of the overburden strata to bridge across each longwall panel and in wide panels the vertical support able to be provided by the extracted goaf.

The second component, called strata compression subsidence, is the subsidence that results from compression of the chain pillar between panels and the rock strata above and below the chain pillar. The total strata compression is seen on the surface as subsidence. The increased load on rock strata above and below the chain pillar contributes almost all of the compression subsidence with compression of coal in the chain pillar contributing only a relatively small proportion of the total.

Strata compression subsidence increases with depth from less than 100mm when the overburden depth is less than 100m to 600-800mm at an overburden depth of 400m. Strata compression subsidence is function of the compression of the strata between panels and is largely independent of the sag subsidence and the capacity of the strata to bridge across each panel.

A1.1.1 Vertical Subsidence

Figures 20 a, b, c, d, and e show a summary of the results of subsidence monitoring over Longwall 4 and 5 on the two centreline subsidence lines and three cross-lines, including one short line, M Line, located across the chain pillar to measure strata compression above the chain pillar.

At the completion of Longwall 4, the maximum subsidence in the centre of the panel was 1.3m and this represents the sag subsidence for a single panel 150m wide and about 340m deep. When Longwall 5 had finished, centreline subsidence ranged from 1.1-1.8m and the centreline subsidence on Longwall 4 had increased to 1.6-1.8m consistent with strata compression at the intermediate chain pillar. Subsidence monitoring on M Line indicated that the total elastic chain pillar compression was approximately 0.7m based on superposition of the subsidence measured on M Line during Longwall 5 and goaf edge monitoring observed during mining of Longwall 4.

The increase in Longwall 4 centreline subsidence from 1.3m at the completion of Longwall 4 to 1.7m when Longwall 5 had been substantially mined is consistent with strata compression above the chain pillar between the panels of about 0.8m causing the surface above one side of the panel to be lowered 0.8m and the surface above the centre of Longwall 4 to be lowered a further 0.4m. There has been no significant increase in sag subsidence over Longwall 4 as a result of mining Longwall 5. The additional subsidence is due to strata compression above the chain pillar between Longwalls 4 and 5.

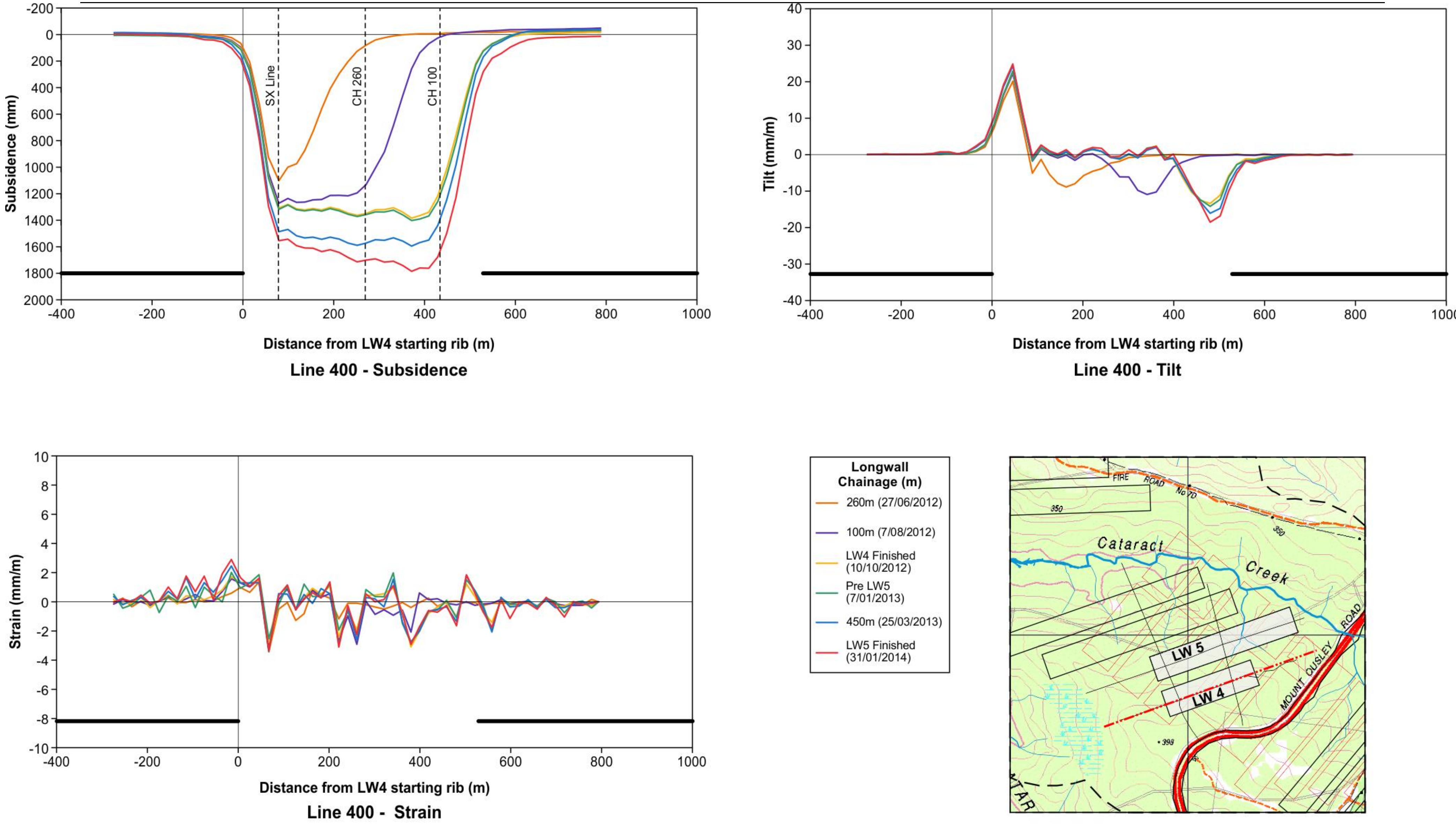


Figure 20a: Summary of Subsidence Monitoring Results from Longwalls 4 in the Wongawilli Seam.

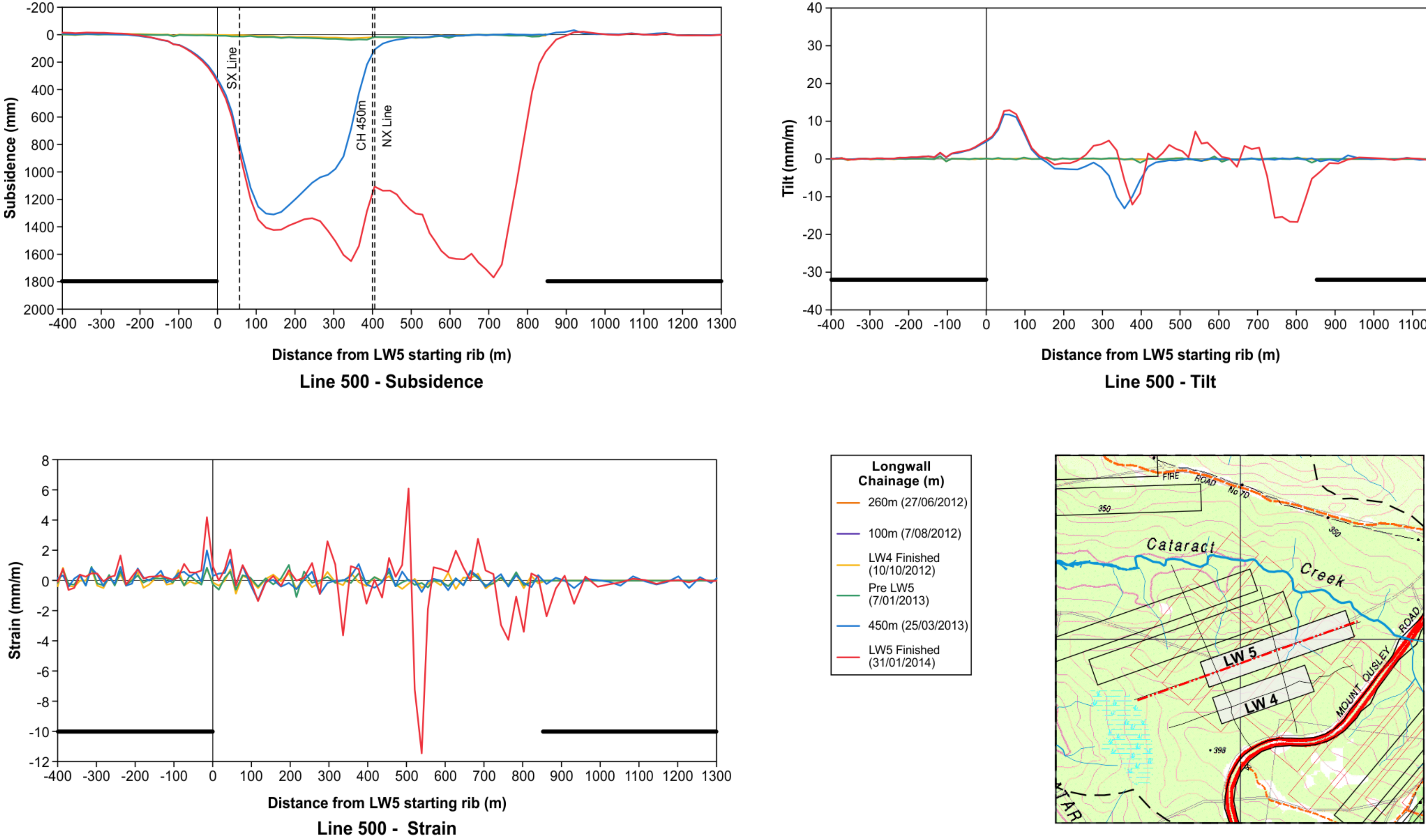


Figure 20b: Summary of Subsidence Monitoring Results from Longwall 5 in the Wongawilli Seam.

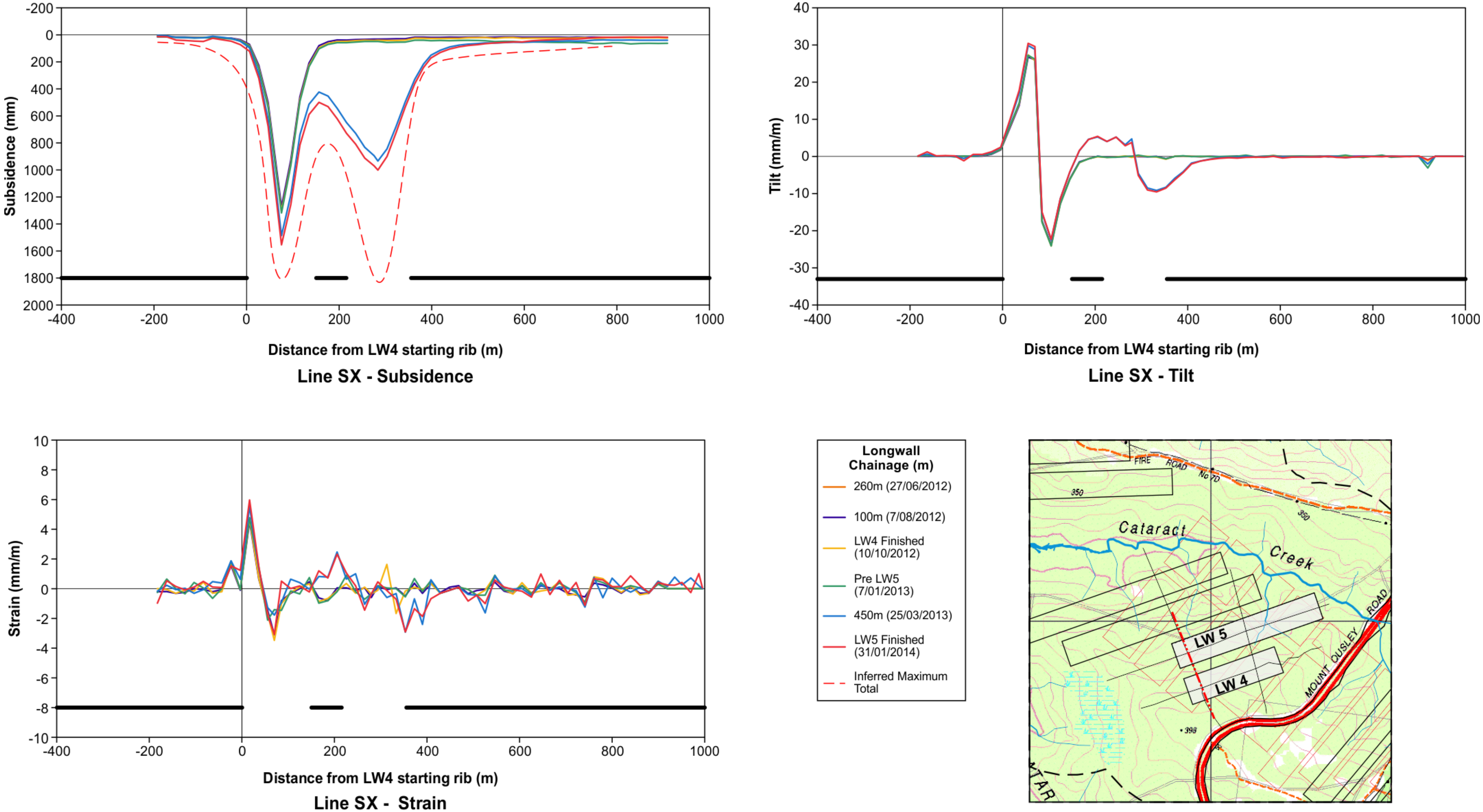


Figure 20c: Summary of Subsidence Monitoring on SX Cross Line – Longwalls 4 and 5 in Wongawilli Seam.

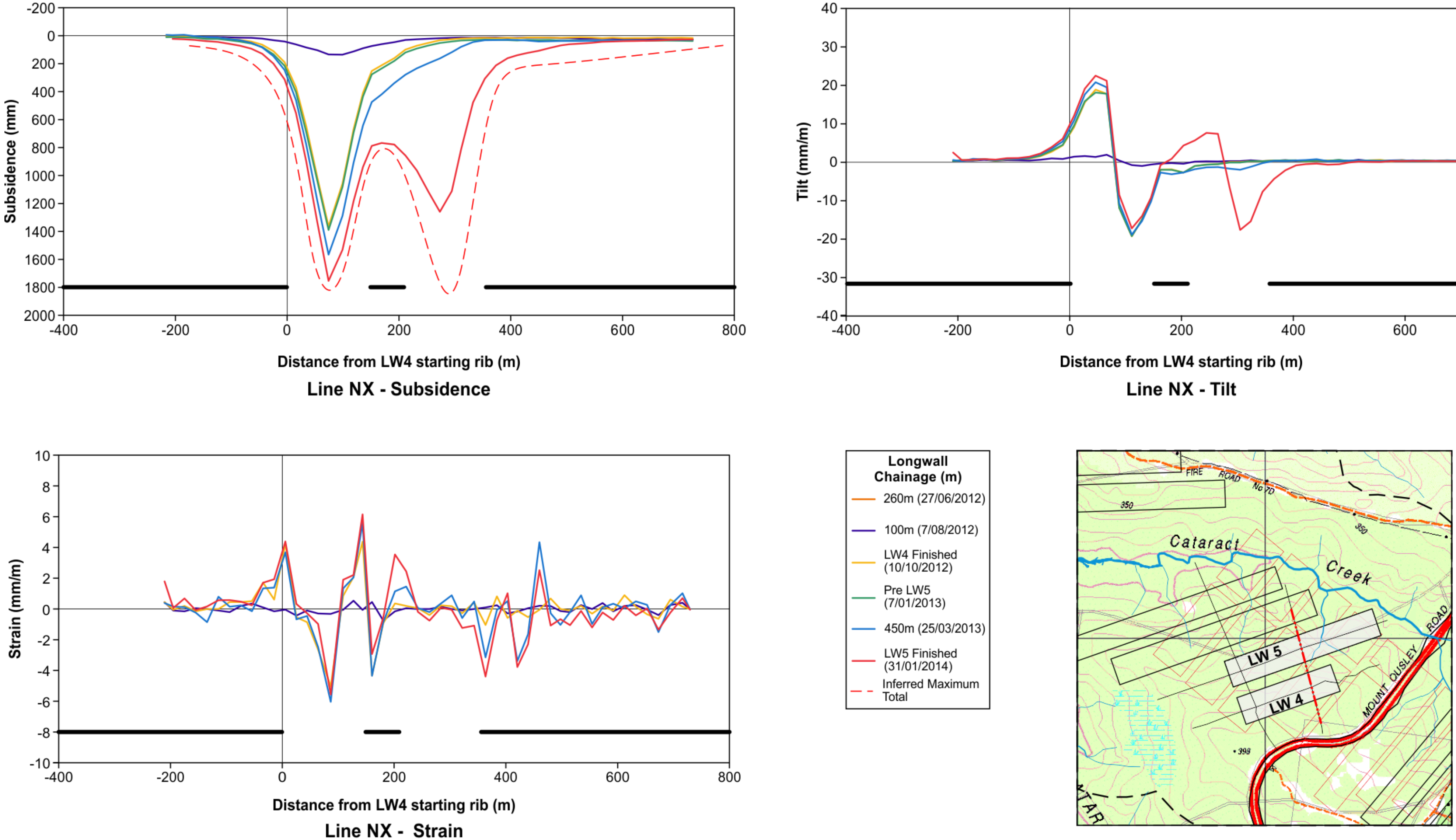


Figure 20d: Summary of Subsidence Monitoring on NX Cross Line – Longwalls 4 and 5 in Wongawilli Seam.

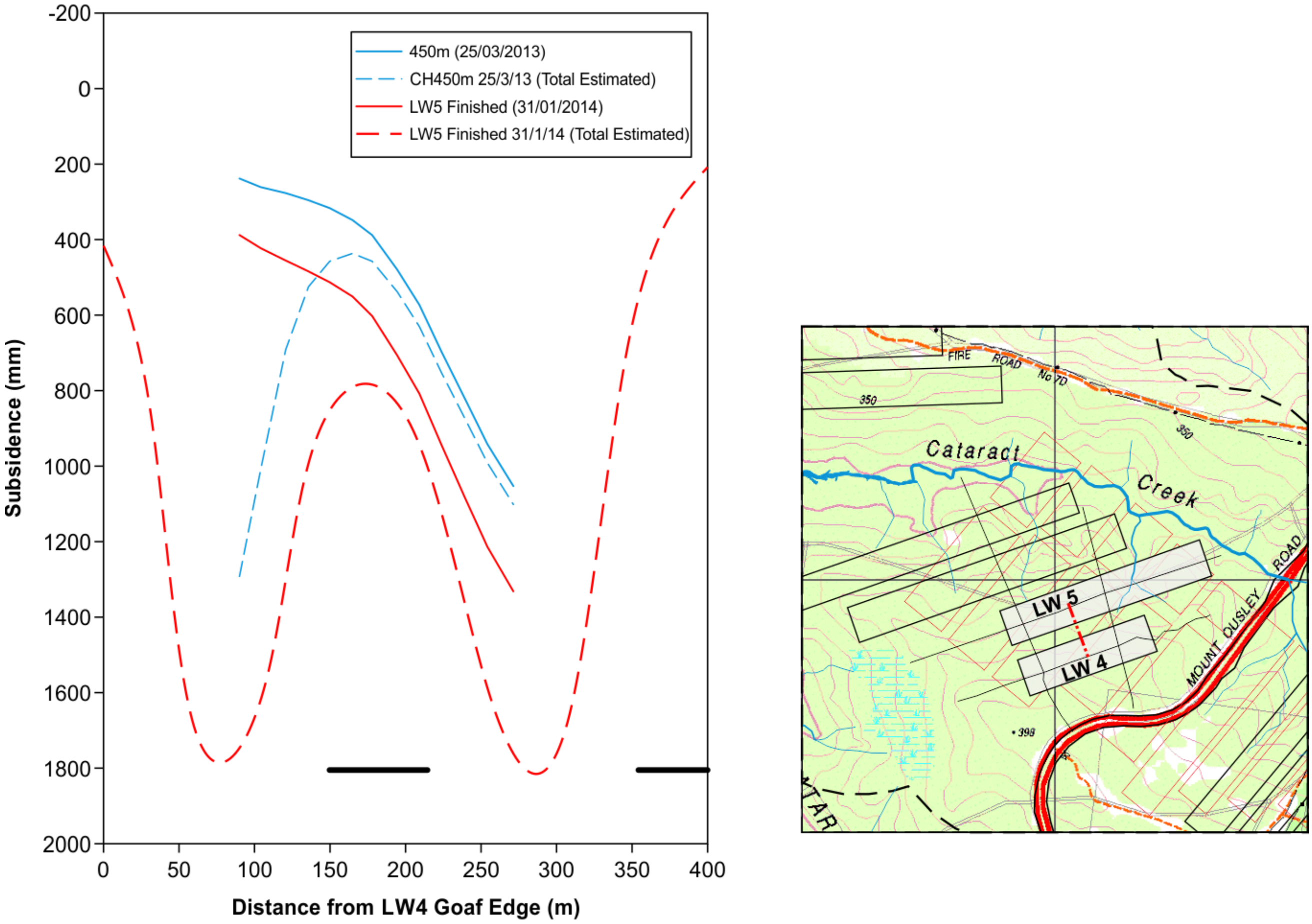


Figure 20e: Summary of Subsidence Monitoring on M Cross Line – Longwalls 4 and 5 in Wongawilli Seam.

The sag subsidence above Longwall 5 is of a similar magnitude to the sag subsidence above Longwall 4 although this does not show on the two cross-lines, SX and NX, because SX is too close to the end of the panel for full subsidence to develop and NX is located near the dyke pillar in the Balgownie Seam where subsidence is reduced. The presence of the full 1.8m of subsidence above Longwall 5 is apparent on the longitudinal 500 Line.

Figure 21 shows the sag subsidence plotted as a function of the panel width for Longwalls 4 and 5 and the sag subsidence that is commonly observed in undisturbed strata for a broad range of panel width to overburden depth ratios. Longwall 4 is mined in an area where there is both Bulli Seam goaf and Balgownie Seam goaf above most of the panel. Longwall 5 is mined in an area where there are Bulli Seam main heading pillars that have been partly mined and Balgownie Seam longwall goaf that has been completely extracted. The difference in disturbance to the overburden strata is clearly evident in the sag subsidence results plotted in Figure 21.

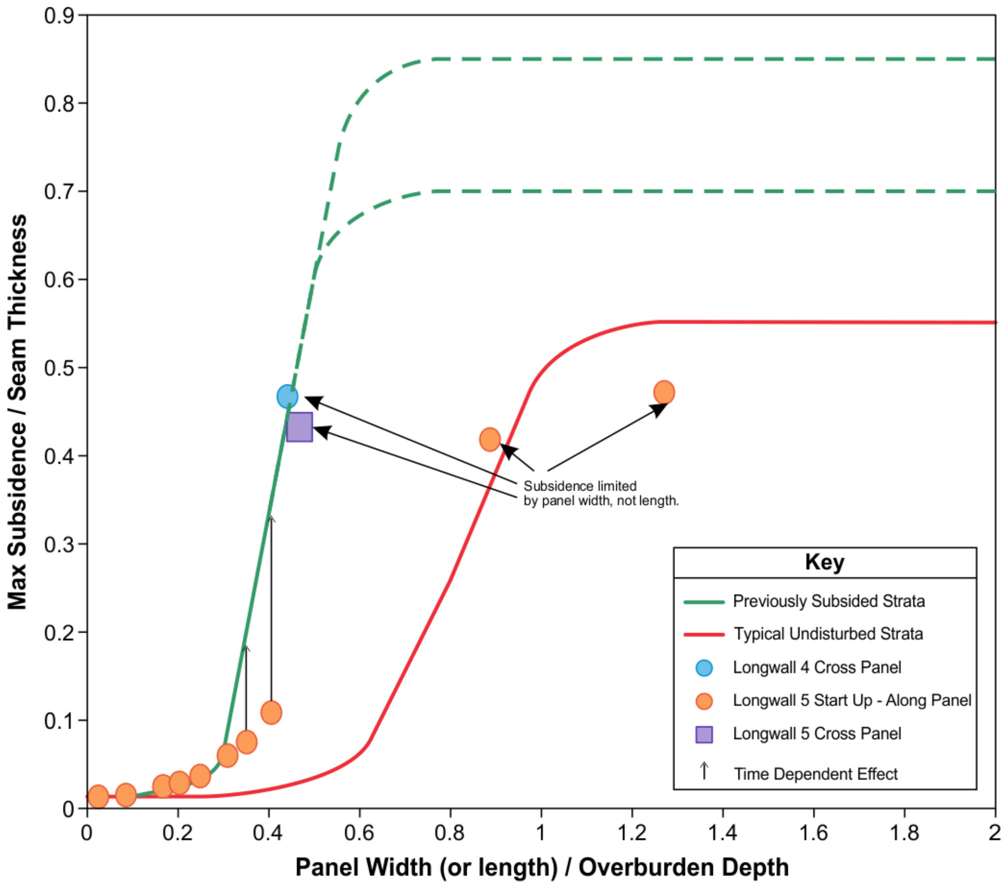


Figure 21: Summary of Sag Subsidence Measured at Start of Longwalls 4 and 5 in the Wongawilli Seam.

Above Longwall 5 where the Balgownie Seam has been fully extracted, the sag subsidence is significantly more than the sag subsidence that would be expected in previously undisturbed strata. Above Longwall 4, the Bulli Seam has also been mined, the sag subsidence is greater again consistent with the additional mining in the overlying Bulli Seam and the greater disturbance to the overburden strata that mining in both overlying seams has caused.

In narrow panels that depend on the overburden bridging to reduce the magnitude of surface subsidence as was the intention in the original Pt3A application, this reduction in the bridging capacity of the overburden strata has a profound effect on the maximum subsidence observed at the surface.

Another way to visualise the reduction in bridging capacity of overburden strata is through the goaf edge subsidence profiles. Figure 22 shows the range of goaf edge subsidence profiles observed in undisturbed strata compared to when one seam and two seams have been mined. These profiles show that as the number of seams mined increases and the disturbance to the overburden strata increases, the shear stiffness and rigidity of the overburden strata decreases.

The profiles in Figure 22 show that the sag subsidence behaviour above multiple goafs is consistent with subsidence behaviour observed over panels in single seam mining operations except that the shear stiffness or rigidity of the overburden strata is greatly diminished as a result of the previous mining activity. The reduced shear stiffness leads to reduced bridging capacity of the overburden strata and significantly increased maximum subsidence for the same overburden depth and longwall panel geometry.

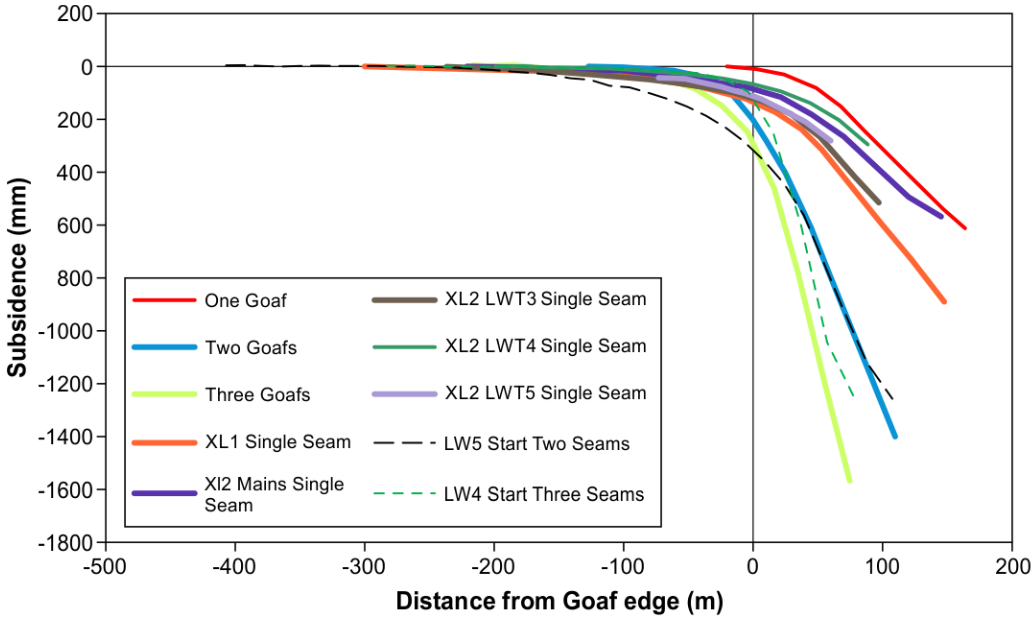


Figure 22: Summary of Goaf Edge Profiles for Mining in One, Two, and Three Seams.

In previously undisturbed overburden strata, the maximum subsidence above a 150m wide longwall panel at 300m to 360m would be of the order of 0.1m to 0.3m and barely perceptible for all practical purposes. The measured maximum sag subsidence has been 1.3m because softening of the overburden strata by previous mining has significantly increased the sag subsidence.

This phenomenon was also apparent in the Balgownie Seam longwall panels located below Bulli goaf compared to when the longwall panels were mined below solid pillars as summarised in Table 1 above.

Strata compression subsidence of 0.6m to 0.8m observed above the 60m wide chain pillar between Longwalls 4 and 5 is consistent with the level of strata compression subsidence that would be expected for the panel geometries at an overburden depth of 340m.

A significant characteristic of the subsidence observed over Longwalls 4 and 5 is that the additional sag subsidence caused by mining panels in the deeper seams is substantially limited to within the footprint of the panel, much the same as for single seam mining operations. This characteristic is clearly apparent despite the presence of an irregular overlying mining geometry. In some areas above Longwalls 4 and 5, there are overlying goafs in both seams, in others just one seam and not the other, and in other areas there are standing pillars. And yet, in all three circumstances, the surface subsidence is substantially limited to within the area that has been mined.

The form of the cross-panel subsidence profiles indicates that maximum subsidence in the centre of each panel is not being controlled by recompression of the strata directly above the longwall goaf but rather by the disturbance to the overburden strata from previous mining affecting the ability of the overburden strata to bridge.

There are subtle variations outside the goaf edge associated with previous mining in the overlying seams. More gradual subsidence profiles and greater goaf edge subsidence are evident where there are goaf areas in both the Bulli and Balgownie Seams as can be seen in Figure 23. Where there are goaf areas directly above the goaf edge in only one of the overlying seams, the subsidence profile is sharper and shows less subsidence outside the goaf. When there are no overlying goaf areas, the subsidence profile is sharpest and the subsidence profile beyond the goaf edge is the same as for single seam mining geometries.

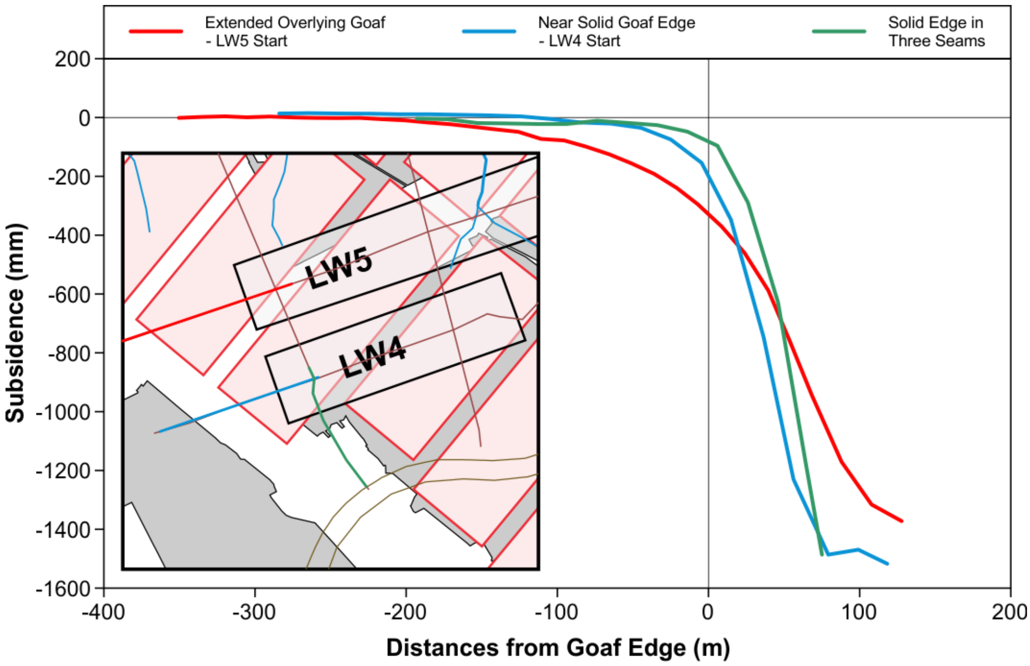


Figure 23: Goaf edge variations above Longwalls 4 and 5.

In areas where there are small standing pillars in the Bulli Seam above the goaf edge, there exists the possibility that mining in the Wongawilli Seam below will cause these pillars to be destabilised. If the pillars were destabilised, the resulting subsidence from the pillar destabilisation could then extend outside the Wongawilli Seam goaf edge to the edge of the overlying pillar panel in the Bulli Seam.

There has been no evidence of this type of behaviour so far from longwall mining in the Wongawilli Seam or in the Balgownie Seam but there is considered to be some opportunity for additional subsidence if additional longwalls panels are mined in proximity to areas of small standing pillars in the Bulli Seam. A panel of Welsh bords was visited during the site inspection on 21 June 2013 in an area of the Bulli Seam immediately above and to the northeast of the end of Longwall 1 as planned in the PPR layout. This area is shown in Figure 15.

A1.1.2 Extent of Vertical Subsidence Outside the Panel

Survey measurements conducted along the edge of the northbound lane of Mount Ousley Road have measured the influence of multi-seam mining based on the distance from the goaf edge providing evidence that vertical subsidence diminishes to low levels a short distance beyond the goaf edge.

Figure 24(a) and (b) show a summary of the vertical subsidence measured along Mount Ousley Road during mining of Longwall 4 and the timing of the subsidence that developed at key points. The projections of adjacent goaf areas in the Bulli, Balgownie, and Wongawilli Seams are also shown. The subsidence observed is of low-level reaching a maximum of approximately 40mm at the projected centre of Longwall 4 some 180m from the goaf edge at an overburden depth of 350m.

These measurements indicate the angle of draw to 20mm of subsidence is greater than 26.5° consistent with experience elsewhere in the Southern Coalfield at this overburden depth. At the projection of the north-eastern corner of Longwall 4 where both the Bulli Seam and the Balgownie Seam have been mined, subsidence at 230m from the goaf corner is 20mm at 320m deep indicates the angle of draw to 20mm off the corner of the panel is equal to 35°. At the south-eastern corner of Longwall 4, where the Balgownie Seam has not been mined but there are areas of mining in the Bulli Seam, the 14mm of subsidence at 225m at 360m overburden depth indicates an angle of draw off the corner of the panel of less than 32°. There does not appear to be any evidence of significant vertical subsidence outside the panel being mined associated with any type of pillar instability.

Other cross line measurements indicate the vertical subsidence is 50mm at between 20m and 100m from the goaf edge.

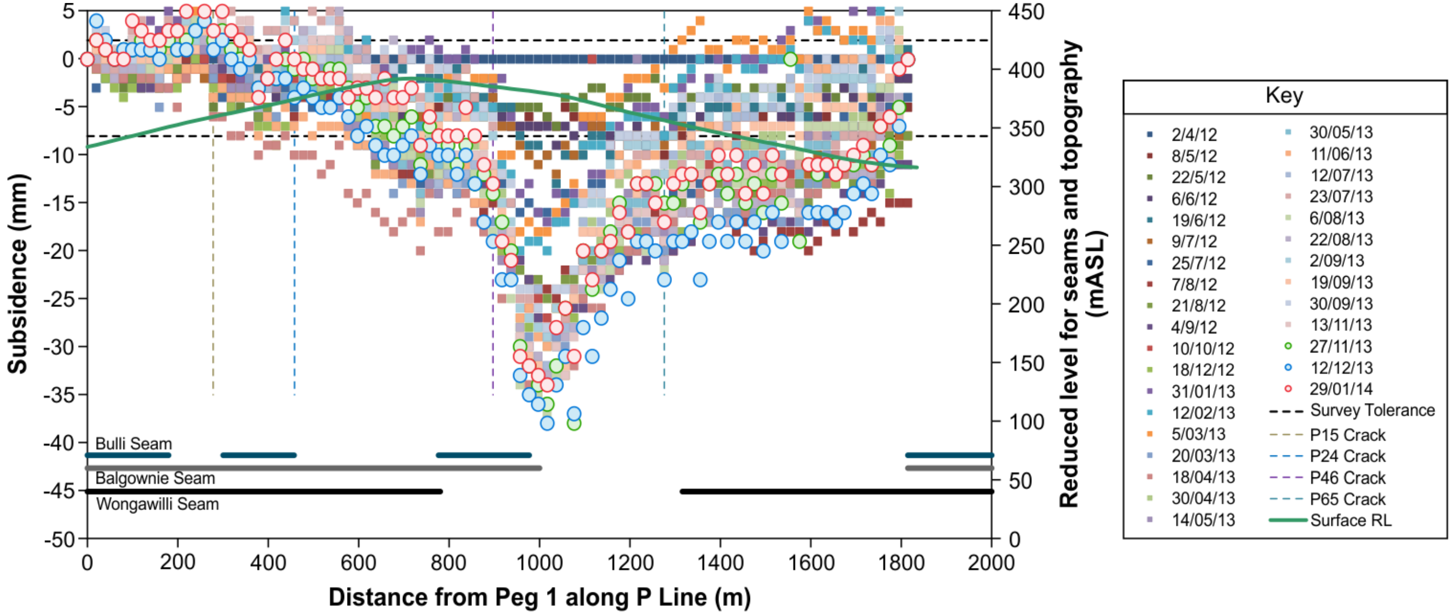
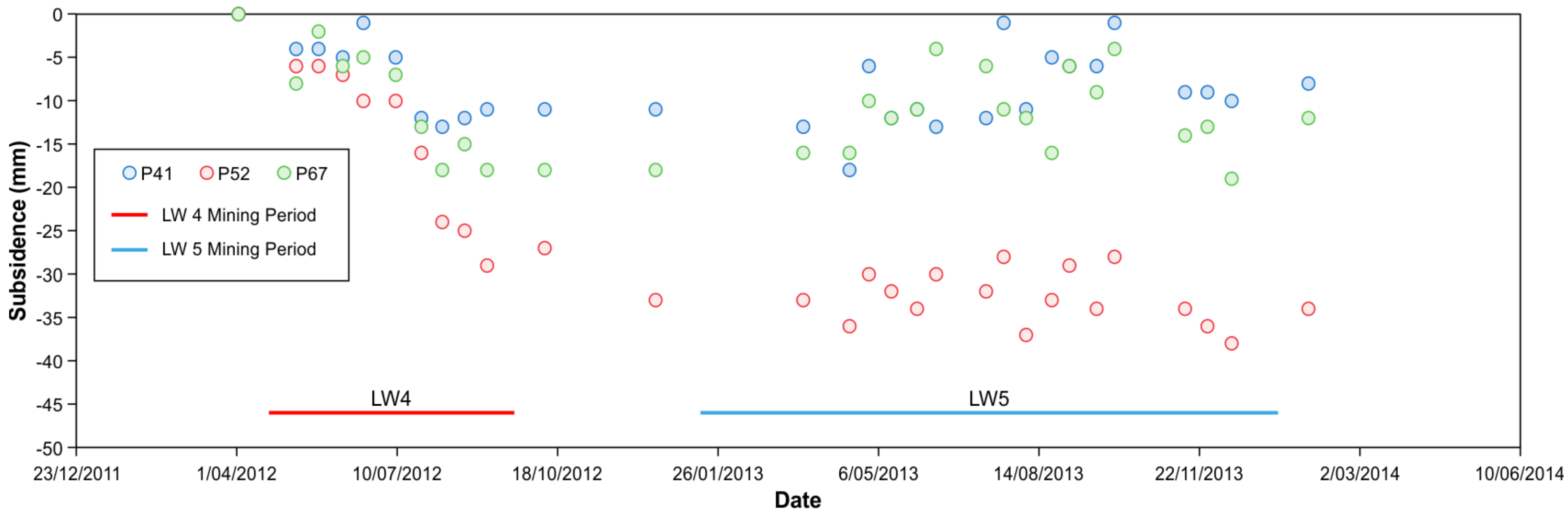


Figure 24a: Subsidence measured on P Line alongside Mount Ousley Road.



a) Development of P Line Subsidence over Time.

Figure 24b: Development of subsidence on P Line over time and as a function of longwall retreat.

On the basis of these measurements, the angle of draw to 20mm of subsidence is considered likely to be slightly greater than 35° in areas where both overlying seams have been mined and slightly less than 35° where only one overlying seam has been mined. The angle of draw is therefore not significantly different to the angle of draw that would be expected for mining in a single seam at similar overburden depths. If pillar instability were to occur near the edge of a Wongawilli Seam longwall panel, it is possible that that low-level subsidence may extend outside the panel edge and potentially increase the angle of draw slightly. However, the impact of any such increase is expected to be small.

A1.1.3 Far-Field Horizontal Movements

There are several sources of far-field horizontal subsidence measurements available from mining Longwalls 4 and 5. The Mount Ousley Road P Line and Picton Road Interchange provide measurements of horizontal movements based on three dimensional GPS controlled surveying and the closure measurements across Cataract Creek provide an indication of the horizontal movement in the middle distance. Observations of cracks on Mount Ousley Road provide an indication of the horizontal distance that changes potentially associated with mining have been observed.

The GPS controlled surveying does not show any convincing evidence of far-field horizontal movements. The survey tolerance of the systems being used is ±20mm. The monitoring at Picton Road Interchange is approximately 1300m from the southern end of Longwall 4 and there is no evidence that there has been any differential or even total movement at the interchange associated with mining Longwalls 4 and 5.

Figure 25a shows the closure measurements on Cataract Creek observed during mining of Longwall 5. Closure measurements across Cataract Creek first became evident at three of the four measurement points when Longwall 5 was approximately 450m from the finishing end of the panel (i.e. at longwall chainage CH400m). The longwall face at this position was approximately 320m from CC4, 420m from CC2, 530m from CC1, and 700m from CC3.

At Cataract Creek where the measurement points are located, the overburden depth to the Wongawilli Seam is approximately 280m, so the horizontal closure movements have been observed out to a distance from the goaf edge equal to between 1.1 and 2.9 times depth.

The closure measured on the Cataract Creek closure lines has steadily increased as Longwall 5 has continued to retreat. These measurements indicate that far-field downslope movements have been evident to a distance of up to about 450m from the approaching longwall panel but increase linearly with longwall retreat so that the longwall retreat required to generate a set amount of closure can be estimated with confidence.

Relatively fresh cracks that appeared on Mount Ousley Road at P24 and P25 during mining of Longwall 5 are approximately 500m from the southern end of Longwall 4 at an overburden depth of about 360m, so there is some evidence of small horizontal movements to a distance of about 1.4 times overburden depth.

Small far-field movements are evident from the longwall mining conducted so far in the PPR Assessment Area but these movements are of low magnitude and decrease with distance from mining. Figure 25b shows the closure measurements across Cataract Creek at the completion of mining the first 340m of Longwall 6.

A1.4 Historical Mining Impacts

While it is not possible to completely separate the impacts from previous mining in the Bulli Seam from the impacts associated with previous mining in the Balgownie Seam in areas where both have been mined, it is nevertheless helpful to review the impacts that have occurred previously as a basis for estimating the likely impacts of future mining.

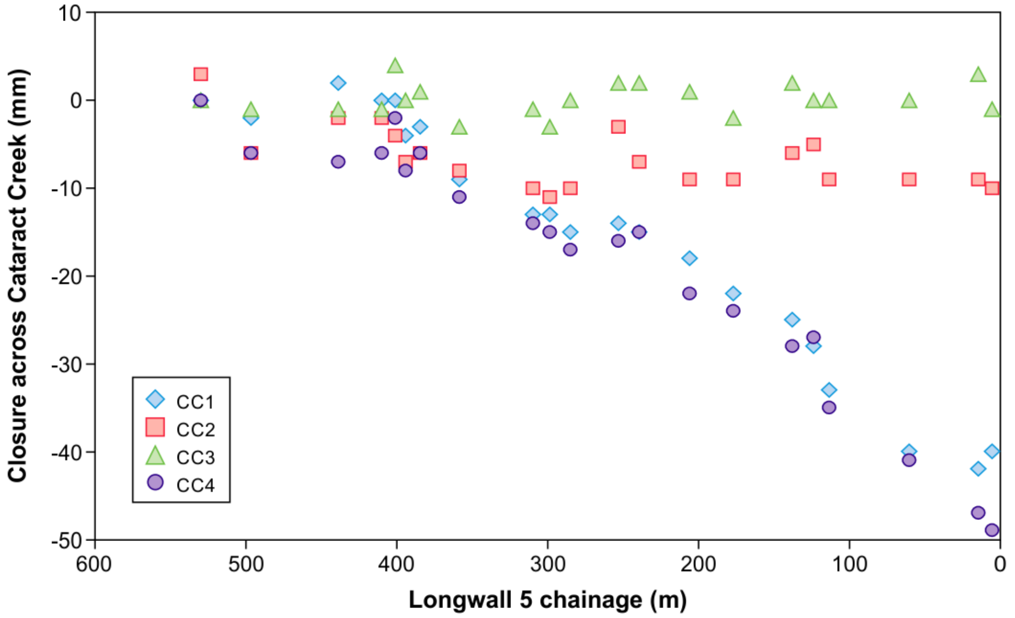
These impacts are most evident as rock falls and surface cracking on hard rock surfaces and changes in the character of stream channels such as upsidence cracking, iron staining, and sediment infilling in areas where the stream bed has been subsided. Other features where evidence of impacts is not so apparent include Mount Ousley Road, the power transmission lines, and natural features such as swamps and other vegetation.

A1.4.1 Surface Cracks

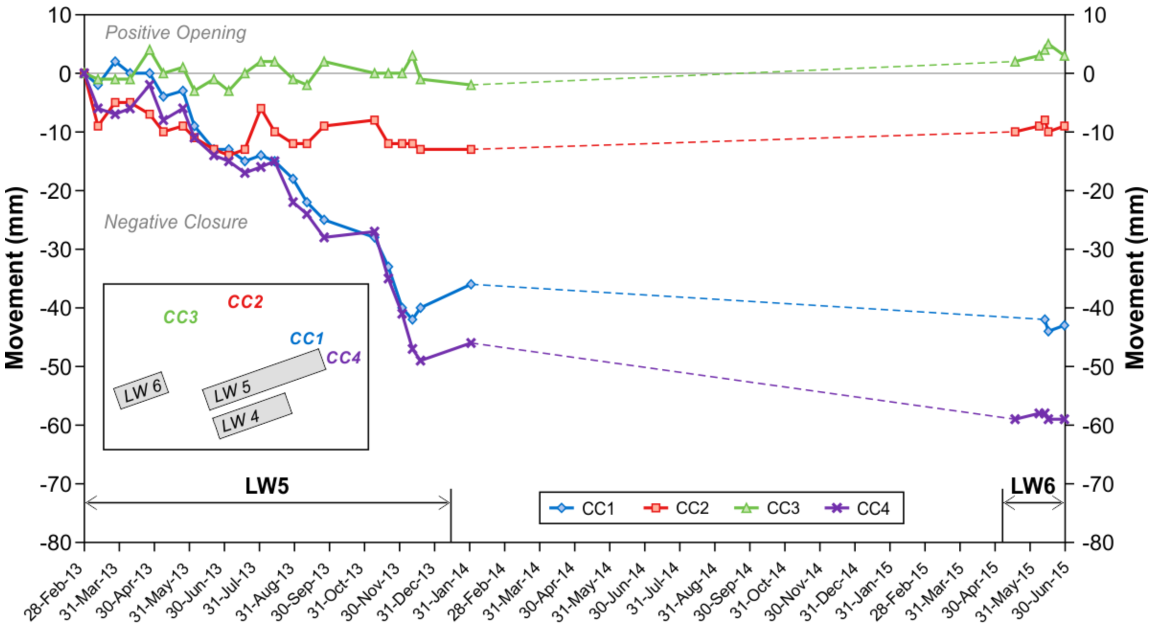
Surface cracking is documented on subsidence plans prepared during and after mining of the Balgownie Seam longwall panels. The cracks reported are mainly located near the start of Longwall 3 in the open terrain of the power transmission line easement.

These cracks are located near the start of the longwall panel on a topographic ridge in an area where the combination of systematic horizontal movements at the start of the panel and horizontal movements in a downslope direction would be expected and are commonly observed. Similar cracks are likely to have occurred at other locations but most of these would be in bushland locations where they would be difficult to detect.

For instance, a linear depression opened up near the southern corner of Longwall 4 in the Wongawilli Seam during mining of Longwall 5. This depression is considered to be associated with subsidence cracking. The depression and associated crack are located in an area where the goaf edges in all three seams are superimposed. The area is also near the top of the ridge between Cataract Creek and Cataract River where horizontal ground movements are expected to concentrate surface cracks.



a) Closures observed across Cataract Creek during mining of Longwall 5.



b) Valley closure across Cataract Creek after 340m of Longwall 6.

Figure 25: Measurement of Valley Closure across Cataract Creek.

The ground displacement indicated by this crack is of the order of 700mm but subsidence monitoring indicates that only a small part of this movement occurred during recent mining of Longwall 5 when the crack was first noticed. The implication of these measurements is that the crack developed during previous mining but was disguised below the soil and had been substantially infilled by soil material over the period since it formed.

Inspections conducted in association with cracking on the Mount Ousley Road show that there are a series of tension cracks and minor sinkholes evident along the northern side of the ridgeline between Cataract River and Cataract Creek. These cracks are locally aligned with the direction of one of the principal joint directions in the Hawkesbury Sandstone.

A1.4.2 Rock Falls

An inspection of cliff formations across the PPR Assessment Area conducted during the original subsidence assessment program informed by LiDAR interpretation indicated that there are several rock falls that are considered to be attributable to mining subsidence from both Bulli Seam and Balgownie Seam mining activity. These rock falls are small in volume and are barely discernible from natural rock falls that have occurred in the general area over the period since mining was completed.

A recent inspection of sandstone cliff formations on the southern side of Cataract Creek indicated the presence of several rock falls and subsidence cracks associated with previous mining.

A sandstone formation immediately downstream of CCUS4 showed evidence of previous mining impacts in the form of cracking and a section of overhanging cliff that had toppled over. The nature of the fracturing is consistent with mining induced subsidence from the Balgownie Seam longwall panels.

A length of cliff formation associated with archaeological site 52-2-3941 appears to have been subjected to fracturing and resultant rock falls which are likely to have been caused by subsidence associated with mining activity in the Bulli Seam. The nature of the fracturing and the age of the rock weathering appear consistent with the rock fall having occurred many decades ago.

A small rock fall of only a few cubic metres of material was also observed above Longwall 10 in the Balgownie Seam. The rock fall is located at the head of a small gully where the horizontal compression movements have been concentrated as the strata has subsided.

A rock fall located over the proposed Longwall 11 in the Wongawilli Seam was observed during a recent surface inspection. This rock fall involving several tens of cubic metres appears to have occurred from natural causes over the last few years. The site is remote from recent mining activity and there is evidence of tree root invasion at the back of the fall.

There are numerous examples of much older natural rock falls along the slopes below most of the cliff formations. These isolated boulders are consistent with the natural processes of erosion. Similar boulders are observed in areas where there has been no mining.

A1.4.3 Iron Staining

Water rich in iron is observed to be flowing into watercourses from the base of the sandstone cliff formations at several locations on the slopes above the southern side of Cataract Creek. These watercourses are dry upstream of the sandstone outcrop and show signs of iron staining downstream of the point where water flows from the strata into the creek.

This phenomenon is consistent with horizontal shear movement at the base of the Hawkesbury Sandstone outcrop caused by mining subsidence. The sandstone strata that is fractured, both naturally and as a result of mining subsidence, appears to be acting as a sub-surface reservoir that delivers water into watercourses downstream of the outcrop of the shear horizon even when there is no overland flow from upstream.

More intense iron staining observed during site inspections appears likely to be a result of recent mining in the Wongawilli Seam.

Proposed mining is not expected to perceptibly increase these impacts associated with previous mining activity.

A1.4.4 Cataract Creek

Subsidence monitoring above Longwall 11 in the Balgownie Seam indicates that Cataract Creek was subsided by more than 0.4m over a 400m length of the creek with maximum subsidence of 1.3m over about 40m. The same length of creek is also estimated to have been subsided 0.2-0.4m during mining in the Bulli Seam.

Inspection of the bed of Cataract Creek indicates that there is almost no physical disturbance to the rock strata in the bed of the creek that is attributable to mining activity despite the indicated closure of 310mm. This level of closure would typically be apparent as surface cracking in Hawkesbury Sandstone strata.

Geological mapping presented in Figure 4 indicates that this section of the creek is located in outcrop of the Bald Hill Claystone and Newport/Garie Formations immediately below it. The presence of the Bald Hill Claystone is considered likely to have contributed to the lack of physical disturbance evident in the bed of Cataract Creek.

The presence of iron staining in the water of Cataract Creek is consistent with previous mining activity in the area causing disturbance to the overlying Hawkesbury Sandstone. Recent mining of Longwall 4 in the Wongawilli Seam appears to have increased the level of iron rich precipitate in the tributary leading down from the area above Longwall 4.

A1.4.5 Power Transmission Towers

The power transmission towers T56 (on the 330kV line) and E57 (on the 132kV line) are located directly over Longwall 3 in the Balgownie Seam where there has been 1-1.2m of subsidence. The tower locations are noted on subsidence plans as T56 and T52 so it appears that they had been constructed prior to mining Longwall 3 in 1975, although this has not been able to be confirmed.

If they were constructed prior to mining, they do not appear to have been significantly impacted by previous mining in the Balgownie Seam. There does not appear to have been any mitigation or remediation.

A1.4.6 Mount Ousley Road

The construction of the Mount Ousley Road on its current alignment appears to have taken place after mining directly below the alignment in the Bulli Seam and Balgownie Seams was complete. Bulli Seam mining in the Russell Vale East areas was complete in the 1950's. By 1979 mining in the Balgownie Seam had progressed to Longwall 9 well to the west of the alignment.

There does not appear to have been any significant impact of historical mining on the operation of the highway despite up to approximately 1.0m of subsidence from Longwall 7 measured from 1976 to 1978 directly below the road alignment. The Cataract deviation was opened in 1980.

Recent longwall mining in the Wongawilli Seam has caused minor cracking on the hard surface of the Mount Ousley Road at several locations. This cracking is considered to be associated with large scale horizontal movement of the slope on the southern side of Cataract Creek in a northward direction toward the creek caused by a phenomenon widely known as valley closure. There is also evidence of minor cracking associated with the goaf edges of previous mining activity in the Bulli and Balgownie Seams and with transitions from cut to fill on the road formation itself.

The large scale horizontal movement caused by previous longwall mining appears to be ongoing at a low-level consistent with detailed observations made at other sites. These movements occur because the basal shear plane where the displacement occurs is at limiting equilibrium (on the verge of moving) as a result of previous subsidence. Only very small changes, such as changes in pore pressure caused by high intensity rainfall events, are required to cause further movement.

APPENDIX 2

Groundwater Assessment

GeoTerra

Groundwater Exploration Services

WOLLONGONG COAL LTD
RUSSELL VALE COLLIERY UNDERGROUND EXPANSION PROJECT RUSSELL VALE EAST FIRST WORKINGS GROUNDWATER ASSESSMENT

Bellambi, NSW

NRE16 – R1D

11 July, 2019

NRE16 - R1D (11 July, 2019) **GeoTerra**

Wollongong Coal Ltd
PO Box 281
Fairy Meadow NSW 2519

Attention: Devendra Vyas

Devendra,

RE: Russell Vale Colliery – Underground Expansion Project, Russell Vale East, Revised Mine Plan Groundwater Assessment

Please find enclosed a copy of the above mentioned report.

Yours Faithfully

GeoTerra Pty Ltd **GES Pty Ltd**

Andrew Dawkins
Principal Hydrogeologist (MAusIMM CP-Env)

Andy Fulton
Principal Hydrogeologist

Distribution: Original		GeoTerra Pty Ltd / GES Pty Ltd
	1 electronic PDF copy	Wollongong Coal Ltd
	1 electronic copy	Umwelt

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Authorised on behalf of GeoTerra Pty Ltd / GES Pty Ltd:	
Name:	Andrew Dawkins / Andy Fulton
Signature:	
Position:	Principal Hydrogeologist

Date	Rev	Comments
27/06/2017		Draft
20/12/2018	A	Incorporate review comments
29/01/2019	B	Incorporate review comments
23/04/2019	C	Incorporate review comments
11/07/2019	D	Incorporate review comments

EXECUTIVE SUMMARY

GeoTerra Pty Ltd and Groundwater Exploration Services Pty Ltd were commissioned by WCL to undertake a revised groundwater modelling based assessment and updated reporting of the regional groundwater system in the proposed first workings mining area prior to, during and after the proposed first workings extraction within the Wongawilli Seam.

Desktop assessments, field monitoring, laboratory analysis and computer modelling studies were used to prepare a baseline assessment of the groundwater system, groundwater quality and aquifer hydraulic parameters within the proposed first workings mining area.

Six hydrogeological domains are present in the Wonga East area:

- Hydraulically disconnected (perched) upland swamps
- Hydraulically disconnected (perched), ephemeral weathered Hawkesbury Sandstone
- Deeper Hawkesbury Sandstone
- Narrabeen Group sedimentary lithologies,
- Illawarra Coal Measures, which contains the Bulli, Balgownie and Wongawilli Seam aquifers, and
- Sedimentary sequence underneath the Wongawilli Seam.

Due to the steep topography and limited alluvium within the Cataract Creek and upper Cataract River catchment areas, there is no notable groundwater bearing stream based alluvium within Russell Vale East area.

There are no private bores or wells within the Russell Vale East Area.

Numerical modelling was undertaken to assess the existing groundwater system status and predict the potential effects from extraction of the proposed workings.

Due to the change in mining method and the considerations in the mine plan layout, subsidence impacts associated with the proposed mining are considered to be negligible and this removes much of the previous uncertainty associated with the modelling of previously considered mine plans.

Groundwater modelling indicates that the influence of the proposed first workings can be broken down into the depressurisation of two separate regimes:

- within the Wongawilli Seam, and
- overburden above the Wongawilli Seam.

The Wongawilli Seam and overburden immediately overhead would be depressurised to atmospheric pressure in the immediate footprint of the workings, however there would be minimal transgression of depressurisation above the Bulli Seam at the end of the mining period due to the lack of goaf development and associated subsidence cracking and strata delamination associated with the first workings extraction.

The overlying Balgownie and Bulli seams have previously been mined and therefore significant depressurisation has occurred historically.

The shallower surficial strata groundwater levels/pressures will be unaffected by the proposed first workings.

There are no anticipated subsidence effects on stream bed alluvium or plateau colluvium as there is minimal predicted subsidence or transmitted overburden depressurisation over and due to the proposed first workings extraction.

The proposed workings are not considered to have any potential to perceptibly impact on upland swamps, with impacts limited to induced depressurisation impacts associated with the depressurisation of sub-cropping strata below the swamps.

Perched, ephemeral, shallow groundwater within the upper Hawkesbury Sandstone could undergo a water level reduction over the proposed workings after subsidence, but as a consequence of transmitted depressurisation from the triple seam mined areas, and not due to the proposed first workings.

The minimal predicted subsidence of the shallow upper layer of the Hawkesbury Sandstone due to the proposed first workings is not anticipated to have an observable effect on stream baseflow or stream water quality where the temporary aquifers seep into local catchments.

Modelling of the surficial Hawkesbury Sandstone, Newport/Garie Formation, Bald Hill Claystone and upper Bulgo Sandstone in eroded creek bed locations after the end of mining in Wonga East indicates up to 10m of cumulative drawdown compared to pre Wongawilli Seam development. The effect, however is related to previous mining, and not the proposed first workings mine plan.

The Project is not considered to result in any strata deformation or cracking impacts, with minor (negligible) reduction in Cataract Creek baseflow.

The maximum stream flow loss as a consequence of only the proposed first workings is modelled to be 0.0006ML/day (0.22ML/yr) in Cataract Creek during 2073, which will be unobservable for practical purposes. Cumulative impacts on baseflow in Cataract Creek associated with all previous and currently proposed mining at Russell Vale are predicted to peak at 0.024ML/day (8.76 ML/year) and are therefore unlikely to be observable.

No observable change in stream flow or groundwater seepage in the Cataract River (upstream of Cataract Reservoir) and Bellambi Creek catchments are anticipated due to the very low proportion of the two catchments that may be partially depressurised.

Modelling predicts a maximum reduction in stream flow, due only to the proposed first workings, of 0.0002ML/day (0.07ML/yr) in Cataract River (upstream of Cataract Reservoir) and 0.0005ML/day (0.18ML/yr) in Bellambi Creek occurring in the period 2072 to 2088, which will be practically unobservable.

Due to the distance of the previously mined longwall panels (LW 4, 5 and 6) and the proposed first workings from the Cataract Reservoir, and the lack of subsidence impacts from the proposed first workings, no adverse impacts on stored water quantity or quality have been observed, or are predicted to occur, as a result of the proposed first working extraction on Cataract Reservoir.

The modelled transfer of stored water within Cataract Reservoir to the underlying groundwater system due to depressurisation of the regional groundwater system in the vicinity of the reservoir is not measureable at the end of the proposed first workings extraction.

The maximum total annual groundwater inflow to the workings, including all previous mining impacts from the Russell Vale lease workings, is predicted to be 288ML/year, with the contribution from the proposed first workings (and the continuing gradual increase from previous workings) being up to 36.5ML/year.

The groundwater inflow rate gradually increases during extraction of the proposed first workings as they are dewatered. After the proposed first working mining activities are completed, the model assumes the pumps are turned off and the mine gradually fills up and re-pressurises the overburden until the recovery reaches the 117.5m AHD elevation of the escarpment adit at around 2057. Outflow rates are modelled up to a maximum of 0.3ML/day.

The Project is covered by the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (Groundwater WSP). The current Water Access Licence (WAL) under the *Water Management Act, 2000* is held by Wollongong Coal Ltd for 515 ML (units)/year (Licence No. WAL36488) and is located within Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source.

Based on the predicted maximum groundwater inflow make into the WCL workings of 288ML/year, Wollongong Coal currently hold a sufficient quantity of units in their WAL. Subsequently, the mine water inflow will stabilise at around 110ML/year once the groundwater level recovery reaches and spills out of the basal elevation of the adit in the Illawarra Escarpment

No observable impact is anticipated on groundwater quality as a result of the proposed workings.

There will be no loss of bore yield as there are no registered private bores or wells located within the Russell Vale lease area as a result of the proposed first workings.

The predicted reductions in baseflows associated with the Revised Preferred Project are considered to be negligible (less than 0.5 ML/year). Under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (Surface Water WSP), which encompasses the overall Study Area and is contained within the Sydney Basin Nepean Groundwater Source Area, Wollongong Coal will require a WAL for the annual (cumulative) take of up to 9.91 ML/yr of stream baseflow and leakage from Cataract Creek and the upper Cataract River catchments resulting from depressurisation of deeper aquifers.

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1. INTRODUCTION

As part of the proposed Russell Vale East Underground Expansion Project (UEP), Wollongong Coal Ltd (Wollongong Coal) proposes to extract the Wongawilli Seam by first workings only within a bord and pillar extraction layout in the Russell Vale East mining domain.

The existing and proposed workings are contained within Consolidated Coal Lease 745 (CCL745) and Mining Lease 1575 (ML1575).

This document describes a revised groundwater modelling based assessment and updated reporting of the regional groundwater system in the Application Area prior to, during and after the proposed first workings extraction within the Wongawilli Seam.

GeoTerra Pty Ltd (GeoTerra) and Groundwater Exploration Services Pty Ltd (GES) were commissioned by Wollongong Coal to address the potential groundwater and stream base flow impacts relating to the proposed extraction of the Wongawilli Seam and associated overburden fracturing and ground surface subsidence in the Russell Vale East mining area, as proposed for the UEP.

This assessment follows on from, and is a refinement of, an earlier proposal to extract longwalls from the Wongawilli Seam within Russell Vale East after Longwalls 4, 5 and 340m of Longwall 6 had been extracted between April 2012 and July 2015.

The Application Area is defined as the region covered by the extent of the groundwater model domain, with a focus on the Wongawilli Seam workings within the Russell Vale East mining domain as shown in **Figure 1-1**.

The extent of historic and proposed mining within the Russell Vale East mining domain is shown in **Figure 1-2**.

This report has been prepared following regulatory reviews by NSW and federal agencies of previous groundwater assessments for the UEP area (GeoTerra / GES, 2014 and GeoTerra / GES, 2015) and provides an updated predictive groundwater model and interpretive report in relation to extraction of first workings only within the Wongawilli Seam.

The proposed and historic workings are predominantly located within the Metropolitan Special Area, which is a restricted area managed by WaterNSW.

This report is designed to address the Planning Assessment Commission (PAC) and Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) groundwater related issues outlined for the previous assessments (GeoTerra / GES 2014 and GeoTerra / GES 2015).

The specific responses to the PAC and IESC issues are outlined in GeoTerra / GES (2015).

The current report has also been through a consultation and review process involving:

- Department of Planning, Industry and Environment (DPIE)
- the Department of Industry – Water (DIW), and;
- Water-NSW.

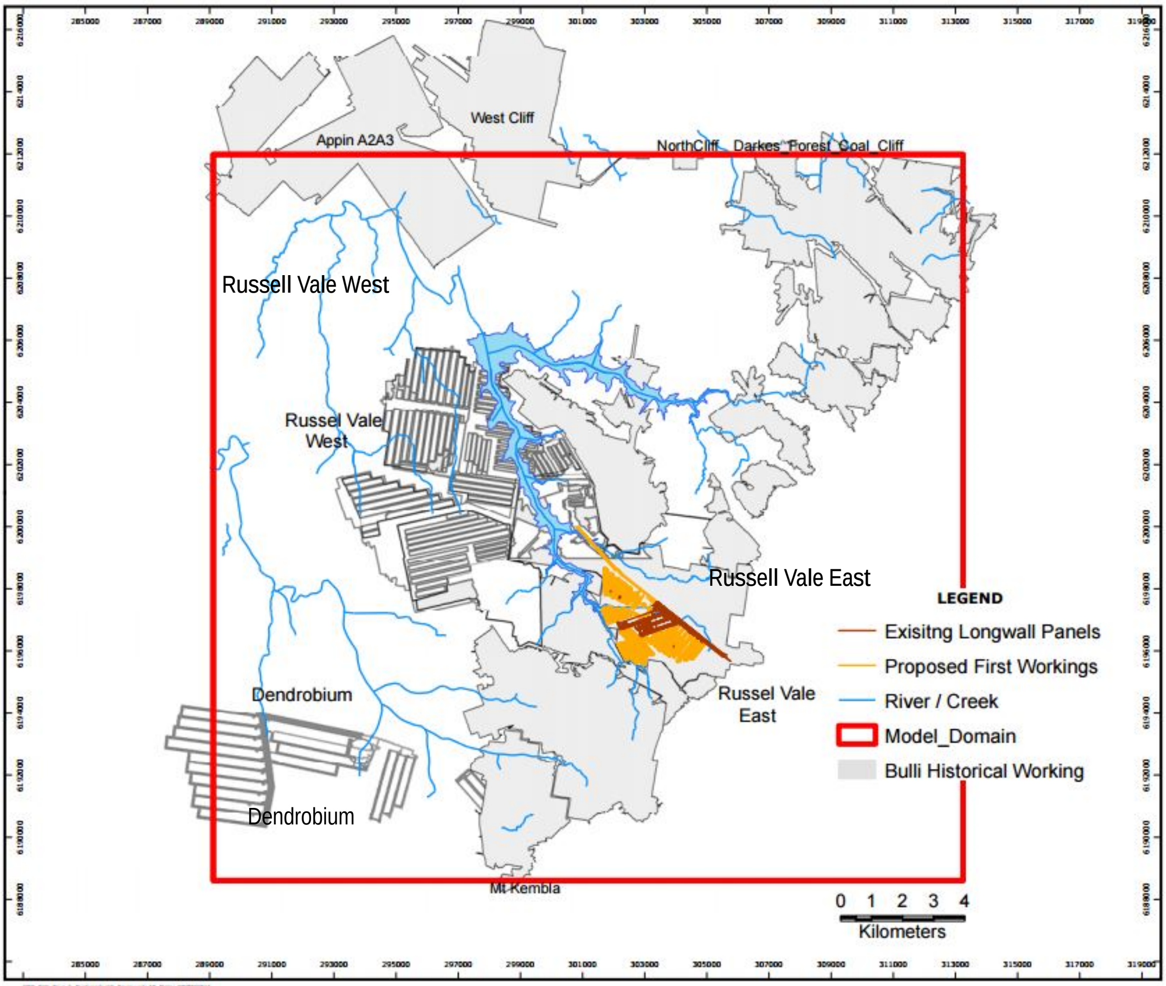


Figure 1-1 Application Area Extent

Within Russell Vale East, 1st and 2nd order tributary creeks drain into the 3rd, and subsequently 4th order catchment of Cataract Creek, downstream of Mount Ousley Road, and the 3rd order catchments of Cataract River.

The Russell Vale East catchments drain directly into Cataract Reservoir and subsequently, to Broughton's Pass weir. Cataract River subsequently drains downstream to the off-take to the Macarthur Water Treatment plant at Broughton's Pass Weir.

Cataract River is regulated by Cataract Dam, which is upstream of the Lizard Creek / Wallandoola Creek confluence, as well as by Broughton's Pass Weir, which is downstream of their confluence with Cataract River.

The Russell Vale East mining area assessments underlies the main channel, catchments and swamps of Cataract Creek and Bellambi Creek as well as the eastern catchment (excluding the main channel) of Cataract River.

No secondary extraction is proposed, including beneath the main creek channels of these streams as part of the proposed mining.

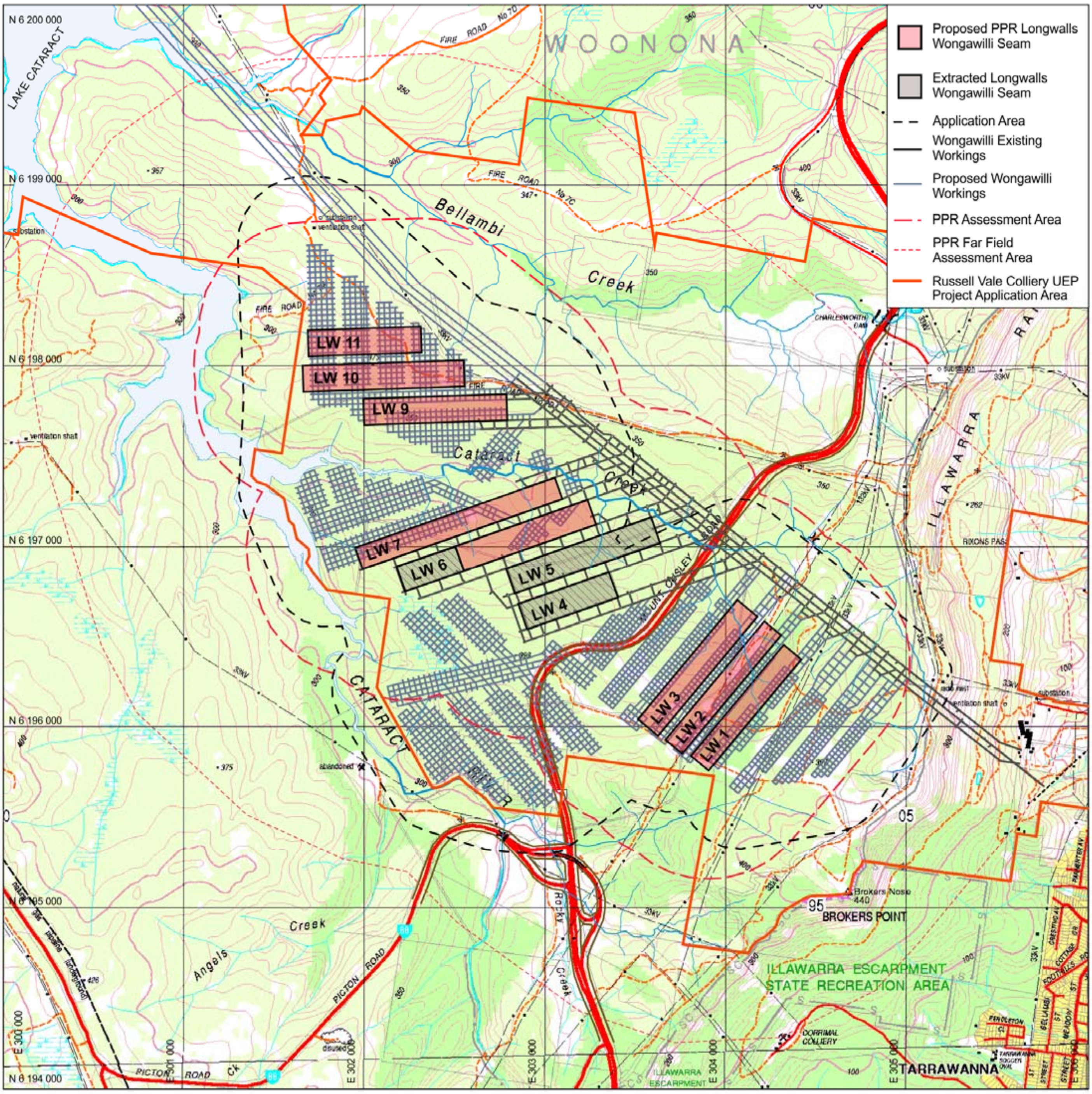


Figure 1-2 Russell Vale East Historic and Proposed Wongawilli Seam Mining

Russell Vale East contains steep gradient valleys that drain off the western slopes of the Illawarra Escarpment to Cataract Reservoir in the west, whilst the proposed workings predominantly underlie the Cataract Creek and Cataract River catchments, and to a lesser degree, the Bellambi Creek catchment.

Thirty nine upland headwater swamps that meet the definition of being a Coastal Upland Swamp Endangered Ecological Community are present in the Russell Vale East area within the Cataract Creek, Cataract River and Bellambi Creek catchments (Biosis, 2014).

Land use within Russell Vale East generally consists of undeveloped bushland, including some limited fire access and electricity transmission line easements.

This study provides a baseline assessment of the current status of potentially affected groundwater systems within the proposed mining area in accordance with the NSW Department of Planning and Environment (DP&E) Director-General's Requirements (DGRs), as well as subsequent Preferred Project Report, as well as federal Department of Environment (DoE) and NSW PAC correspondence for the previous application.

Desktop assessments, field monitoring, laboratory analysis and computer modelling studies have been used to prepare a baseline assessment of the groundwater system, groundwater quality and aquifer hydraulic parameters within Russell Vale East and overall Application Area.

The study assesses the potential mining impact on the groundwater and surface water systems, as well as providing a potential indicative management and monitoring strategy that will be suitable to manage any potential adverse effects that may be caused by subsidence.

Related groundwater features within Russell Vale East include:

- a regional water table which has been intersected between 17m to 48m below surface within the Hawkesbury Sandstone. Where paired measurements are available, the regional aquifer has been shown to be hydraulically separated from the upland swamps by up to 15m of dry to unsaturated, weathered Hawkesbury Sandstone;
- shallow, perched, ephemeral aquifers within the upper (<20m deep) Hawkesbury Sandstone;
- headwater swamps within the Cataract Creek, Bellambi Creek and Cataract River catchments;
- shallow (<1.9m deep) perched, ephemeral highly variable water level aquifers within the swamps, and;
- "Losing" streams, which predominate in the upper catchments, where stream water permeates into the regional Hawkesbury Sandstone aquifer, and "gaining" streams in incised sections, where groundwater seeps under gravity into the main creek channels.

Previous underground mining in the Application Area has been conducted through longwall mining of the Bulli Seam in Wollongong Coal's lease areas to the west, east and beneath Cataract reservoir, as well as in South32's Cordeaux and Corrimal lease areas to the south and the BHP Old Bulli workings to the north.

Multi seam mining has been conducted at Russell Vale East (SCT Operations, 2019) through:

- bord and pillar, as well as pillar extraction of the Bulli Seam at Russell Vale East, along with predominantly bord and pillar mining, and to a lesser degree, longwall extraction in the old Australian Iron and Steel (AIS) (subsequently BHP, BHP Billiton, then South32) Bulli Colliery workings to the north and Corrimal colliery to the south of Russell Vale East.

- longwall extraction of the Balgownie Seam at Russell Vale East, and;
- extraction of Longwalls 4, 5 and 340m of Longwall 6 in the Wongawilli Seam at Russell Vale East.

The proposed first workings (bord and pillar) mine plan has been specifically re-designed to avoid any secondary extraction beneath Cataract and Bellambi Creeks or Cataract River and their associated swamps, as well as Cataract reservoir.

The Russell Vale Vale East stream assessment is discussed separately in WRM Water and Environment (2014) and (2015), whilst the swamp assessment is detailed in Biosis (2014), (2015) and (2018).

1.1 Scope of Work

In accordance with the DGRs for Project Application 09_0013, (20/3/2009), the requirements for the groundwater component of the assessment are:

- *a description of the existing environment, using sufficient baseline data;*
- *an assessment of the potential impacts of all stages of the project, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions and the findings and recommendations of the recent Southern Coalfield inquiry;*
- *a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potentially significant risks to the environment, and;*
- *a detailed assessment of the potential impacts of the project on the quantity, quality and long-term integrity of the groundwater resources in the project area, paying particular attention to the Upper Nepean River sub-catchment (Metropolitan Special Area)*;

This document addresses submissions from the relevant NSW based regulators in response to the Underground Expansion Project Preferred Project Report provided by Gujarat NRE Coking Coal Ltd (now Wollongong Coal) to DP&E, on 28 August 2013.

The document also addresses issues subsequently raised by the federal Department of the Environment (DoE) and, specifically, issues regarding the revision of groundwater modelling and associated reporting that were raised by the NSW PAC and its independent peer reviewer.

The PAC recommended that changes and further discussion be made to a number of facets of the groundwater model and the modelling code utilised to derive predictive outcomes. As discussed further in Sections 9, 12 and 13, these included:

- reasoning behind the use of the same value of drainable porosity for all strata in the groundwater model since this parameter significantly influences the evolution of the phreatic surface and mine inflows;
- discussion of revised model calibrations including presentation of hydrographs showing measured and predicted pressure heads using the 'pseudo soil' option;

- illustration of model pressure heads (in plan) in the coal seams, Bulgo Sandstone and Hawkesbury Sandstone prior to, during and after mining (50 and 100 years);
- assessment of the long term steady state groundwater flow systems post mining and identification of shallow and surficial areas that are likely to be dewatered;
- assessment of potential leakage via the adit and assessment of the role played by the abandoned overlying workings (and their adits) in constraining the recovery of pore pressures;
- risk assessment associated with potential leakage from Cataract Dam via the proposed panel extractions and adit; and
- mitigation measures that might be invoked to minimise impacts.

This groundwater investigation was conducted to assess the current and historic:

- standing water levels and / or hydrostatic pressures within formations overlying the existing and proposed workings;
- groundwater quality of the formations overlying the existing and proposed workings;
- hydraulic parameters of selected overburden formations within the Russell Vale lease area, and;
- any observed or inferred groundwater discharge zones into local streams.

In addition, the study aims to:

- identify potential groundwater dependent ecosystems;
- collate and review mine water management data;
- collate and review additional data from adjacent mines and government agencies;
- develop a conceptual groundwater model and represent the Application Area with a numerical MODFLOW SURFACT groundwater model to assess potential underground mining impacts on the local and regional groundwater system;
- provide a qualitative and quantitative assessment of cumulative impacts from adjacent existing and approved mines;
- assess post mining groundwater impacts in regard to groundwater level recovery;
- develop measures to avoid, mitigate and/or remediate potential impacts on groundwater resources, and;
- indicate groundwater monitoring methods that will measure any impacts on the local and regional groundwater system.

The study provides a baseline, pre-mining assessment of the potentially affected groundwater systems within the proposed mining area and has been conducted to satisfy the requirements for an Environmental Assessment.

2. RELEVANT NSW / FEDERAL LEGISLATION AND GUIDELINES

As these details have previously been outlined, the reader is referred to GeoTerra / GES (2015) for further details, with guidelines released since GeoTerra / GES (2015) outlined below.

2.1.1 WaterNSW

WaterNSW Principles for Managing Mining and Coal Seam Gas Impacts in Declared Catchment Areas are as outlined below;

- **Protection of water quantity**

In Declared Catchment Areas mining and coal seam gas activities must not result in a reduction in the quantity of surface and groundwater inflows to storages or loss of water from storages or their catchments.

- **Protection of water quality in Declared Catchment Areas**

In Declared Catchment Areas mining and coal seam gas activities must not result in a reduction in the quality of surface and ground water inflows to storages.

- **Protection of human health in Declared Catchment Areas**

Mining and coal seam gas activities must not pose increased risks to human health as a result of using water from the drinking water catchments.

- **Protection of water supply infrastructure**

The integrity of the WaterNSW water supply infrastructure must not be compromised.

- **Protection of ecological integrity in Special Areas**

The ecological integrity of the Special Areas must be maintained and protected.

- **Sound and robust evidence regarding environmental impacts**

Information provided by proponents, including environmental impact assessments for proposed mining and coal seam gas activities, must be detailed, thorough, scientifically robust and holistic. The potential cumulative impacts must be comprehensively addressed.

3. PREVIOUS GROUNDWATER RELATED STUDIES

Within the Wollongong Coal Russell Vale lease area, groundwater level and / or hydrostatic water pressure monitoring has been conducted for the Hawkesbury Sandstone and underlying lithologies over the 500 series Longwalls adjacent to the western side of Cataract reservoir (Singh, R.N. Jakeman, M. 2001).

Vibrating wire piezometers in open standpipe bores P501 and P502 were used to monitor groundwater levels since December 1992 and August 1993 over Longwalls 501 and 502 respectively and since November 1998 in an open standpipe piezometer P514 over Longwall 514.

GeoTerra (2012) conducted a detailed groundwater model and impact assessment for both the Russell Vale East and Russell Vale West proposed mining domains as part of the original Underground Expansion Project Part 3A (Pt3A) application.

GeoTerra / GES (2014) updated the 2012 groundwater model and associated reporting for the UEP Preferred Project Report.

The extent of historic fracturing and overburden depressurisation due to subsidence over previous Wollongong Coal workings was initially assessed in SCT Operations (2014) and also updated by their assessment of the hydraulic and geological characteristics of the Corrimal Fault and Dyke D8 (SCT Operations, 2015). Their findings are discussed in subsequent sections of this report.

Ongoing monitoring of stream water quality, groundwater seepage and stream flow studies conducted since 2001, as well as installation and monitoring of the open standpipe and vibrating wire piezometer suite up to the completion of 340m of extraction in Longwall 6 is reported in GeoTerra (2015).

GeoTerra / GES (2015) updated the groundwater model and associated reporting again with a further modified longwall extraction plan, which was not approved by the relevant authorities.

4. PREVIOUS AND PROPOSED MINING

4.1 Previous Mining

Three coal seams have been mined at Russell Vale Colliery.

The uppermost is the 2.0 - 2.5m thick Bulli Seam where most of the previous mining activity has occurred. The 1.3m thick Balgownie Seam is located 5 - 10m below the Bulli Seam, whilst the 7 - 9m thick Wongawilli Seam is located 18 - 26m below the Balgownie Seam. However, only the bottom 3.0 - 3.5m of the Wongawilli Seam has been mined.

4.1.1 Bulli Seam

The Bulli Seam was mined between the late 19th Century and about 1950, initially as a hand worked bord and pillar operation and then with some mechanised pillar extraction. Bulli Seam mining continued under and to the west of Cataract reservoir, initially as a continuation of Continuous Miner pillar extraction operations and then as a longwall mining operation until 2002.

4.1.2 Balgownie Seam

The Balgownie Seam was started in the late 19th Century in the Russell Vale East area using hand worked methods for a brief period. Mining restarted in the late 1960s with continuous miners, then from 1970 to 1982 as one of the first longwall operations in Australia. To the north, some additional mining in the Balgownie Seam included a first workings continuous miner bord and pillar thin seam mining operation between 2001 and 2003 in Gibson's Colliery (S Wilson, pers comm.).

4.1.3 Wongawilli Seam

Installation of the Wongawilli Seam mining access started in 2008 at Russell Vale East, with subsequent secondary extraction occurring as shown in **Table 1**.

Table 1 Russell Vale East Wongawilli Seam Longwall Extraction Summary

Longwall	Start	Finish	Depth of Cover (mbgl)	LW Width (m)	LW Length (m)
4	21/4/2012	21/9/2012	267 - 275	140	523
5	15/01/2013	12/01/2014	272 - 279	140	844
6 (340m)	04/05/2015	08/07/2015	312 - 333	140	340*

**Total length of LW 6 was originally 1,120 m, but only 340 m has been extracted to date.*

After consideration of submissions from the community as well as NSW government agencies to its earlier Underground Expansion Project Part 3A (Pt3A) application, Wollongong Coal (then Gujarat NRE Coking Coal) modified its application to DP&E through a Preferred Project Report assessment.

The Preferred Project groundwater study excluded mining in the Russell Vale West area.

A subsequent proposal included the extraction of the remainder of Longwall 6, as well as Longwall 7 in the Wongawilli Seam to the south of Cataract Creek and Longwalls 9 to 11 to the north of Cataract Creek between Mt Ousley Road and Cataract Reservoir within Water-NSW managed land. Longwall 8 was excluded from the Underground Expansion Project application during the Preferred Project Report mining plan revision.

To the east of Mt Ousley Road, Wollongong Coal proposed to extract Longwalls 1 to 3 in the Wongawilli Seam on private land.

This proposal has subsequently been modified as outlined in Section 4.2.

4.2 Proposed Mining

Wollongong Coal is currently proposing to mine first working panels only within a bord and pillar arrangement in the Russell Vale East mining area at Russell Vale Colliery, which is adjacent to and around the pre-existing Longwalls 4, 5 and 6 (340m).

4.3 Observed and Predicted Subsidence

Table 2 summarises subsidence that has occurred as a result of mining the Bulli Seam (estimated), Balgownie Seam (measured) and Wongawilli Seam (measured subsidence for Longwalls 4, 5 and the westernmost 340m of Longwall 6) within the Russell Vale East domain.

For further discussion of the relevant subsidence observations and predictions, refer to SCT Operations (2019).

Table 2 Predicted and Measured Subsidence

	Previous Subsidence (m)	Predicted (Measured) Subsidence (m)	Predicted (Measured) Tilt (mm/m)	Predicted (Measured) Tensile Strain (mm/m)	Predicted (Measured) Compressive Strain (mm/m)	Maximum Cataract Creek Closure (mm)
LW1	1.3	2.1	40	+12	-24	650
LW2	1.1	2.1	40	+12	-24	610
LW3	1.3	2.6	51	+15	-31	350
LW4	1.9	2.1 **(1.6)**	35 **(30)**	+10.5 **(7.5)**	-21 **(-14)**	N/A
LW5	0.9	1.9 **(1.8)**	36 **(30)**	+10.8 **(6)**	-22 **(-12)**	**(49) closure site CS4**
LW6 (340m)	1.5	2.1 **(0.42)**	38 (TBA)	+11 **(+1.3)**	-23 **(-2)**	400 **(59) CS4**
Proposed 1st Wkgs	1.2	<0.1	imperceptible	imperceptible	imperceptible	imperceptible

NOTE: measured parameters are shown in brackets

5. RUSSELL VALE EAST AREA DESCRIPTION

5.1 Russell Vale East Catchments and Topography

Stream water level monitoring in pools and at selected flow constriction sites in Cataract Creek and Cataract River have been conducted since November 2010, with volumetric stream flow assessment conducted as outlined in WRM Water and Environment (2015).

The following sections describe individual catchments within Russell Vale East.

5.1.1 Cataract Creek

Cataract Creek is a 4th order stream for most of its length and is approximately 5.5km long from its headwaters to the full supply level of Cataract Reservoir.

Channel invert elevations fall from approximately 340m AHD to 285m AHD, with the channel being relatively gently sloping at a gradient of 0.9% for most of its length, except for a 0.5km reach in its headwaters, which slopes at 2.5%.

Approximately 2.5km of the stream reach is located upstream, 2km within and 0.9km is downstream of the predicted 20mm subsidence zone.

5.1.2 Cataract River

Cataract River is a 3rd order stream upstream of the Link Road crossing, and 4th order from the confluence near the crossing to the Cataract Reservoir backwater. It is approximately 6.7km long from its headwaters to the upstream reaches of the Lake Cataract storage.

Channel invert elevations fall from approximately 430m AHD to 285m AHD and the channel is relatively gently sloping at a gradient of 0.5%, for much of its length, except for a steep upstream 0.5km reach, which slopes at around 17%.

The proposed Russell Vale East workings and the 20mm subsidence line do not underlie the Cataract River.

5.1.3 Bellambi Creek

Bellambi Creek is a 3rd order stream upstream for the first 5.5km, then 4th order to the Cataract Reservoir backwater. It is approximately 6.4km long from its headwaters to the full supply level of Cataract Reservoir.

Channel invert elevations fall from approximately 453m AHD to 286m AHD, with the channel being relatively gently sloping at a gradient of 0.6%, except for the first 1km upstream reach, which slopes at around 2.8%.

The predicted 20mm subsidence zone also does not underlie or interact with the main Bellambi Creek stream channel.

5.2 Climate

5.2.1 Rainfall

Daily rainfall has been recorded by the Bureau of Meteorology (BOM), Water-NSW and its predecessors, and the nearest stations with the longest records are located at Cataract and Cataract Dam, with good quality records extending from 1883 to 1966 and 1904 to 2016 respectively.

The BOM's SILO data service has prepared Patched Point Datasets (PPDs) from the Cataract and Cataract Dam records. Gaps in the records are infilled with data interpolated from other nearby stations to provide continuous records between 1889 and the present day.

Annual rainfall at Cataract Dam between 1889 and 2013 varied from 480mm in 1944 to 2,293mm in 1950, with a mean annual rainfall of 1,085mm/a.

Cataract Dam rainfall is highest between January and June, and lowest between July and December as shown in **Figure 5-1**.

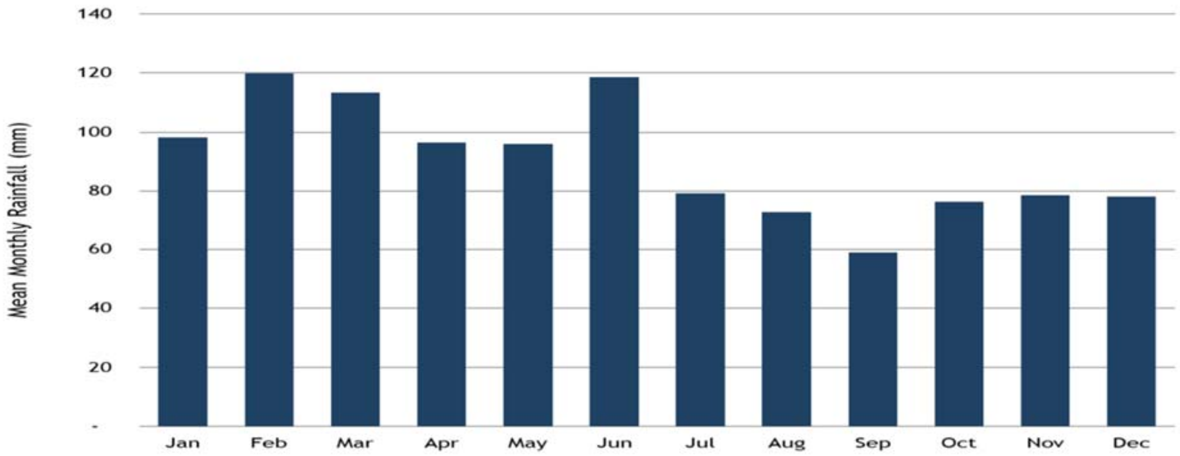


Figure 5-1 Annual Monthly Average Variation in Mean Rainfall at Cataract Dam

Figure 5-2 shows a plot of cumulative rainfall residual at Wonga East between November 2009 and the present. The cumulative rainfall residual shows departures from the long-term average, with upward sloping lines indicating relatively wet periods and downward sloping lines indicating relatively dry periods.

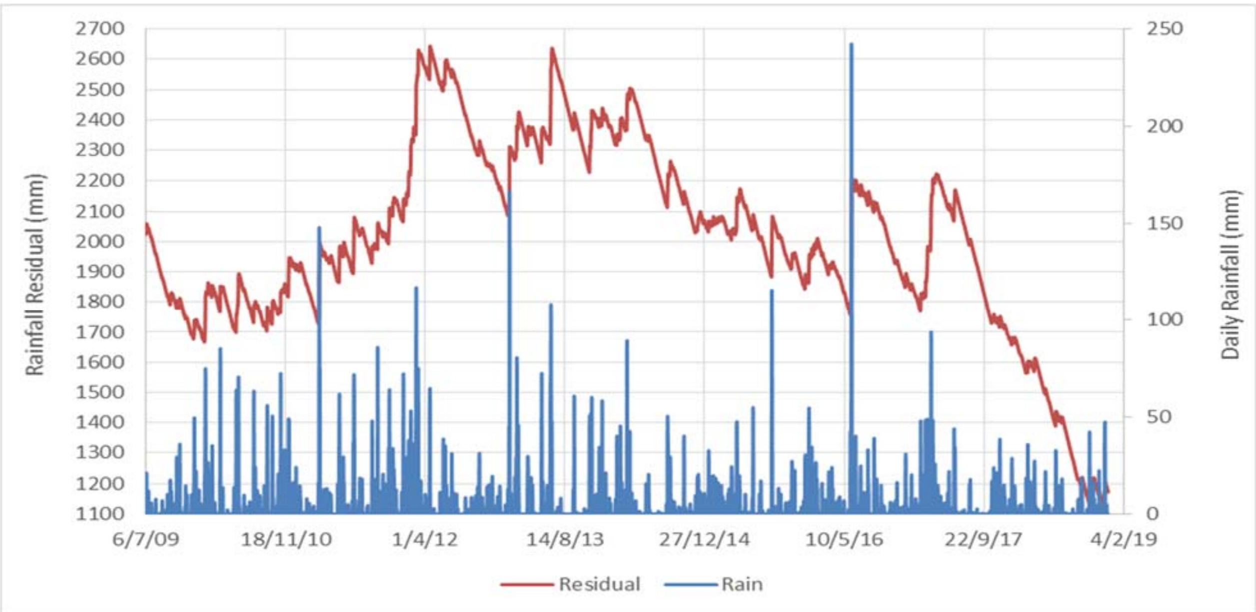


Figure 5-2 Rainfall Residual

5.2.2 Evaporation

The mean annual pan evaporation at Cataract Dam is approximately 1,420mm/yr as shown in the PPD data in **Figure 5-3**, and is highest in the summer months. There is no Bureau of Meteorology evaporation data available for this location.

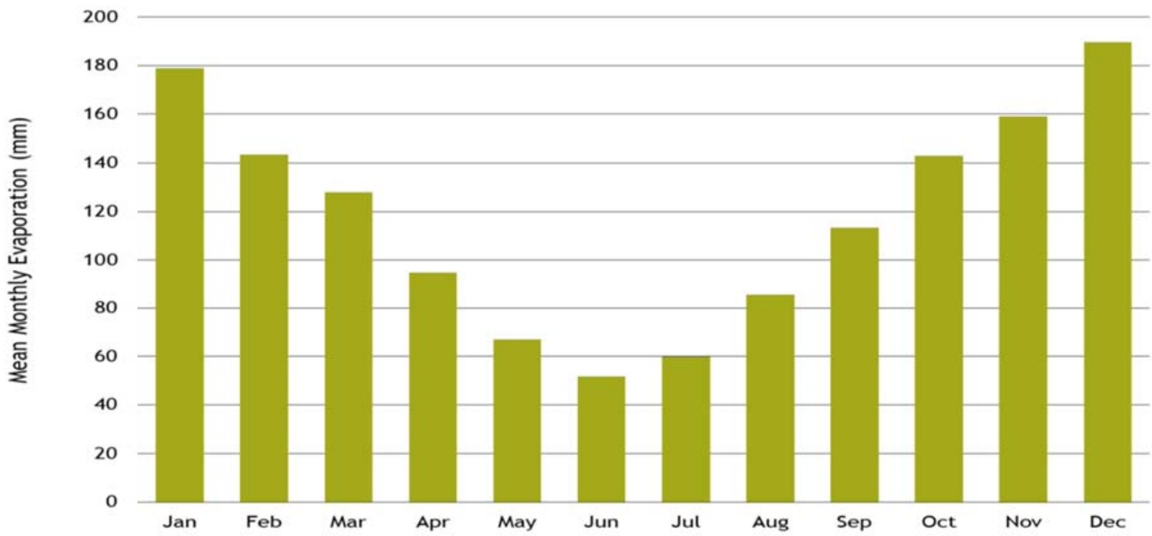


Figure 5-3 Annual Average Monthly Pan Evaporation at Cataract Dam

On the basis that the reservoir has a surface area of 8,500ha, this equates to an average annual evaporation rate (at 1,420mm/yr) of 120,700ML/year off the surface of the reservoir, when it is at Full Supply Level.

5.3 Geology

Russell Vale Colliery is situated at the southern end of the Permo-Triassic (225-270 million years) Sydney Basin within the Illawarra Coal Measures, which contains the Bulli, Balgownie and Wongawilli seams.

The Russell Vale East area is predominantly covered by shallow hillslope-based colluvium, with very thin to no alluvial sedimentary deposits in the valley floors as shown in **Figure 5-4**.

Outside of the upland swamps, there are no alluvial deposits of any significance within the Wollongong Coal lease area except for possibly within, or under, Cataract Reservoir.

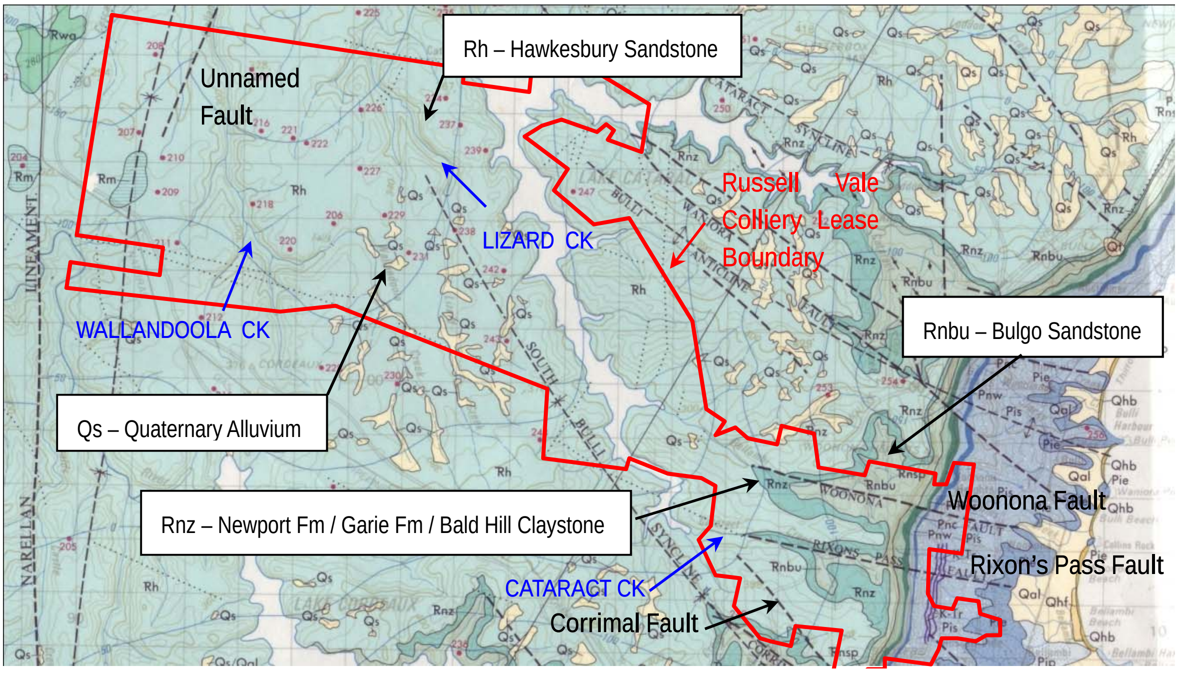


Figure 5-4 Published Regional Surface Geology

Quaternary unconsolidated alluvial and colluvial sediments are also present within both valley fill and headwater upland swamps, and are generally less than 2m thick, comprising humic sands and clayey sands overlying weathered Hawkesbury Sandstone.

The Quaternary sediments in the Russell Vale East area are, in turn, sequentially underlain by the:

Wianamatta Group (due to erosion, this formation is absent at Russell Vale East)

Hawkesbury Sandstone (absent to 181m thick) – the bedded to massive quartzose sandstone with grey shale lenses up to several metres thick is uppermost in the stratigraphic sequence in the majority of the Application Area except where it has been eroded in the headwater valleys of Cataract and Bellambi Creeks in the Russell Vale East area. Exposed Hawkesbury Sandstone is prevalent across the central and western areas of the lease. The Hawkesbury Sandstone also outcrops in the catchment headwaters of Russell Vale East, with the underlying Newport and Garie Formations, Bald Hill Claystone and Bulgo Sandstone being exposed in reaches of Cataract Creek.

It can contain up to 4% manganiferous siderite and up to 0.5% of iron sulfide (principally marcasite) with minor solid solution incorporation of nickel, zinc and manganese sulfides.

Narrabeen Group – the Narrabeen Group consists of the following units as described below.

- **Newport and Garie Formations** (4.6 - 36m thick) – The Newport Formation has interbedded grey shales and sandstones which has a variable thickness across the Application Area. The Garie Formation is generally around 3m thick and contains cream to brown, massive, characteristically oolitic claystone with a relatively constant thickness across the Application Area.

- **Bald Hill Claystone** (17 - 42m thick) – The unit is typically a chocolate brown to red brown kaolinitic marker bed claystone with silty and sandy grey and mottled grey - brown zones with a relatively constant thickness over the Application Area. It predominantly consists of 50 - 75% kaolinite with hematite and siderite as accessories, which give it its distinctive colour.
- **Bulgo Sandstone** (113 - 154m thick) - thickly bedded, medium to coarse grained lithic sandstone with occasional conglomerate and shale.
- **Stanwell Park Claystone** (15 - 26m thick) - greenish-grey mudstone and sandstone, with a general thickening of the claystone to the north west.
- **Scarborough Sandstone** (16 - 31m thick) - thickly bedded sandstone with shale and sandy shale lenses up to several metres thick.
- **Wombarra Claystone** (35 - 61m thick) – has a similar lithology to the Stanwell Park Claystone and generally thickens to the south east.
- **Coal Cliff Sandstone** (8 - 13m thick) - shales and mudstones contiguous with the underlying Bulli seam and varies from a quartzose sandstone in the east to a more shale/mudstone dominated unit in the west.

Illawarra Coal Measures – The Illawarra Coal Measures consist of interbedded shales, mudstones, lithic sandstones and coal seams, including the Bulli Seam, Loddon Sandstone, Balgownie Seam, Lawrence Sandstone, Eckersley Formation, Wongawilli Seam and Kembla Sandstone. The major coal seams in sequentially lower order are described below.

- **Bulli Seam** (2.0 - 4.7m thick) – Coal from the Bulli Seam has been worked extensively by both longwall as well as bord and pillar methods within and surrounding the Wollongong Coal lease area. The depth of cover to the Bulli Seam varies from 205 - 290m at Russell Vale East, with a seam dip to the north-west of approximately 1 in 30 with modification in the vicinity of the north west / south east trending South Bulli Syncline to the west of Cataract Reservoir, and a north south trending unnamed syncline to the west of Wallandoola Creek. A small scale north south trending syncline is present in the Bulli Seam workings. The Bulli Seam overlies the Balgownie Seam by 5.5 - 13.6m with a median 9.9m separation in the lease area.
- **Loddon Sandstone** (5 - 8m thick) – shale, mudstone, siltstone, sandstone with a sharp conglomeratic base
- **Balgownie Seam** (0.8 - 1.5m thick) – The Balgownie Seam has not been worked extensively in the southern coalfield, although limited longwall extraction has been conducted in the Russell Vale East area. The Balgownie Seam overlies the Wongawilli Seam by 10.6 - 24.7m with a median 18.7m in the lease area.
- **Lawrence Sandstone** (16 - 17m thick) – mudstone, siltstone to sandstone at the base
- **Cape Horn Seam** (0.1 - 0.4m thick) – a thin seam that is not mined commercially
- **Eckersley Formation and Hargraves Coal Member** (6 - 8m thick) – mudstone, claystone, siltstone and shales with the intercalated very thin (0.1 -0.3m), uncommercial Hargraves Coal Seam

- **Wongawilli Seam** (6.2 - 10.5m thick) – comprised of up to 11 sub seams. It has predominantly been mined in the southern area of the Southern Coalfields, although has also been mined by Longwalls 4 and 5 in the Wollongong Coal lease. The depth of cover for Wongawilli Seam varies from 237 - 321m at Russell Vale East. In the lease area the Wongawilli Seam underlies the Bulli Seam by 24.1 - 36.4m with a median of 30.4m.

Lithologies underlying the Wongawilli Seam – the following units underlie the Wongawilli Seam:

- **Kembla Sandstone** (5 - 9m thick) – shale, siltstone and finer to coarse grained sandstone
- **American Creek Coal Member** (0.3 - 3.5m thick) – this seam has not been mined in the Southern Coalfields
- **Allens Creek Formation** (14 - 15m thick) – shale, siltstone and finer to coarse grained sandstone
- **Darkes Forest Sandstone** (5 - 9m thick) – fine to medium grained sandstone
- **Bargo Claystone** (10 - 12m thick) – mudstone, siltstone, shale
- **Tongarra Seam** (1.5 - 2.0m thick) – this seam was mined to a limited extent in the southern part of the Southern Coalfields
- **Wilton Formation** (minimum 4m thick) – claystone, siltstone and shale

5.4 Russell Vale East Geological Mapping

5.4.1 Outcrop Mapping

Outcrop mapping of the surface geology, faults and dykes in the Russell Vale East area was completed by Wollongong Coal geologists in 2013 (Gujarat NRE Coking Coal, 2014) as shown in **Figure 5-5**.

For discussion of the Russell Vale East geology, refer to Gujarat NRE Coking Coal (2013).

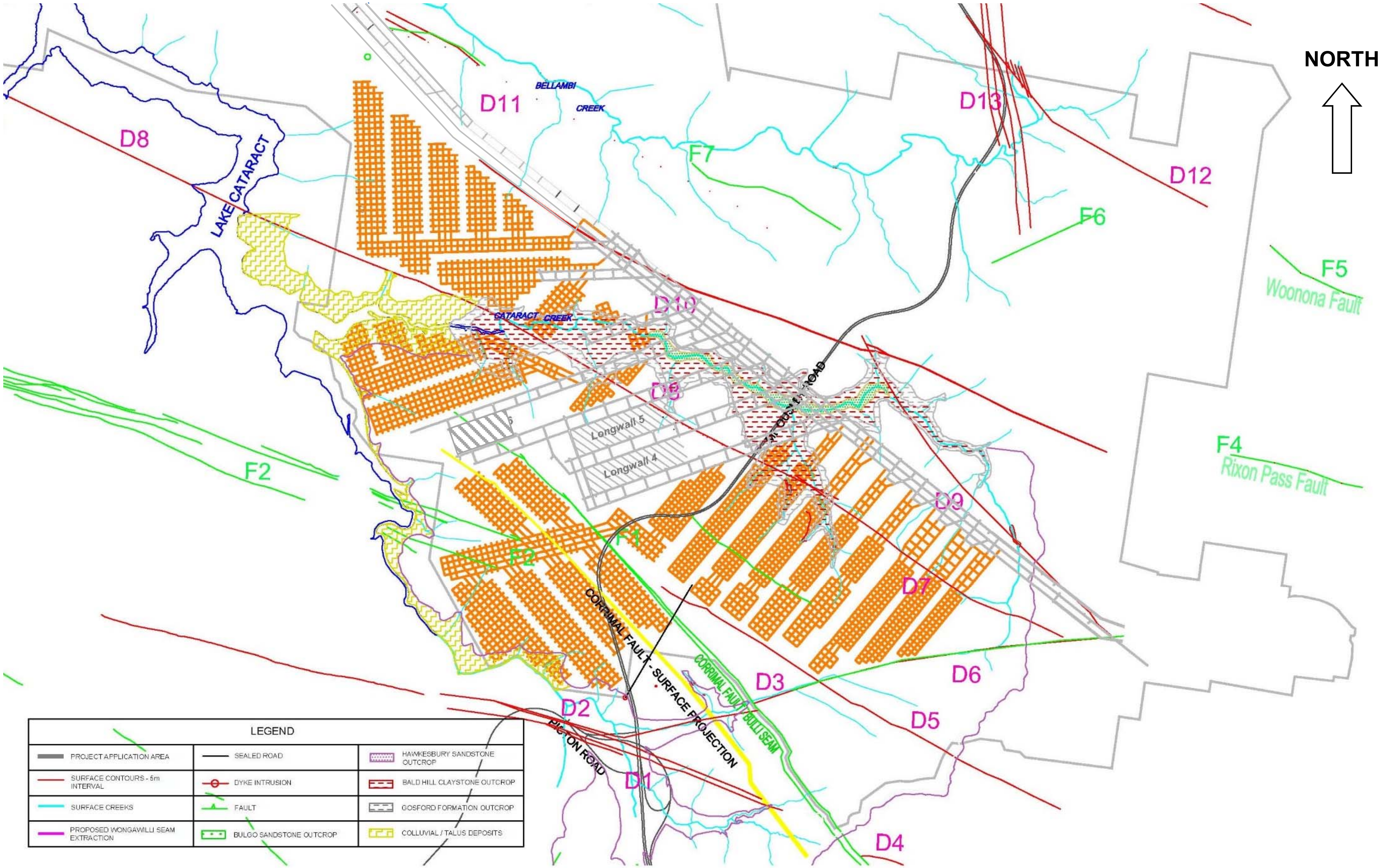


Figure 5-5 Russell Vale East Outcrop Geology and Structures

5.4.2 Underground Mapped Faults

There are no known major faults in the overburden above the proposed Russell Vale East workings, apart from the Corrimal Fault which has only been mapped in the Bulli workings in the western periphery of Russell Vale East as shown in **Figure 5-6**.

No known or observed groundwater inflows have been associated with any faults intersected by the workings at Russell Vale East in the Bulli, Balgownie or Wongawilli Seams (SCT Operations, 2019).

At the Bulli Seam level, the Corrimal Fault has a 1.3 – 3.0m displacement in the vicinity of the proposed workings. The Corrimal Fault trends in a SE / NW direction, and is located to the west of Longwalls 4 and 5, but passes through Longwall 6 (340m). It then phases out to the north of Longwall 6.

The maximum displacement of the Corrimal Fault within a 20m wide faulted zone is 28.7m, which reduces toward zero to the north of Longwall 6, and is not interpreted to be present between the proposed first workings and Cataract Reservoir (SCT Operations, 2019).

A NW / SE trending splay off the Corrimal Fault (associated with Dyke D5) and a SW / NE fault (associated with Dyke D6) are located to the south of the eastern block of workings, with the D6 fault crossing under Cataract River, to the west of the proposed eastern block.

The north-west south-east trending Rixon's Pass Fault is shown at surface on the 1:100,000 geological map to be sub-parallel to Cataract Creek, however, no trace of it has been identified in the Bulli or Balgownie workings.

Outside of the historic mine workings, the exact location, throw and inclination of the faulted zones are not known, and their potential position is extrapolated from drilling data and in-seam mapping.

5.4.3 Underground Mapped Intrusives

The proposed Wongawilli Seam workings are bound by dkyes D1,2,3,5,9, 10 and D11.

The SE / NW trending Dyke D7 cuts through the south eastern group of workings, then phases into Dyke D8, which cuts through the eastern end of Longwall 5 and within Longwall 6, before passing to the north west to the south of the northern group of workings. Limited in-seam silling has been mapped within the western end of Longwall 5, which significantly affected the extraction rate of LW5 and into Longwall 6 (340m).

Dyke D8 underlies Cataract Creek between the two northern groups of workings, but does not intersect Cataract Reservoir until it is approximately 720m west of the proposed first workings.

Dyke D8 has been mapped at surface as a highly weathered illite / montmorillonite clay, or totally eroded feature of up to 0.5m wide and with up to 0.8m of displacement. It is associated with smaller first order SE / NW trending gullies over the proposed south eastern workings as well as LWs 4 to 6 (340m).

No inflows to any of the three seams of workings have been observed in association with Dyke D8 (SCT Operations, 2019). No diatremes have been identified within the proposed subsidence area, however a large sill is located to the east and north of Russell Vale East. For further discussion of underground structures and intrusives, the reader is referred to Gujarat NRE Coking Coal (2014) as well as SCT Operations (2019A, B).

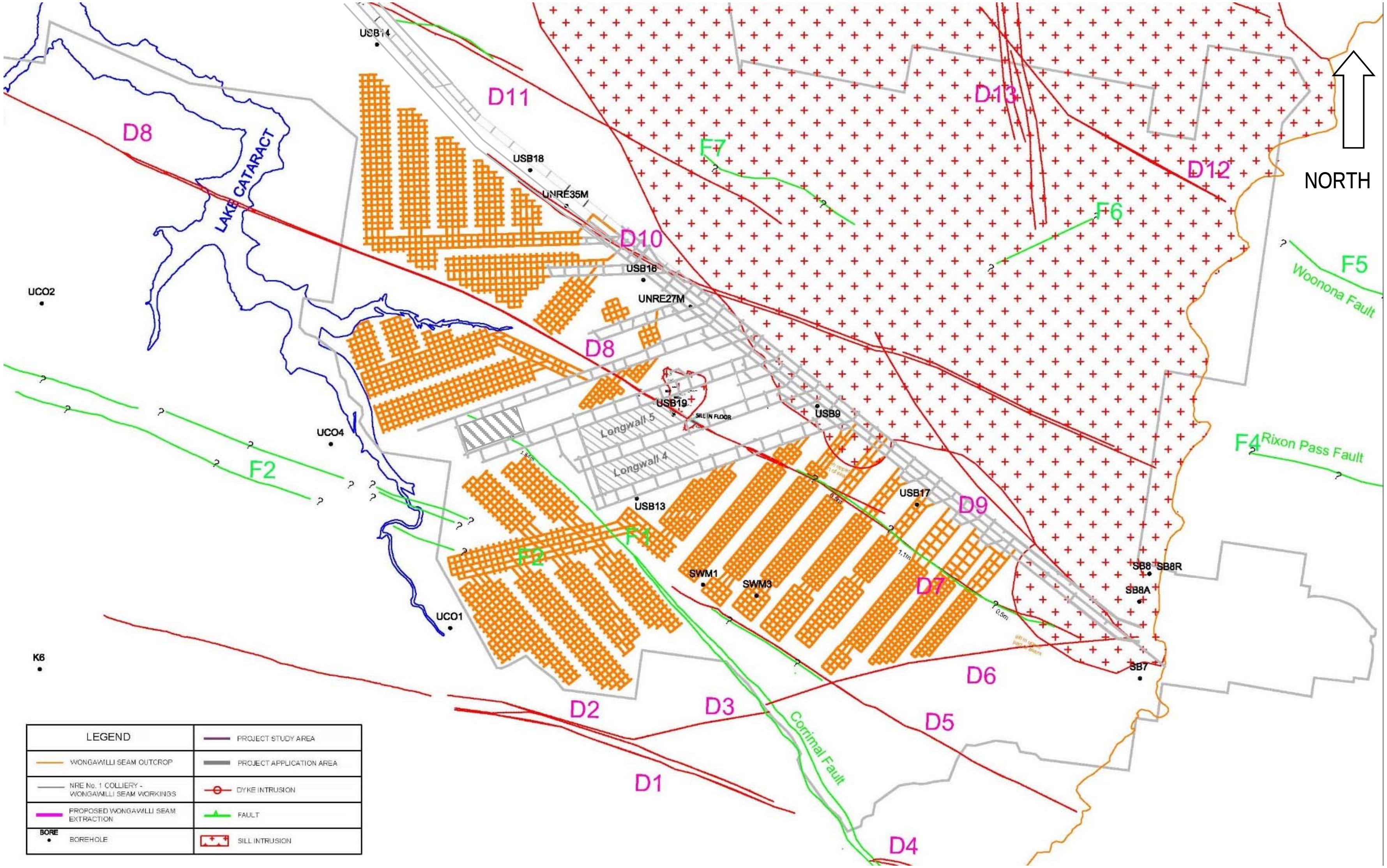


Figure 5-6 Russell Vale East (Wongawilli Seam) Structures and Intrusives

5.5 Basement Hydrogeology

Six general hydrogeological domains are present in the Russell Vale East and overall Application Areas, including the:

- hydraulically disconnected (perched) upland swamps;
- hydraulically disconnected (perched), ephemeral weathered Hawkesbury Sandstone;
- deeper Hawkesbury Sandstone, which is hydraulically separated from the underlying Bulgo Sandstone and deeper lithologies by the Bald Hill Claystone, except where the claystone is fractured by subsidence or eroded away in the channel of Cataract Creek;
- Narrabeen Group sedimentary lithologies, the lower portions of which have already been locally fractured and depressurised above the existing Wongawilli, Bulli and Balgownie seam workings and are interpreted to be fractured and/or depressurised over areas of triple seam mining up to the shallow surficial strata, whilst areas only mined in the overlapping Bulli and Balgownie secondary extraction areas are interpreted to extend to the upper Bulgo Sandstone;
- Illawarra Coal Measures, which contains the Bulli, Balgownie and Wongawilli Seam aquifers that have also been fractured and depressurised to varying degrees by the existing workings and will be locally fractured and depressurised by the proposed workings, and the;
- sedimentary sequence underneath the Wongawilli Seam.

Due to the steep topography and limited alluvium within the Cataract Creek and upper Cataract River catchments, there is no notable groundwater bearing stream based alluvium within Russell Vale East.

5.5.1 Hawkesbury Sandstone

Apart from aquifers in the coal seams, the main aquifer in the Application Area is the dual porosity (i.e interstitial pore space along with fractures and joint porosity) Hawkesbury Sandstone which, although having generally low permeability, can provide relatively higher groundwater yields compared to other lithologies in the area.

The Hawkesbury Sandstone outcrops over the majority of the lease area although it has been partially eroded in the central valley of Cataract Creek where the upper Bulgo Sandstone is exposed.

Regional water levels within the sandstone result from interaction between rainfall infiltration (recharge) through the shallow weathered zone into the underlying clastic rocks and with topography over geologic time. Rainfall infiltration elevates the water table whilst drainage channels incised through to the water table can provide seepage pathways that constrain groundwater levels to the elevation of stream beds through seepage into “gaining” streams.

Evapo-transpiration losses from deep and shallow rooted vegetation would also reduce the phreatic surface of the water table to varying degrees.

The low groundwater flow rates within the Hawkesbury Sandstone are primarily horizontal with minor vertical leakage due to the dominant horizontal bedding planes and bedding discontinuities interspersed with generally poorly connected vertical joints.

Ephemeral perched water tables within the upper 20m of the Hawkesbury Sandstone that are hydraulically disconnected from the underlying regional aquifer, can occur following extended rainfall recharge periods.

In rainfall recharge periods, water levels in shallow aquifers respond by rising, whilst in dry periods, levels are lowered through seepage to the local watercourses. During dry periods the salinity in surface drainages normally rises as the basement baseflow seepage proportionally increases.

Measured standing water levels in the Hawkesbury Sandstone range from to 12m to 39m below surface.

High yields of up to 30L/s have been identified outside of the local area by Water-NSW in the Kangaloon and Leonay-Wallacia areas where the sandstone is distinctly affected by deep regional scale fracturing associated with igneous intrusions or a major regional lineament along the base of the Blue Mountains associated with the Lapstone Monocline (SCA, 2006).

These high yielding sandstones are not located in or near the Russell Vale lease area.

Water quality in the Hawkesbury Sandstone generally has low salinity (81 - 420µS/cm) with relatively acidic pH (3.22-5.45) and can contain high iron levels up to 12.0mg/L in the Application Area.

5.5.2 Narrabeen Group

The Narrabeen Group lithologies have significantly lower yielding aquifers compared to the Hawkesbury Sandstone, with very minor productive supplies obtained in the Southern Coalfields due to its generally deeper elevation below surface and its very low permeability. The Bulgo Sandstone can contain salinities of up to 2300µS/cm (KBR, 2008) whilst the Scarborough Sandstone (Short et al. 2007) can average around 850µS/cm.

The Narrabeen Group is generally low yielding (<1.0L/sec), with its highest yields obtained from the coarser grained or fractured units.

The Narrabeen Group has generally low permeabilities, where the sandstones can provide porous storage with limited fracture flow and with low transmissivity, whilst mudstones, siltstones and shales effectively impede vertical flow. In some localities, groundwater flow may be enhanced by localised, secondary fracturing where faulting and/or jointing associated with bedding flexure or igneous intrusions can increase the hydraulic conductivity.

Hydraulic connection between the lithologies occurs through fractures and joints. Where vertical connectivity is present, more laterally uniform pressure distributions are exhibited. Some local scale faults and dykes are present in the Russell Vale lease area as shown in **Figure 5-6** although they are not anticipated to be large enough to enable loss of stream flow into the workings if dislocated by subsidence.

The Newport and Garie Formations, along with the underlying Bald Hill Claystone and the upper Bulgo Sandstone outcrop within the base of the headwater valleys within the Russell Vale East area would be directly recharged by stream flow leakage from Cataract Creek and Bellambi Creek.

The base of the Narrabeen Group is marked by the Wombarra Claystone which has very low permeability in its unsubsided state.

5.5.3 Illawarra Coal Measures

Water quality varies regionally both within and between coal seams and inter-burden in the Illawarra Coal Measures due to the complexity of groundwater flow, with the water being mostly brackish to saline.

The Balgownie, Bulli or Wongawilli Seams do not outcrop within the Application Area, although they outcrop along the lower section to the base of the Illawarra Escarpment. They would be recharged by vertical infiltration from overlying lithologies, and there is no direct connection between the seams and the surface creeks.

5.6 Registered Bores and Piezometers

There are no private bores or wells within the Russell Vale East Area.

The nearest registered bore on the Woronora Plateau is a test bore at Appin Colliery registered to BHP, which is located approximately 4.9km to the north of the proposed workings.

At present, one monitoring piezometer P514 (GW102223) is recorded in the NSW Natural Resource Atlas database in the vicinity of the proposed workings.

No local data within the proposed extraction area is available on bore yields, as there are no production bores present.

5.7 Geomorphology

The Application Area contains the regulated catchment of Cataract Creek, as well as portions of Cataract River and Bellambi Creek, upstream of Cataract Reservoir at Russell Vale East, which drain into Cataract Reservoir.

The catchments are described in detail in an associated report (WRM Water and Environment, 2015) to which the reader is referred for further discussion.

5.8 Stream Flow, Stream Water Quality, Rainfall and Land Use

Conversion of stream pool depths to volumetric flows at Sites CC3, CC4, CC8 and CR2 has been conducted and is presented in WRM Water and Environment (2015), with subsequent data presented in Umwelt (2018).

Based on drilling information and site observations, streams are interpreted to be “losing” in the Russell Vale East catchment headwaters and “gaining” near Cataract reservoir.

However, due to the lack of drill rig accessibility to install piezometers in the valley floors, there is insufficient data to map where the transition occurs within the lease area.

Surface water drainage from the plateau to the local streams is through ephemeral first and second order gullies. The smaller gullies discharge into the major streams from elevated stream beds after sufficient rain, whilst the majority of rain would infiltrate into the plateau and swamp soils and weathered sandstone.

Recharge to the shallow, and subsequently the deeper regional groundwater system, would occur over an extended delay of months to years. It would occur after the meteoric water has soaked through the plateau's soil and bedrock, with the majority of water discharging back into the creek system from temporary seeps in the swamps and creek beds along preferential horizontal flow regimes in the shallow outcropping bedrock.

The predominantly horizontal flow regime and restricted vertical recharge is essentially determined by the:

- horizontally bedded strata with preferential flow along bedded zones with coarser grain size,
- claystone/mudstone banding at the base and tops of sedimentary facies which restrict vertical migration and enhance horizontal flow at the base of the more porous unit,
- fracture zones enhancing horizontal flow through the strata, and;
- bedding planes or unconformities located immediately above finer grained sediments or iron rich zones.

Groundwater seepage to the local streams can occur at isolated iron stained seeps along the creek beds, where low volume and variable duration seeps discharge for a few days to weeks after significant rainfall. The seeps are generally located at the interface between coarser and underlying finer sandstone or shale/ sandstone interfaces which restrict vertical flow through the bedrock and enhance lateral flow. Most observed seeps in the local streams are anticipated to flow at less than 1L/sec.

The current interaction between surface water, perched and regional groundwater systems is postulated to be that pre-mining conditions prevail in that during wet periods there is a net contribution of groundwater to the surface system, while in dry conditions there is a net loss of surface water, with the resulting surface flow depending on the relative balance between seepage baseflow and stream outflow.

Mapping of the stream reach over the proposed workings indicates Cataract Creek is an ephemeral, "losing" stream in its first order headwater tributaries over the eastern and southern section of the southern proposed first workings, then becomes perennial downstream of that point where a seepage face is present in a 3m high sandstone rock face, down to its junction with Cataract Reservoir.

The surface water and shallow groundwater system is interpreted to be hydraulically isolated from the Bulli Seam workings in areas where only overlapping Bulli and Balgownie secondary extraction is present, although may not be separated where the overlapping workings of the Wongawilli Seam (Longwalls 4, 5 and 6(340m) have also been subject to longwall mining.

At present there are local scale aquifer systems at Russell Vale East over the subsided zone of the Bulli, Balgownie and Wongawilli Seam workings.

It is assessed an upper fractured unit is present from surface to approximately 20m below ground, which transitions into an elevated horizontal permeability zone caused by vertical bedding dilation, which does not necessarily contain a hydraulically connected, subsidence enhanced, vertical permeability component. This zone subsequently transitions into a sequentially higher permeability zone in the goafed and overlying deeper lithologies which can have a higher potential hydraulic connection to the Wongawilli Seam workings.

The Hawkesbury Sandstone and Bulgo Sandstone groundwater systems are not interpreted to be hydraulically separated in the valley of Cataract Creek where the Bald Hill Claystone is eroded through to the Bulgo Sandstone, downstream of the freeway. In addition, they may not be separated where the sandstone may have locally enhanced permeability due to its lack of lithostatic pressure where it has limited or no overburden, or where the Bald Hill Claystone has been fractured by subsidence.

The creeks and perched swamps are separated from the underlying regional groundwater system by a profile of unsaturated strata.

5.9 Groundwater Dependent Ecosystems and Upland Swamps

As no change to the potential effects on groundwater dependent ecosystems has occurred since the last two groundwater assessment reports, further discussion of the stream and upland swamp groundwater dependent ecosystems is contained in GeoTerra / GES (2014).

6. PREVIOUS GROUNDWATER SYSTEM SUBSIDENCE EFFECTS

As no new assessment has been derived since GeoTerra / GES (2015) in relation to the historical groundwater system subsidence effects within the adjacent South32 or Russell Vale West workings, the reader is referred to GeoTerra / GES (2014) for further details.

7. POTENTIAL STRATA DEFORMATION AND ASSOCIATED GROUNDWATER EFFECTS

7.1 Horizontal Strata Shear Zone Formation

Based on studies conducted in the Southern Coalfield at the South32 Appin Colliery, Sandy Creek waterfall (Walsh R.W, et al 2014), Waratah Rivulet at the Peabody Coal Metropolitan Colliery (Mills, K.W. 2007) and the Wollongong Coal Russell Vale East area, SCT Operations Pty Ltd (2014) has inferred that lateral movement of hillsides in toward the valley floor and associated horizontal to sub-horizontal shearing of the strata is possible.

The lateral shear mechanism occurs naturally in valleys, however it may be exacerbated by dilational hillslope shearing movement from the hillslopes toward the valley floor associated with mining induced subsidence as shown in **Figure 7-1**.

This mechanism is inferred to occur where lateral shear movement, which is not necessarily associated with pre-existing bedding plane or strata discontinuities, is mobilised following periods of intense rainfall.

At Russell Vale, the horizontal shearing of pre-existing natural bedding planes and vertical joints is inferred to have occurred in association with previous mining induced subsidence and hillslope dilational movement following extraction of the Balgownie and Bulli Seams.

The inferred shear plane (or multiple en-echelon planes) may have been re-mobilised following extraction of Longwalls 4, 5 and 6 (340m) in the Wongawilli Seam, particularly after the heavy rain periods.

SCT Operations (2014) infer that the main shearing may be located between 6 – 10m below the valley floor and may extend from the creek bed, under the subsided hillslope within the zone of subsidence for up to approximately 400 - 450m away from the creek.

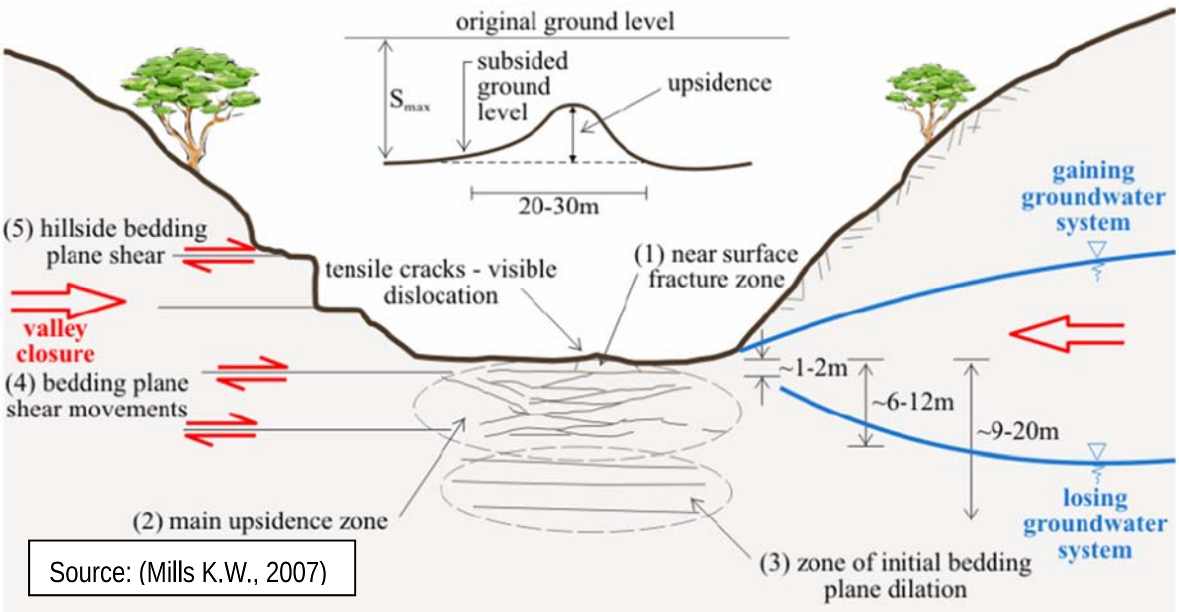


Figure 7-1 Conceptual Valley Closure Shearing

A definitive assessment of the location, presence and complex nature of the potential shear plane/s is not possible with current field / drilling data in the valleys and hillslopes overlying subsided areas at Russell Vale East, however, the horizontal shear zones do not pose a risk of direct hydraulic connection of stream flow from the stream beds in the upper catchments to the mine workings.

7.2 Height of Fracturing and Associated Strata Depressurisation Prediction

Two empirical based methods for the height of fracturing (Tammetta, 2012) as well as Ditton and Merrick (2014), and by association, the height of groundwater depressurisation, have been proposed using the height of single seam longwall extraction, width of extraction and the depth of cover, as well as a geological factor in Ditton and Merrick (2014) over the centre of single seam longwall panels.

No reliable comparison between the theoretically predicted and observed Russell Vale East in-situ height of depressurisation was able to be established from VWP data over the Russell Vale East multiple seam longwall extraction area.

Comparison of the predicted versus observed depressurisation height is also complicated in that a VWP array may not directly overlie the centre of secondary extracted workings, as most of the VWPs at Russell Vale are installed to the side of the Balgownie and Wongawilli Seam workings.

As a result, the observed depressurisation response in the subsided strata does not conform to a tacit assumptions in the strata depressurisation theories, in that a VWP is located over the centre of a single longwall panel.

Neither of the two theoretical approaches are applicable to the Russell Vale East triple seam or first workings extraction environment.

Accordingly, this document is based on a conceptual groundwater model using geological lithologies and in-situ VWP water pressure data to predict the impacts, consequences and effects of the historic longwall and proposed Wongawilli Seam first workings extraction on the groundwater system at Russell Vale East.

8. HYDROGEOLOGICAL INVESTIGATIONS

To date, groundwater investigations in the Russell Vale lease area have involved installation of:

- 8 open standpipes, with 5 additional piezometers installed since September 2014, as well as;
- 7 vibrating wire array piezometers, with 5 additional VWP arrays installed since July 2014

as shown in **Figures 8-1** and **8-2**, with drilling extending to 374m below surface.

Drilling was contained within the Russell Vale lease area, although the groundwater model domain extends out to include the adjacent South32 lease areas and current / decommissioned / proposed workings as well as peripheral areas within the major watersheds outside of the lease.

A summary of the open standpipe and vibrating wire piezometers is presented in GeoTerra / GES (2015).

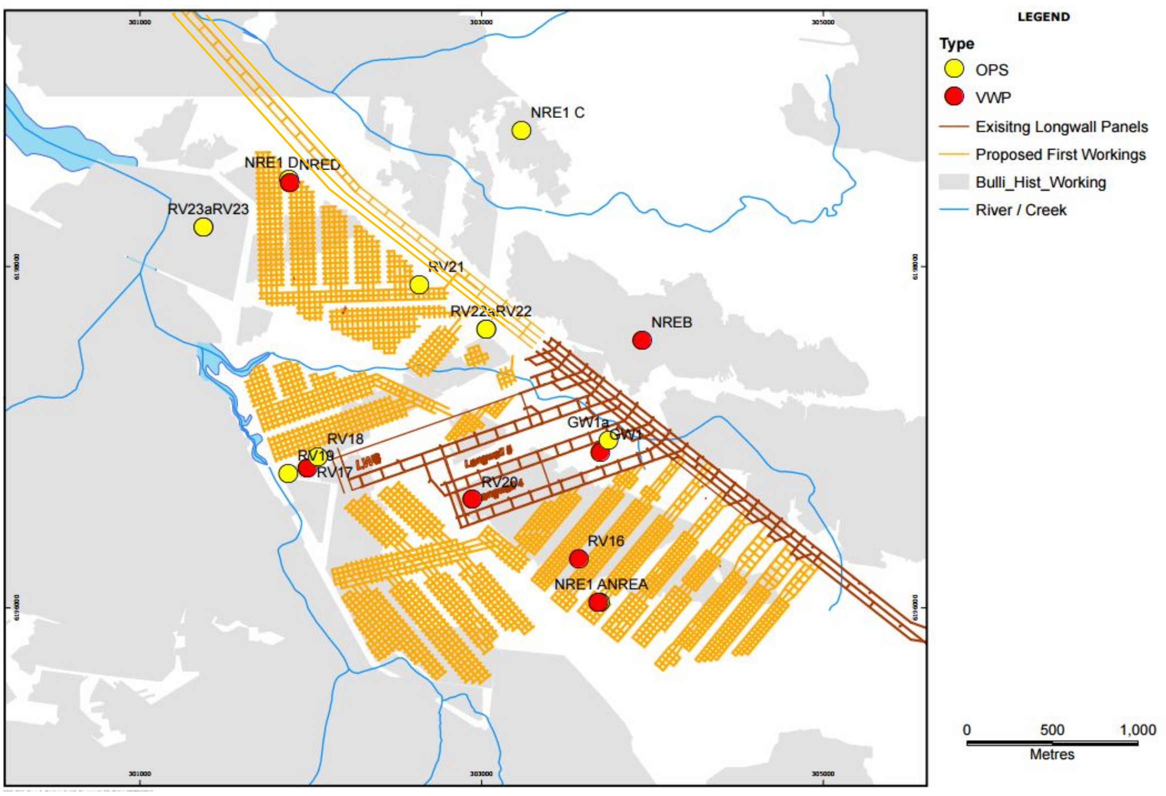


Figure 8-1 Russell Vale East Colliery Piezometer Location

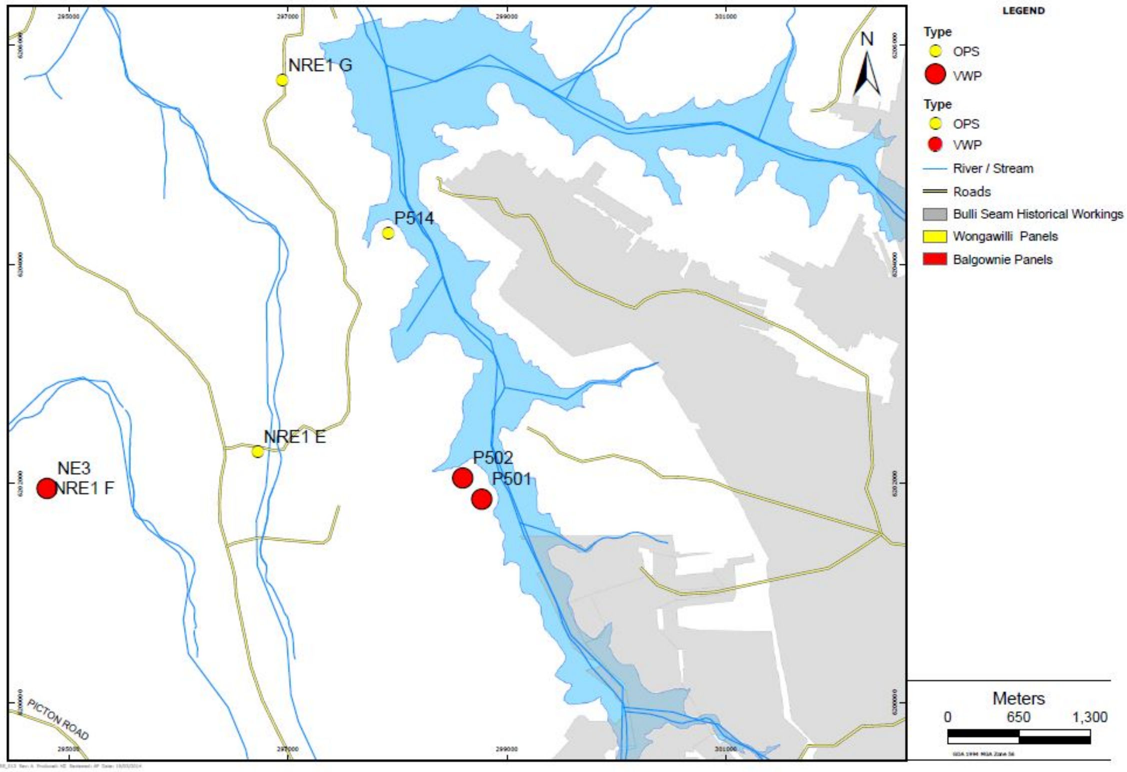


Figure 8-2 Russell Vale West Colliery Piezometer Locations

8.1 Basement Hydraulic Properties

As the basement hydraulic properties have previously been outlined, for further information refer to GeoTerra / GES (2015).

8.2 Hawkesbury Sandstone Open Standpipe Shallow Groundwater Levels

The open standpipe piezometer locations are shown in **Figures 8-1** and **8-2**.

Water level variability has been measured in open standpipe piezometers installed in the upper Hawkesbury Sandstone as shown in **Figures 8-3** and **8-4**.

The monitoring data indicates that the Russell Vale East piezometers are generally more responsive to rainfall than in the western part of the lease area, with the variability principally due to the degree of subsidence and overburden fracturing that has occurred over the Russell Vale East workings.

The open standpipe piezometers in the vicinity of the recently active Wongawilli Seam Longwalls 4, 5 and 6 (i.e. GW1A, RV18 and RV19) do not show depressurisation resulting from subsidence induced fracturing of the overburden, whilst other piezometers such as NRE A and NRE D exhibit a heightened response to rainfall recharge as a result of shallow sandstone overburden subsidence induced fracturing.

Interestingly, the WCRV21 water levels have been tracking down to lower elevations in accord with the rainfall residual plot since the piezometer was installed in December 2014.

The high water level variability in NRE F is unusual, and is interpreted to be due to incomplete sealing of the surface casing annulus, which allows overland surface water runoff to enter the casing and “artificially” raise the standing water level in the piezometer.

All of the shallow sandstone piezometers show a variable responsiveness to climatic variability and rainfall recharge that replicates, in a subdued manner, the variability of the rainfall residual plot.

8.2.1 GW1A

GW1A was installed to a depth of 27m in September 2012 after completion of Longwall 4. It is located above Longwall 7B in the Balgownie Seam where the Hawkesbury Sandstone has been completely eroded and is installed at the same stratigraphic depth in the Bulgo Sandstone as the 30m intake in the VWP array in bore GW1.

The bore is located between the VWP piezo (GW1) and Cataract Creek, which is approximately 105m to the north east. It is approximately 420m from the northern end of LW4 and 125m to the southeast of LW 5.

The piezometric pressure profile in GW1A is essentially the same as the 30mbgl VWP intake water level within the Bulgo Sandstone.

The water level in GW1A is near the level of Cataract Creek (RL300m) with a moderate correlation to the rainfall residual plot.

The slight reduction in the phreatic surface that commenced soon after LW5 started and continued throughout the period of mining LW5 correlates to a reducing trend in the rainfall residual plot and is not definitively associated with Longwall 5 subsidence effects.

The intake zone of GW1A may be hydraulically connected to Cataract Creek, possibly via a horizontal shear/s located just below the level of Cataract Creek, where rainfall recharge and / or stream water is able to flow within the shear horizon.

8.2.2 RV18 and RV19

RV18 is located approximately 135m west of Longwall 6 (340m), whilst RV19 is located approximately 330m west of Longwall 6, with both piezometers overlying first workings within the Bulli Seam. RV18 was installed to 20mbgl and RV19 to 17.5mbgl in the Hawkesbury Sandstone.

Both piezometers lie between the Longwall 6 and the Cataract Reservoir and both have a moderate correlation to the rainfall residual plot.

The water level in RV18 ranges from 7.6 to 10.3mbgl, or 332.1 – 329.3 mAHD, which is at least 39.4m above the reservoir FSL of 289.87 mAHD.

The monitoring data does not indicate a correlation to, or depressurisation resulting from, extraction of Longwall 6 (340m) in either piezometer, although there is a definitive rise and fall in associated with an east coast low rain event in mid to late April 2015 that occurred whilst LW6 was being mined as well as in June 2016.

8.2.3 NRE A

NRE A is located next to the VWP array (also called NRE A) on a ridge in the Hawkesbury Sandstone in an area with only first workings in the Bulli Seam (approx. 285 mbgl), with nearby longwall mining in the Balgownie Seam and no nearby mining in the Wongawilli Seam.

Pre-existing tension cracks are present close to NRE A, with the high level of vertically connected cracking and consequently a high level of vertical conductivity considered to result from vertical fractures and opening of existing joints caused by horizontal tensional stretching of the shallow overburden (SCT Operations, 2019).

NRE A was installed to 47mbgl in Hawkesbury Sandstone. It is located approximately 750m south east (and upgradient) of Wongawilli Seam Longwall 4 and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6(340m).

It is also located approximately 450m southwest of Cataract Creek and, like NRE A (VWP) has a strong correlation to the rainfall residual plot.

8.2.4 NRE C

NRE C is located on a ridge in the Hawkesbury Sandstone in an area with predominantly first workings in the Bulli Seam and no workings in the Balgownie or Wongawilli Seams.

No pre-existing tension cracks have been observed near NRE C.

NRE C was installed to 24mbgl in Hawkesbury Sandstone. It is located well outside the area of depressurisation influence from Longwalls 4, 5 or 6(340m) and is located approximately 430m north of Bellambi Creek, with a moderate correlation to the rainfall residual plot.

8.2.5 NRE D

NRE D is located on a ridge in the Hawkesbury Sandstone, adjacent to NRE D (VWP) in an isolated area of pillar extraction and first workings in the Bulli Seam and no workings in the Balgownie or Wongawilli Seams.

No pre-existing tension cracks have been observed near NRE D.

NRE D was installed to 52mbgl in Hawkesbury Sandstone and is located well outside the area of depressurisation influence from Longwalls 4, 5 or 6(340m).

It is located approximately 580m east of Cataract Reservoir and has a moderate to strong correlation to the rainfall residual plot.

8.2.6 RV21, 22A and RV23A

RV21 and RV22A are located on a ridge and south facing hillslope to the north of Cataract Creek, whilst RV23A is located approximately 85m east of the reservoir FSL over first workings in the Bulli Seam of Corrimal Colliery, with no workings in the Balgownie or Wongawilli Seams.

No pre-existing tension cracks have been observed near any of the three piezometers.

RV21 was installed to 22.7mbgl, RV22A to 37.4mbgl and RV23A to 26.6mbgl in Hawkesbury Sandstone, and they are all located well outside the area of depressurisation influence from Longwalls 4, 5 or 6(340m).

RV21 has a very strong, whilst RV22 and RV23 both have a moderate to strong correlation to the rainfall residual plot.

8.2.7 NRE F, NRE G and NRE3

All three piezometers are located in the Russell Vale West mining area, to the west of Cataract Reservoir and all overlie first workings and longwalls in the Bulli Seam.

No pre-existing tension cracks have been observed near any of the three piezometers.

NRE F was installed to 60mbgl, NRE G to 53mbgl and NRE3 to 60mbgl in Hawkesbury Sandstone.

NRE F and NRE G have a low correlation to the rainfall residual plot, whilst NRE3 appears to have a poor annular seal and responds significantly to rain events.

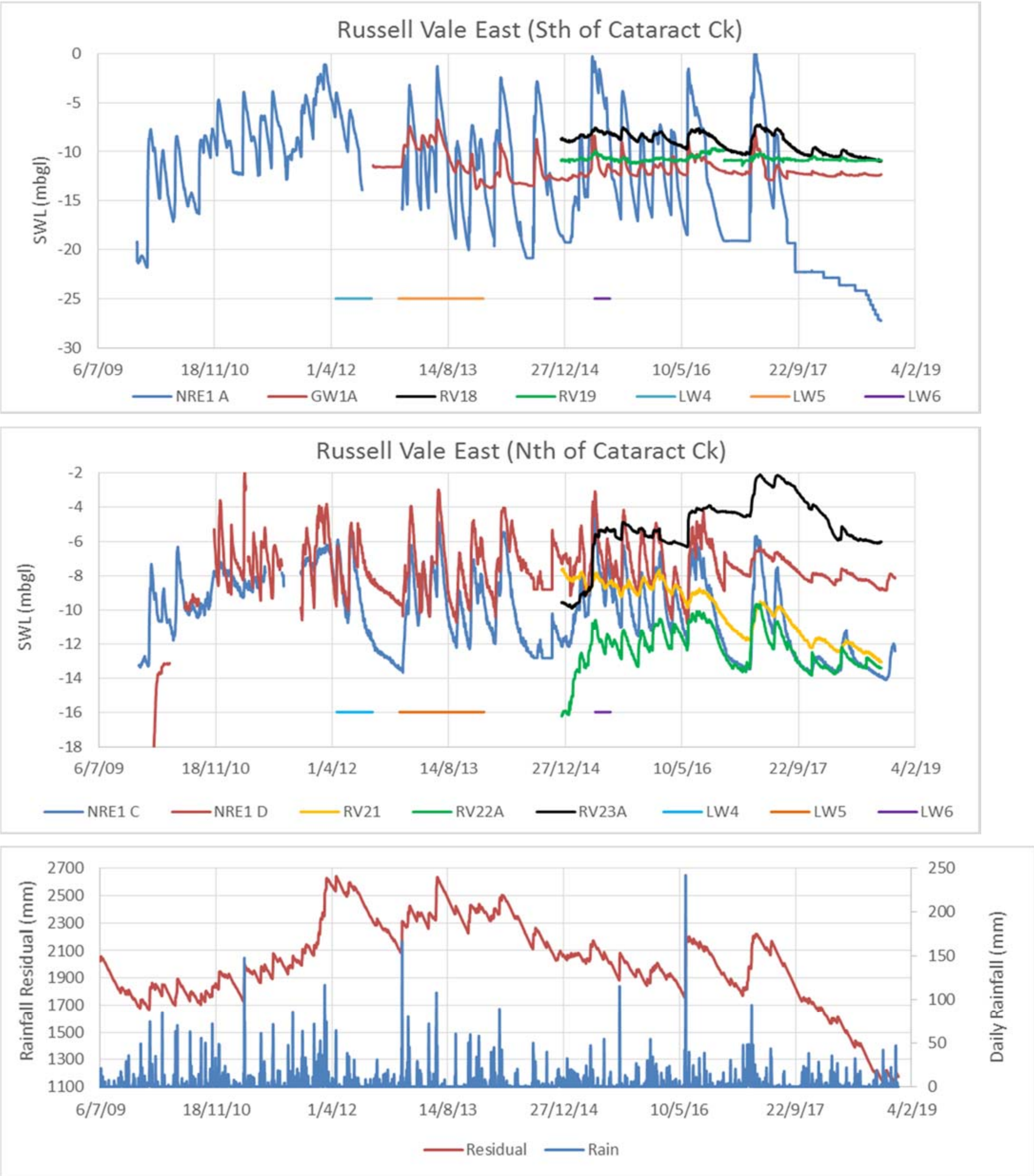


Figure 8-3 Russel Vale East Open Standpipe Groundwater Levels (mbgl) and Rainfall

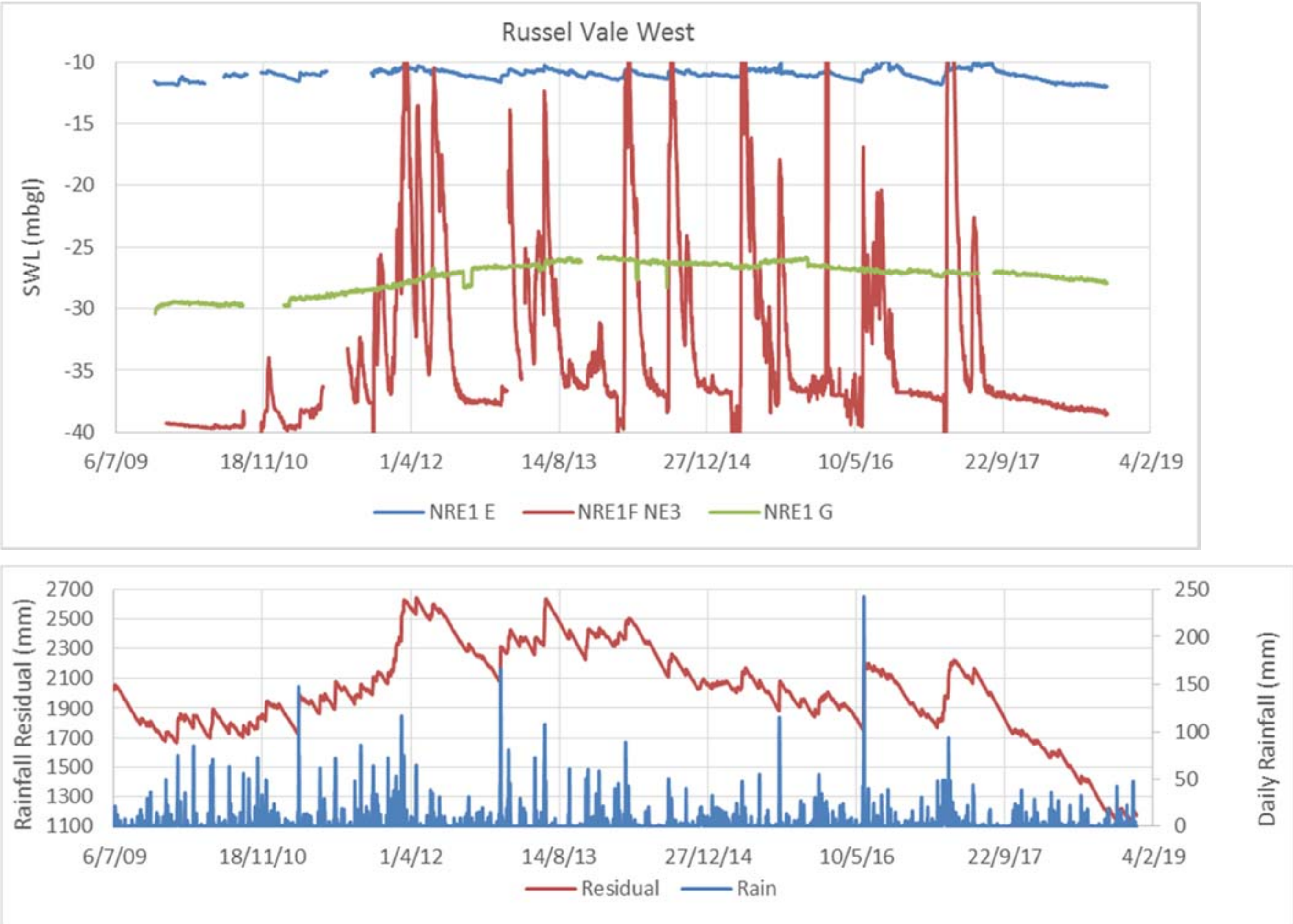


Figure 8-4 Russel Vale West Open Standpipe Groundwater Levels (mbgl) and Rainfall

A contour plot of the regional upper Hawkesbury Sandstone piezometric surface based on data from the open standpipe and upper vibrating wire piezometer intakes as well as assumed water levels in the base of valleys and along Cataract Reservoir is shown in **Figure 8-5**.

The plot indicates a general flow at Russell Vale East toward Cataract Reservoir.

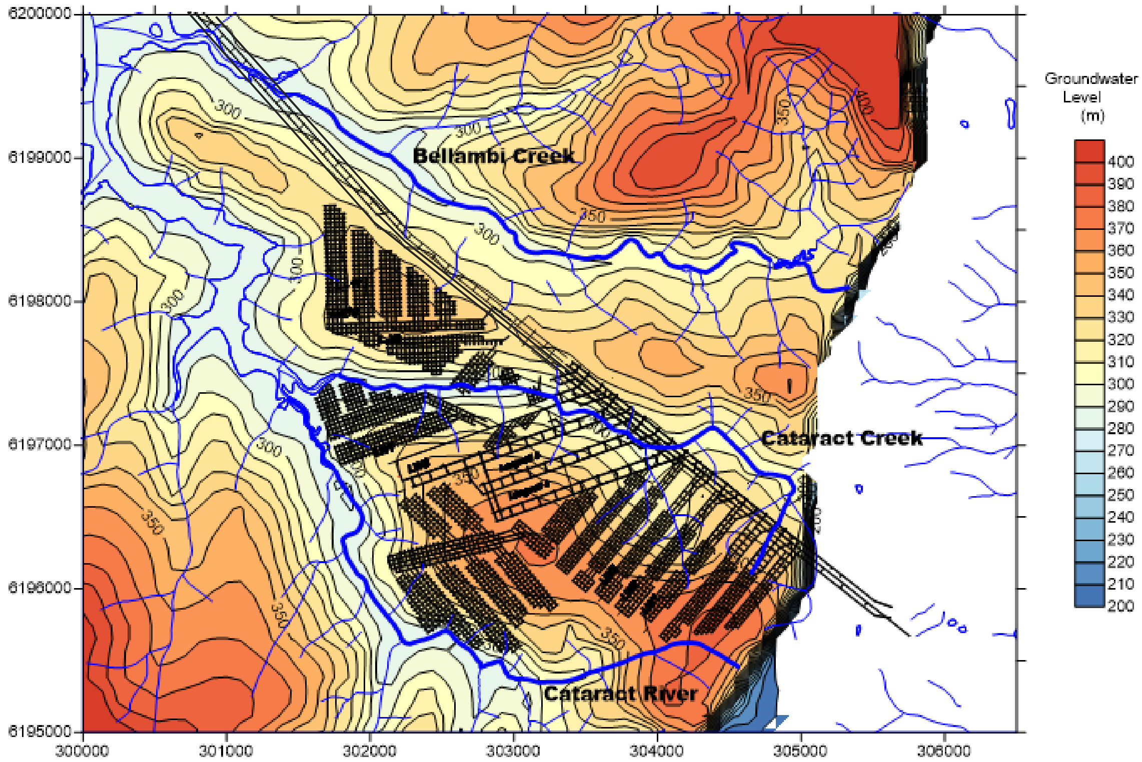


Figure 8-5 Russell Vale Colliery Phreatic Surface Groundwater Contours

8.3 Multi-Level Piezometers

Multi-level piezometers have been installed at selected depths between the Upper Hawkesbury Sandstone and the Stanwell Park Claystone since July 2009 in nine bores at Russell Vale East and one at Wonga West as summarised in GeoTerra / GES (2015).

Vibrating wire piezometers arrays were also installed in 1992 as part of an investigation of the Russell Vale West 500 series longwall subsidence and groundwater response in piezometers P501, P502 and 514 (Singh R.N, Jakeman, M. 2001).

These earlier piezometer arrays augment the latter VWP installations at Russell Vale East and Russel Vale West as discussed in GeoTerra / GES (2014).

8.3.1 GW1

GW1 was installed in September 2012 to 165mbgl into the Scarborough Sandstone after completion of Longwall 4 and prior to extraction of Longwall 5.

It is approximately 350m east of Longwall 4 and 130m south east of Longwall 5 in an area mined by Bulli Seam bord and pillar, Bulli Seam pillar and Balgownie Seam longwall extraction.

GW1 is located above the goaf of Balgownie Seam Longwall 7B where the Hawkesbury Sandstone has been completely eroded away, and is approximately 175m west of Cataract Creek.

Two groundwater systems are indicated in the VWP array, with a near surface perched water table around 30mbgl and a deeper system within the Bulgo Sandstone and below with limited vertical hydraulic connection between the two as shown in **Figure 8-6**.

The phreatic surface of the perched water table, as indicated by the 18mbgl intake, is close to, although above the level of Cataract Creek (approximately RL300m). The 30mbgl intake is near the level of Cataract Creek (RL300m) whilst the 45mbgl intake is below the creek, between 298.9 and 289.3mAHD.

Apart from the 30mbgl intake, the VWP array has a weak responsiveness to rainfall, with a slightly enhanced response in the deepest two intakes.

The array responded to extraction of Longwall 5, particularly in the mid to lower Bulgo Sandstone and Stanwell Park Claystone, but not in the Scarborough Sandstone, with depressurisation in the shallow Bulgo Sandstone intakes possibly due to basal shear plane activation whilst the lower responses were due to enhanced secondary fracture porosity and enhanced vertical and horizontal permeability in the overburden.

Longwall 5 was extracted in stages, with the VWPs showing depressurisation whilst the longwall was active and recovery when it temporarily stopped. A longer term depressurisation response occurred when the longwall was completed, which is sympathetic with the decline in rainfall shown in the rainfall residual plot.

The uppermost piezometer at 18m below the surface does not change significantly over time whilst the 30m intake shows enhanced responsiveness to rainfall and catchment runoff / streamflow after the extraction of Longwall 5, although there is no long term depressurisation at that intake depth.

The 45mbgl intake has a muted response to rainfall but shows a definitive depressurisation during and after extraction of Longwall 5.

The relative pressure heads shown by the shallowest three piezometers indicates a slight downward gradient, with flow into the lower overburden, with a downward hydraulic gradient also being evident throughout the Bulgo Sandstone.

The height of depressurisation in GW1 lies between 140 and 165mbgl.

The pressure profile indicates that the vertical flow rate is likely to be relatively insignificant in comparison with rainfall recharge.

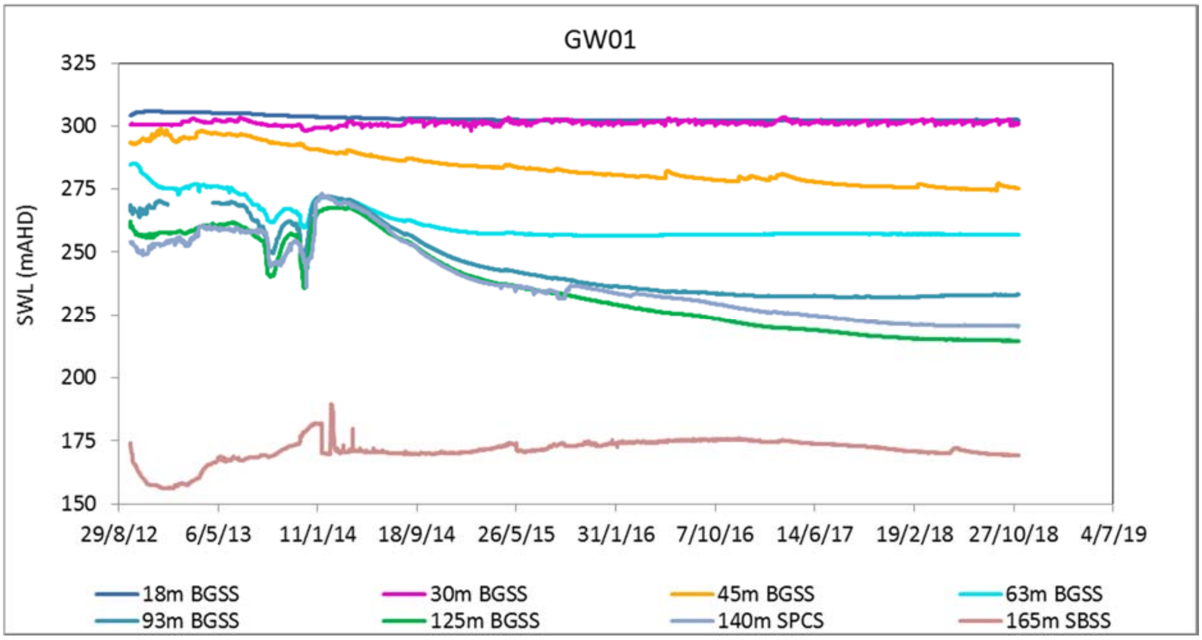


Figure 8-6 GW1 VWP

8.3.2 RV20

RV20 was installed in mid December 2014 to a depth of 134mbgl in the lower Bulgo Sandstone, after Longwall 5 was completed but prior to extraction of Longwall 6 (340m).

It is located over the Wongawilli Seam Longwall 5, as well as Bulli Seam pillar and Balgownie Seam longwall extraction areas.

RV20 is in an area with remnant Hawkesbury Sandstone and is approximately 715m south southwest west of Cataract Creek.

No definitive shallow system perched water table is evident, with a deeper pressurised system in the mid to lower Bulgo Sandstone, whilst the lower Bulgo Sandstone contains limited pressures. As a result of drilling difficulties, no data is available deeper than 134m in the Bulgo Sandstone as shown in **Figure 8-7**.

The VWP array has an overall weak responsiveness to rainfall, with no responses observed at 134mbgl in the Bulgo Sandstone, whilst a weak response is evident at the shallower 105mbgl intake in the Bulgo Sandstone.

The array did not observably respond to extraction of Longwall 6 (340m), but did respond by its water level rising to approximately 105mbgl in response to a high rainfall event associated with an east coast low system in mid to late April 2015. This occurred whilst extraction of Longwall 6 (340m) was underway.

The height of depressurisation in RV20, as a result of triple seam extraction, lies between 105 and 134mbgl, whilst there is no significant pressure in the upper overburden between 35 and 85mbgl, with pressure being maintained in the 105mbgl intake.

The pressure profile indicates that the vertical flow rate is likely to be enhanced at this location.

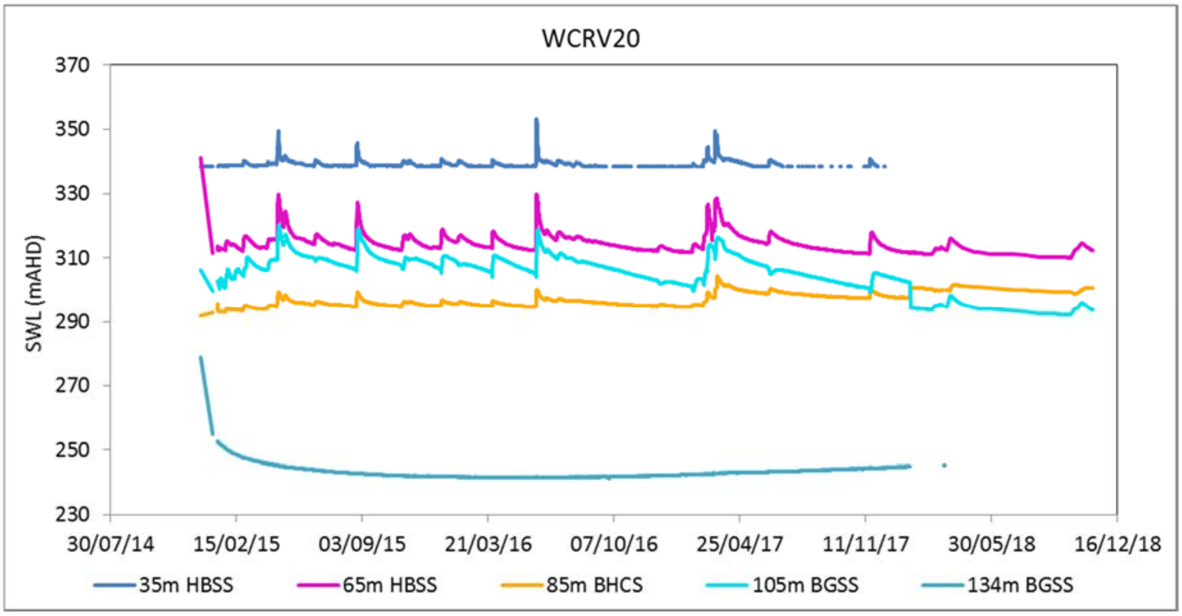


Figure 8-7 RV20

8.3.3 RV17

RV17 was installed in mid-September 2014 to a depth of 79.5mbgl in the upper Bulgo Sandstone, after Longwall 5 was completed, but prior to extraction of Longwall 6 (340m).

It is located approximately 205m west of Longwall 6 and overlies Bulli Seam first workings, with no Balgownie or Wongawilli extraction.

RV17 is in an area with remnant Hawkesbury Sandstone and is approximately 220m east of Cataract River. Shallow pressures within the Hawkesbury Sandstone remain stable at 298m AHD and are slightly elevated above the adjacent Cataract River.

No definitive shallow system perched water table is evident, with a reduced hydraulic gradient down to the base of the bore at 79.5mbgl as shown in **Figure 8-8**.

The VWP array has a minor, delayed responsiveness to rainfall at 40mbgl in the Bald Hill Claystone and 60mbgl in the upper Bulgo Sandstone.

The array did not observably respond to extraction of longwall 6 (340m), but did respond in an intake approximately 60m below surface, to a high rainfall event associated with an east coast low system in mid to late April 2015. This occurred whilst extraction of Longwall 6 (340m) was underway.

The height of depressurisation in RV17, as a result of single seam first workings in the Bulli Seam has not been identified as the drill hole was not deep enough (due to drill rig limitations).

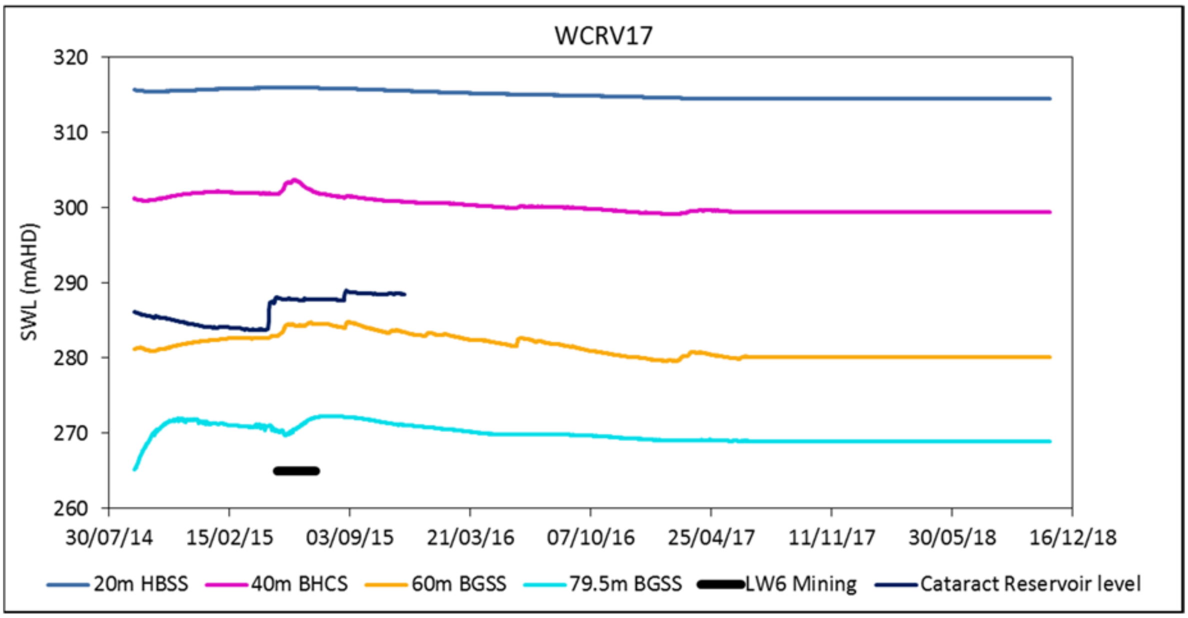


Figure 8-8 RV17

8.3.4 NRE A (VWP)

NRE A (VWP) was installed in mid November 2009 to a depth of 140mbgl in the mid to lower Bulgo Sandstone.

It is located on a ridge in the Hawkesbury Sandstone in an area where there are only first workings in the Bulli Seam (approx 285 mbgl), with nearby longwall mining in the Balgownie Seam and no nearby mining in the Wongawilli Seam.

Pre-existing tension cracks are present close to NRE A (VWP), with the high level of vertically connected cracking and consequently a high level of vertical conductivity observed in NRE A (VWP) is considered to be a result of the presence of vertical fractures and opening of existing joints caused by horizontal tensional stretching of the shallow overburden (SCT Operations, 2014).

It is located approximately 750m south east (upgradient) of Wongawilli Seam Longwall 4 and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6.

The VWP array is located approximately 540m north of Cataract River and 485m south west of Cataract Creek.

The elevation of the phreatic surface ranges from RL340m to RL360m which is at the level of the upper headwaters of Cataract Creek and is likely to be contributing to an intermittent to perennial base flow into Cataract Creek as shown in **Figure 8-9**.

No definitive shallow system perched water table is evident, and it has an essentially hydrostatic gradient from 45 – 140mbgl.

The VWP array has a strong responsiveness to rainfall in all intakes, albeit slightly subdued at 140mbgl consistent with the full column being vertically connected through the Hawkesbury Sandstone, the Bald Hill Claystone and approximately 75m into the Bulgo Sandstone as a result of mine subsidence indicating a high degree of vertical connectivity, with the Bald Hill Claystone not reducing vertical downward flow at this location.

Given the high vertical conductivity indicated by the rainfall response, the presence of a downward hydraulic gradient indicates a potential for this area to be a significant area of rainfall recharge.

The array did not respond to extraction of Longwalls 4, 5 or 6 (340m) due to its separation distance from the workings.

The bore does not extend deep enough to assess the height of depressurisation, however, the data indicates there is a downward hydraulic gradient, although the hydraulic properties of the overburden is sufficiently low to generate a very small downward flow component.

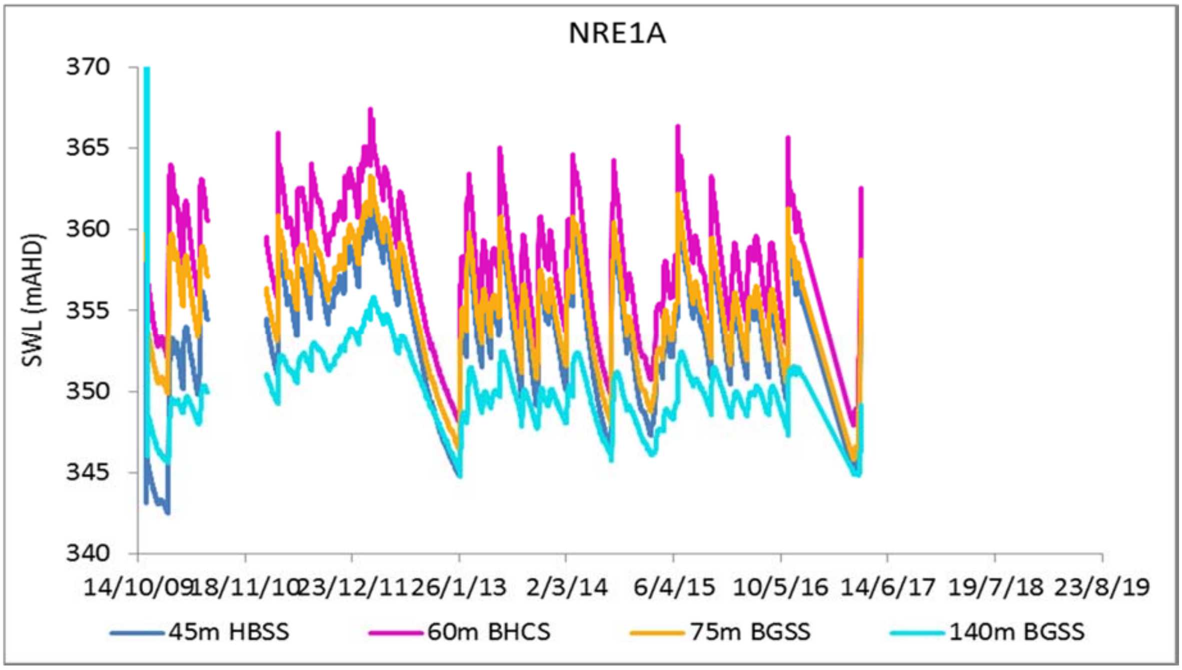


Figure 8-9 NRE A (VWP)

8.3.5 RV16

RV16 was installed in early July 2014 to a depth of 242mbgl in the Scarborough Sandstone.

It is located on a lower elevation of the same ridge line as NREA in Hawkesbury Sandstone in an area with pillar extraction in the Bulli Seam and is over a chain pillar between two longwalls in the Balgownie Seam, with no nearby mining in the Wongawilli Seam.

No pre-existing tension cracks are present close to RV16, and it shows a low degree of vertical conductivity.

It is located approximately 460m southeast (upgradient) of Wongawilli Seam Longwall 4 and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6 (340m).

The VWP array is located approximately 850m north of Cataract River and 570m southwest of Cataract Creek.

The elevation of the phreatic surface a ranges from RL340m to RL360m which is at the level of the upper headwaters of Cataract Creek and is likely to be contributing to an intermittent to perennial base flow into Cataract Creek as shown in **Figure 8-10**.

No definitive shallow system perched water table is evident.

The VWP array has an overall low responsiveness to rainfall, albeit slightly more enhanced in the Bald Hill Claystone at 52mbgl.

The array did not respond to extraction of longwalls 4, 5 or 6 (340m) due to its separation distance from the workings.

The height of depressurisation lies between 197 and 242mbgl at RV16.

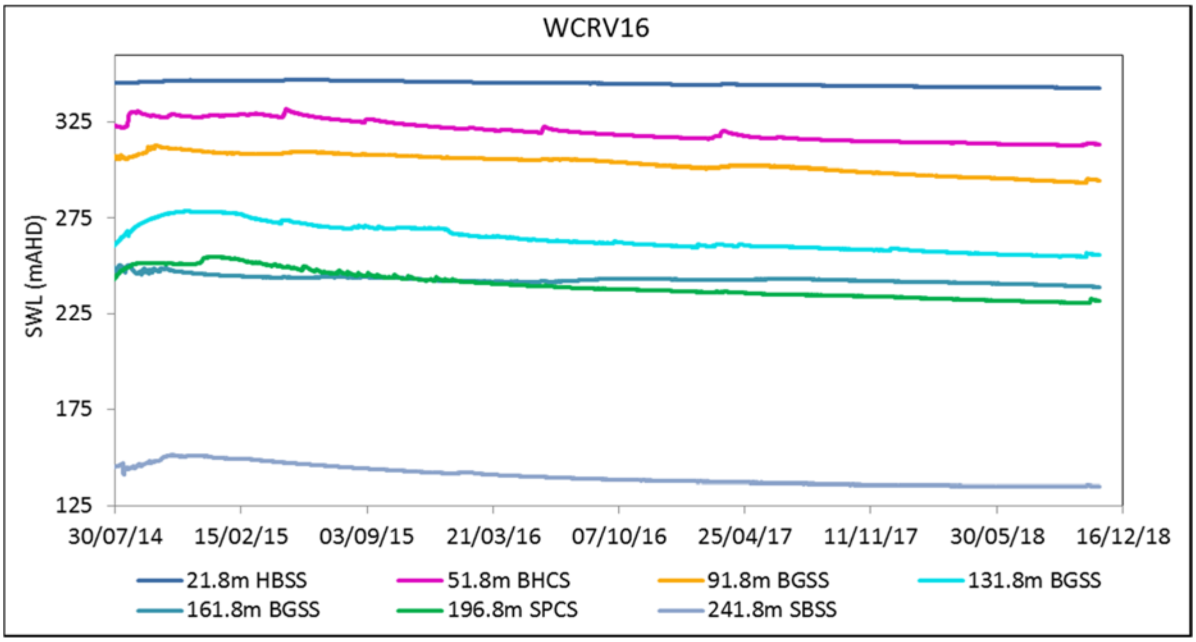


Figure 8-10 RV16

8.3.6 NRE B

NRE B was installed in late November 2009 to a depth of 168mbgl into the Bulgo Sandstone.

It is located on a watershed in Hawkesbury Sandstone in an area with only pillar extraction in the Bulli Seam and is approximately 790m ENE of the proposed eastern end of Longwall 6 in the Wongawilli Seam and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6 (340m).

No pre-existing tension cracks are present close to NRE B, and its shows a low degree of vertical conductivity.

The VWP array is located approximately 515m north east of Cataract Creek.

An elevated phreatic surface is present to approximately 43mbgl (RL330m) which is likely to be contributing to base flow in Cataract Creek, however the profile is essentially depressurised at 63mbgl as shown in **Figure 8-11**.

The VWP array has an overall low responsiveness to rainfall.

Pore pressures in the Hawkesbury Sandstone are perched well above the level of Cataract Creek and the Cataract Reservoir, whilst pore pressure in the Bulgo Sandstone is below the 289.87mAHD Full Supply Level (FSL) of Cataract Reservoir.

The VWP array did not respond to extraction of Longwall 4, 5 or 6 due to its separation distance from the workings.

The bore does not extend deep enough to assess the height of depressurisation, however, the data indicates there is a downward hydraulic gradient, although the hydraulic properties of the overburden is sufficiently low to generate a very small downward flow component.

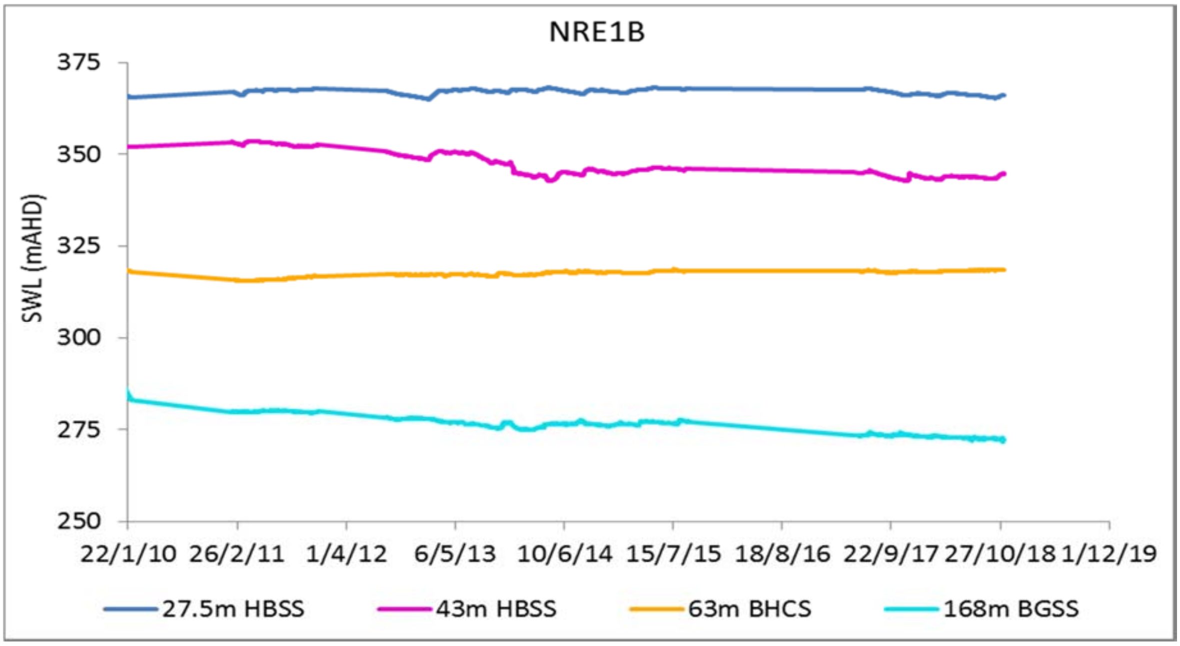


Figure 8-11 NRE B

8.3.7 NRE D

NRE D was installed in December 2009 to a depth of 160mbgl into the Bulgo Sandstone.

It is located on a watershed in Hawkesbury Sandstone in an area with limited pillar extraction in the Bulli Seam and is approximately 1650m north of Longwall 6 (340m) and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6 (340m).

No pre-existing tension cracks are present close to NRE D, and its shows a low degree of vertical conductivity.

The VWP array is located approximately 1030m north of Cataract Creek and 575m east of the full storage level of Cataract Reservoir.

Insufficient shallow depth VWP intakes are present to assess the presence of an elevated phreatic surface, as the shallowest intake lies at 70mbgl as shown in **Figure 8-12**.

The VWP array has an overall low responsiveness to rainfall at 70mbgl in the Hawkesbury sandstone, and a moderate responsiveness at 90 and 110mbgl.

Pore pressures in the Hawkesbury Sandstone are perched at approximately 5m above the Cataract Reservoir 289.87mAHD Full Supply Level (FSL) in the 90mbgl intake.

The VWP array did not respond to extraction of Longwall 4, 5 or 6 (340m) due to its separation distance from the workings.

The bore does not extend deep enough to assess the height of depressurisation, however, the data indicates there is a downward hydraulic gradient, with the overburden hydraulic properties being sufficiently low to generate a very small downward flow component.

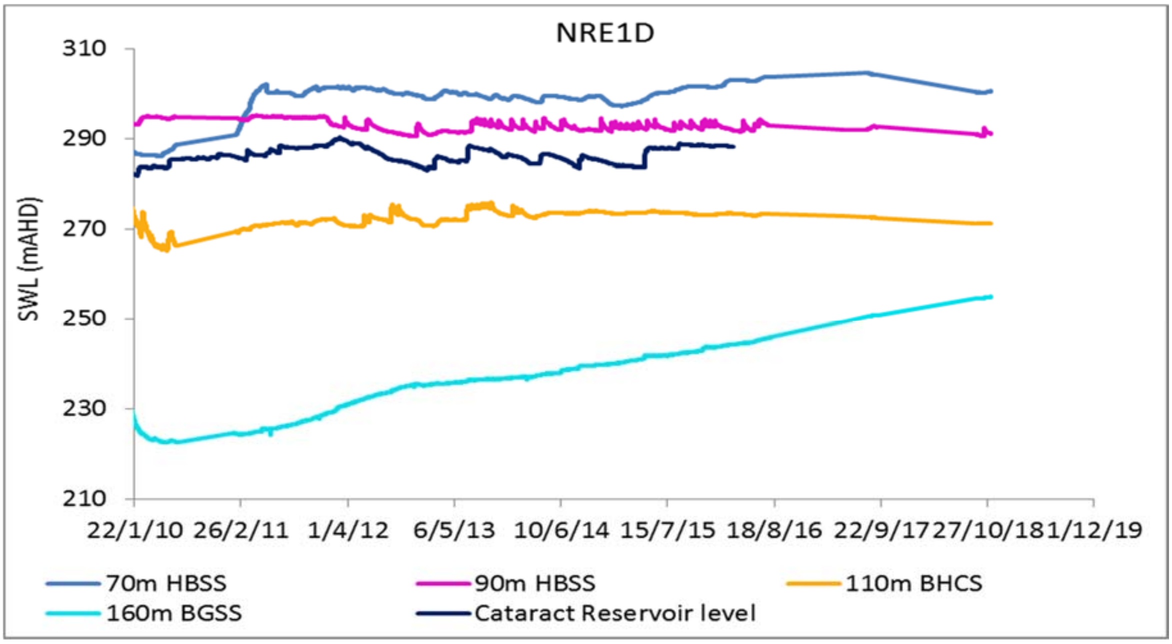


Figure 8-12 NRE D

8.3.8 RV23 (VWP)

RV23 (VWP) was installed in late November 2014 to a depth of 220mbgl into the Scarborough Sandstone.

It is located approximately 85m east of Cataract Reservoir FSL in the Bald Hill Claystone in an area of first workings extraction within the Corrimal Colliery.

No pre-existing tension cracks are present close to RV23, and its shows a low degree of vertical conductivity.

It is located approximately 1570m north west of Wongawilli Seam Longwall 6 (340m) and is well outside the area of depressurisation influence from Longwall 4, 5 or 6.

It has an essentially hydrostatic head increase down to 90mbgl, below which a marked drop in pressure is observed, with no evident perched water table. It also has a rise in head pressures between the 200 and 220mbgl intake depths.

The VWP array has a low responsiveness to rainfall as shown in **Figure 8-13**.

The array did not respond to extraction of Longwalls 4, 5 or 6 due to its large separation distance from the workings.

The height of depressurisation lies between 197 and 242mbgl at RV23.

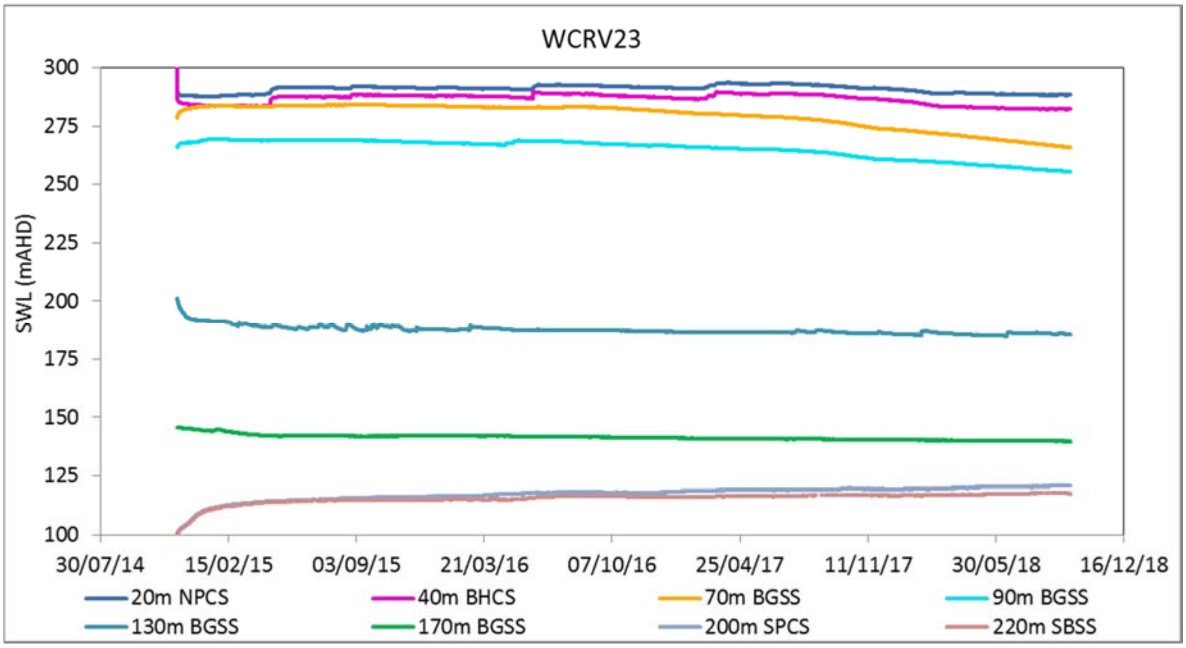


Figure 8-13 RV23 (VWP)

8.3.9 NRE3 (Wonga West)

NRE3 is located approximately 1,300m west of Cataract Reservoir and was installed in mid December 2009 to a depth of 255mbgl into the Bulgo Sandstone over Bulli Seam Longwalls.

No pre-existing tension cracks are present close to NRE3, and its shows a low degree of vertical conductivity.

It is located on the opposite side of the reservoir and is well outside the area of depressurisation influence from Longwalls 4, 5 or 6.

The VWP array is located approximately 190m west of Lizard Creek.

Insufficient shallow depth VWP intakes are present to assess the presence of an elevated phreatic surface, as the shallowest intake lies at 100mbgl.

It has an essentially hydrostatic pressure gradient from 100mbgl (Upper Hawkesbury Sandstone) to 155mbgl (Lower Hawkesbury Sandstone), with a decrease away from hydrostatic from 155mbgl to the Bulgo Sandstone at 255mbgl as shown in **Figure 8-14**.

The VWP array has a moderate responsiveness to rainfall in the 130mbgl and 155mbgl intake depths.

The array did not respond to extraction of Longwall 4, 5 or 6 (340m) due to its very large separation distance from the workings, whilst its height of depressurisation was not established below the deepest intake of 255mbgl.

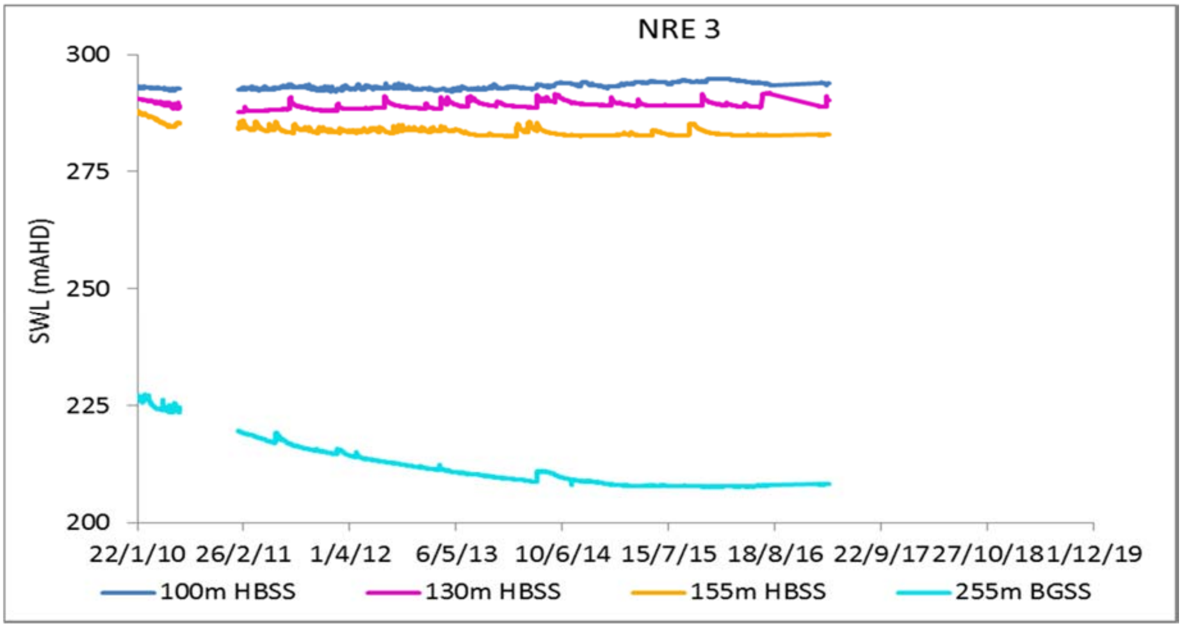


Figure 8-14 NRE3

8.4 Mine Water Pumping

This section outlines an adaptation of a mine water balance and groundwater assessment conducted by SCT Operations (2019).

All three seams dip to the west towards a low point in the 200 series longwall panels, which are located to the west of Cataract Reservoir.

The natural pathway for water flow underground is from the outcrop on the Illawarra Escarpment down to the low point in the 200 series longwall panels. However, because of the irregular nature of the lease boundaries and the various panels within the mine, there are numerous underground storages created where water is impounded behind coal barriers within the mine and between mines.

Water is removed from the mine by active pumping and through passive means either by moisture content in coal removed from the mine and within ventilation system exits. Water within the mine workings occurs through groundwater entry to excavated areas and through the use of potable water for dust suppression and general service underground during periods of active mining.

The removal of water through pumping has two main components. Water is removed from the Bulli Seam where everything captured in-bye from the old South Bulli Mine plus some of the trickle down through the overburden strata that occurs above Longwalls 4, 5 and 6 (340m). This outlet also captures water in the Balgownie Seam which is pumped from 48 cut-through (C/T) to 27 C/T as shown in **Figure 8-15**.

It is also considered likely that there is some inflow through the barriers from Corrimal, Cordeaux, and Old Bulli mining area, but it is not possible for these various components be differentiated from the flows that come from South Bulli. It is estimated that total leakage from other background mining areas is in the order of 0.2 ML/day and is likely to be dominated by leakage across the barrier with Cordeaux where down dip areas are believed to be flooded.

The removal of water from the Wongawilli Seam is from the main sump at 18 ½ C/T through to 12 ½ C/T and then via the Wongawilli portal. This captures some of the flow from up dip in the Bulli and Balgownie that makes its way down through the Wongawilli Seam goaf and through to the southern (in-bye) end of Longwalls 4 and 5.

The volumetric recording of flows of water removed from the mine is calculated from the pump hours which have had flow rates calibrated to running pump rates. Active pumping is not continuous and the periodic pump operation means that the measured pump rates recorded daily are extremely variable and the recognition of trends has been undertaken using averaged data over weekly and monthly periods.

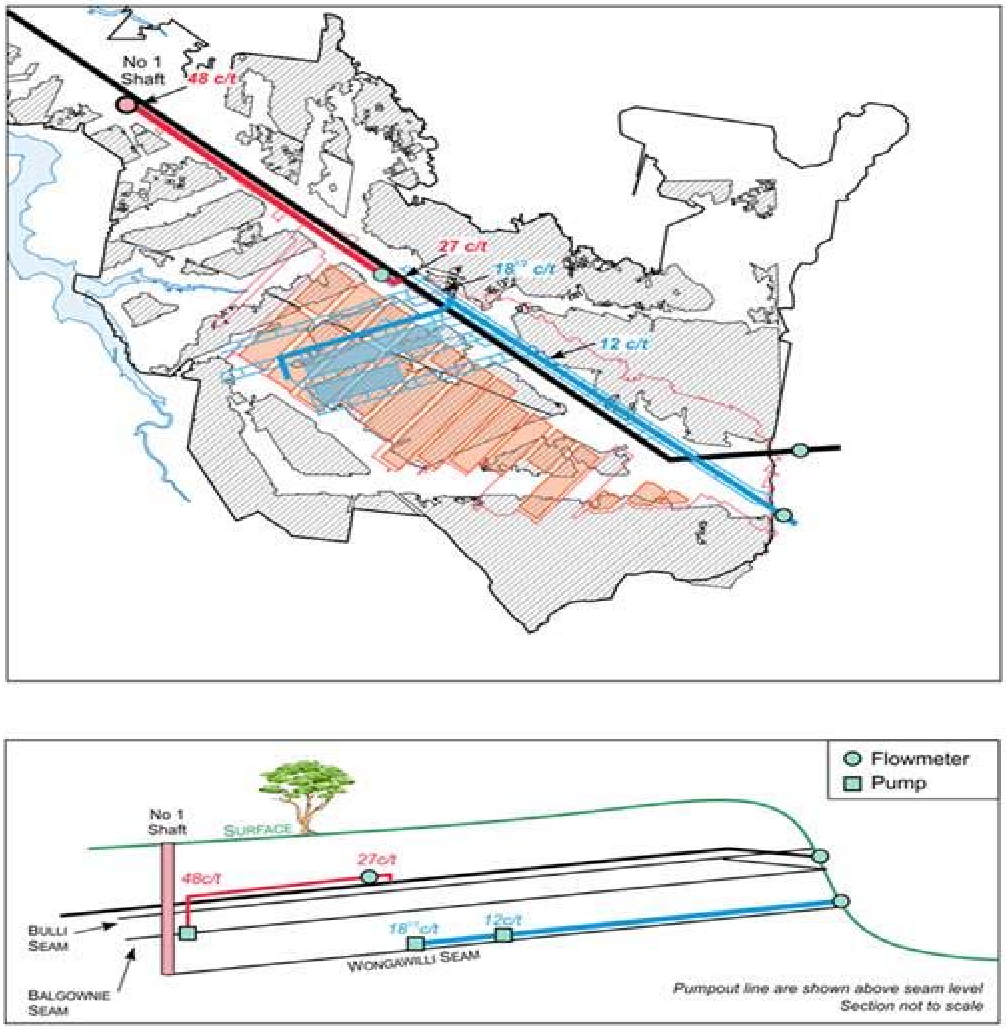


Figure 8-15 Underground Water Management Schematic

Investigation into the dynamics of the various inflow components has led to an improved understanding of these trends. Groundwater make to the mining areas increases as would be expected with down dip mining progression in the Wongawilli Seam. However recent scrutiny of the various components of the water inflow totals has shown that there is a component of the inflow variability which can be partially correlated to rainfall trends. This is particularly the case for the Bulli Seam component where a correlation can be seen as shown in **Figure 8-16** albeit with some time lag that suggests a tortuous flow path.

In the Wongawilli Seam, the inflow data suggests that rainfall recharge has an influence, however this is likely to be coincidental as increases in the flow rates also align with the mining progression down dip into saturated strata. Detailed rainfall trends are not absolutely reflected in the flow rates emanating from the Wongawilli Seam and are more representative of mining progression, however as there is a small amount of water from the Bulli Seam making its way to the Wongawilli Seam through the fracture zone, it may account for some of the small scale inflow variability along with the variable pump rates.

Water flowing from up dip flows into these underground storages until they become full and overtop allowing flow to continue down into the lowest point in the mine. Over time, all the storage areas have filled up and so any additional flow occurs through a chain-of-ponds along each of the barriers. A similar process is occurring in the Bulli and Corrimal Collieries.

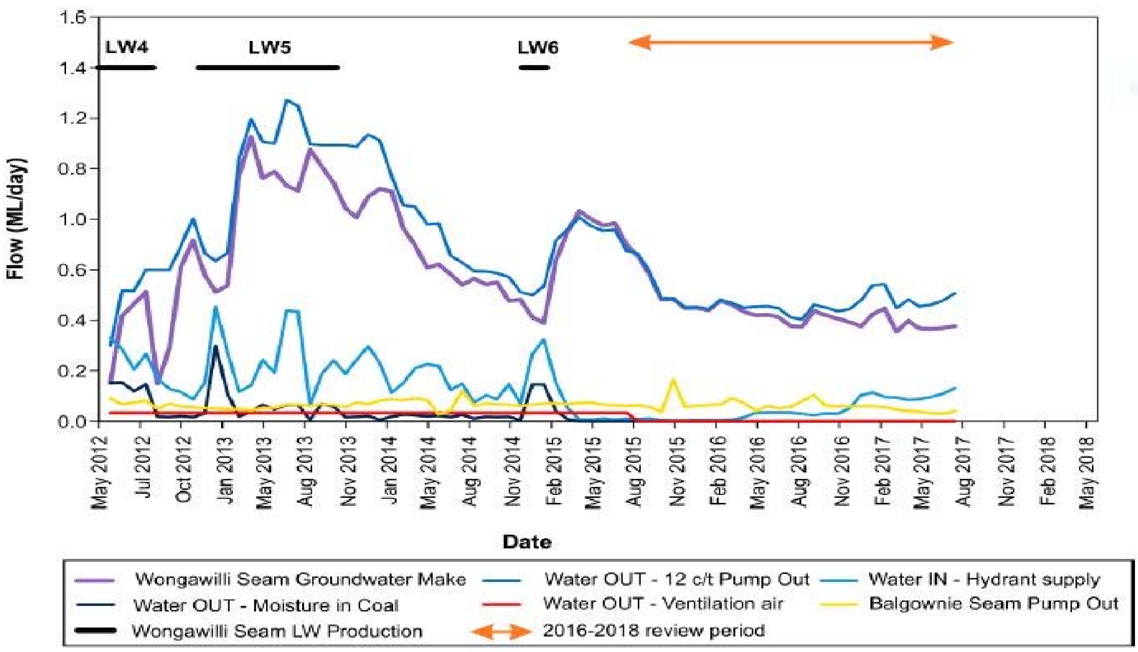


Figure 8-16 Wongawilli Seam Mine Water Pump Out

8.4.1 200 and 300 Series Longwalls West of Cataract Reservoir

It is assessed there is no free drainage through the Bald Hill Claystone at Russell Vale West, as the existing workings are currently depressurised and essentially dry, although ponded water is present in a syncline in the central, southern section of the 200 series longwalls as well as within the South32 Cordeaux workings (S Wilson, pers comm.).

Monitoring of mine water pump-out from workings to the west of Cataract Reservoir, along with observations from underground supervisors (SCT Operations, 2019) indicate there is no short term increase in mine water make from the current workings following significant rain in the Lizard and Wallandoola Creek catchments.

Monitoring of water level trends in piezometers over the 200 and 300 series longwalls indicates the upper Hawkesbury Sandstone does not have an enhanced response to rainfall recharge.

8.4.2 Current Workings East of Cataract Reservoir

It is assessed there is no free drainage into the existing workings to the east of Cataract Reservoir as they are currently depressurised and essentially dry apart from a few small ponding areas at the down dip end of the old workings where the dewatering pump is not able to extract the water, until it “spills” into a downgradient section of the workings (SCT Operations, 2019).

Monitoring of water pump-out from the Russell Vale East workings indicates there is no observed associated short term increase in mine water make from the current Russell Vale East workings following significant rain in the Cataract Creek, Cataract River or Bellambi Creek catchments.

8.4.3 Mine Water Pumping Volumes

The total mine water pumping rate from the Wongawilli Seam, which is the lowest drainage point in Russell Vale Colliery, peaked at around 1.3ML/day (475L/yr) as shown in **Figure 8-16** and has since reduced to 0.4ML/day (SCT Operations, 2019).

Of the total mine water pump out volumes, inflows entering the Russell Vale mine (i.e. not related to strata groundwater seepage generated within the Russell Vale Colliery lease area) comprised approximately;

- 0.14 ML/day background inflow from Wongawilli Seam first workings;
- 0.17 ML/day background inflow from Longwall 4 and 5 goafs (primarily Longwall 4) from the previously mined Bulli / Balgownie workings;
- 0.07ML/day from Longwall 6, and;
- during active mining periods, an average of 0.15ML/day pumped into the mine for dust suppression, drilling operations and other purposes (with a peak of 0.35ML/day during Longwall production periods) minus 0.1 to 0.3 ML/day of moisture extracted from the mine in coal product when the mine is in production, with less than 0.02ML/day extracted at other times.

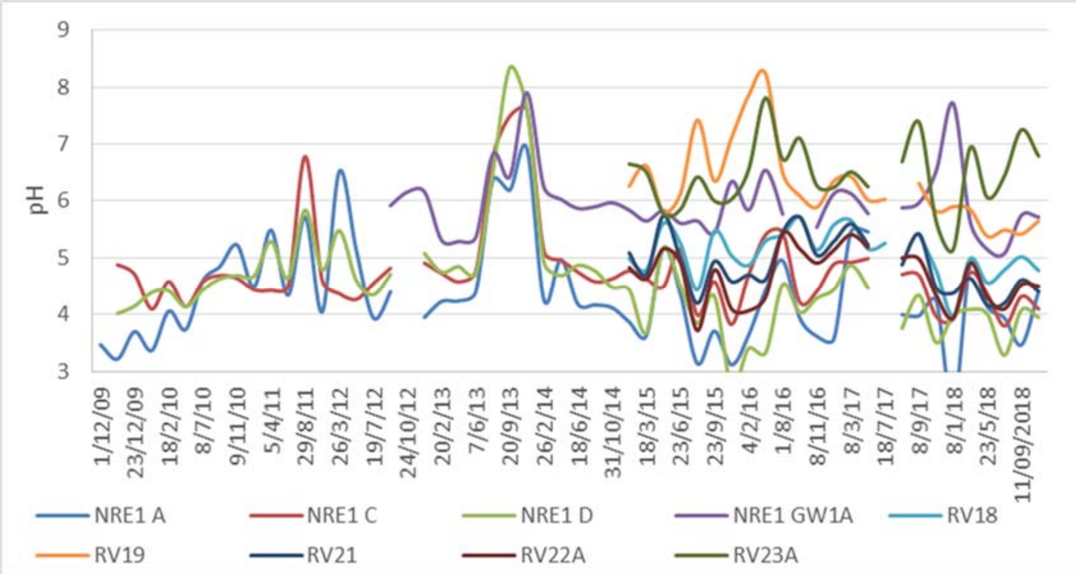
8.5 Groundwater Chemistry

Based on data supplied by WCL, groundwater in the Hawkesbury Sandstone at Russell Vale East ranges from 76 - 776μS/cm with a pH from 3.2 – 6.8 as shown in **Figure 8-17**.

The moderate pH acidification and low salinity indicate meteoric rainfall recharge into the Hawkesbury Sandstone, with the salinity and pH range being typical of similar lithologies in the Southern Coalfields. It is noted that the pH readings monitored between August and December 2013 are anomalously alkaline and may be inaccurate.

On the basis that the shallow groundwater discharges through seeps into the local streams, monitoring indicates the groundwater salinity is generally within the acceptable range for potable water, however it is predominantly outside the ANZECC 2000 South Eastern Australia Upland Stream criteria for pH and can be above the ANZECC 2000 95% Species Protection Level for Freshwater Aquatic Ecosystem Guidelines for:

- filtered copper, lead, zinc and aluminium (where the pH exceeds 6.5, which rarely occurs), as well as;
- total nitrogen and total phosphorus.



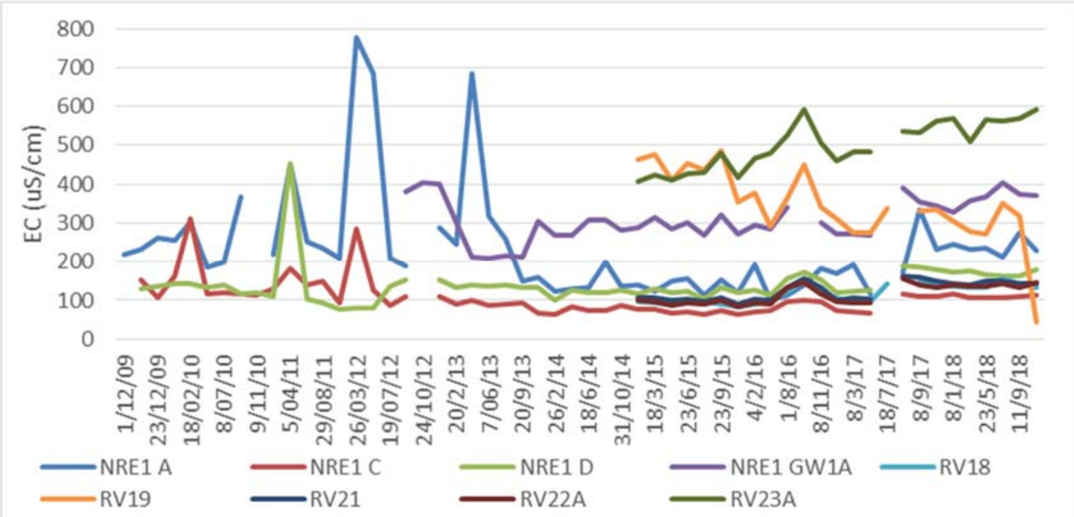


Figure 8-17 Russell Vale East Hawkesbury Sandstone Salinity and pH

Further detailed analysis of groundwater chemistry in the Russell Vale East area is contained in GeoTerra (2017) and WCL Ltd (2017).

9. GROUNDWATER MODELLING

9.1 Background

A number of groundwater modelling studies have been undertaken within the Russell Vale Underground Expansion Project (UEP) area.

A FEFLOW groundwater model and associated interpretation was reported in GeoTerra (2012B) which assessed proposed mining in both the Russell Vale West and Russell Vale East areas.

Subsequently, a revised mine plan within Russell Vale East (Longwalls 1-7 and 9-11) was assessed via a MODFLOW SURFACT groundwater model for the UEP Preferred Project Report (PPR) in GeoTerra / GES (2014).

Finally, a third model and associated report was developed by GeoTerra / GES (2015) in response to State and Federal regulatory review of the proposed development, culminating in the PAC review, and incorporated additional piezometer installations and groundwater monitoring duration.

This version of the MODFLOW SURFACT modelling and associated reporting was conducted following review of the previous state and federal assessments and assesses the potential impacts of a first workings only extraction in the Wongawilli Seam within a bord and pillar layout, following extraction of Longwalls 4, 5 and 6 (340m).

The current model structure, approach and simulations generated by Groundwater Exploration Services (GES) in association with GeoTerra Pty Ltd are detailed in the following sections.

9.2 Model Code and Complexity

Numerical modelling has been undertaken using the Groundwater Vistas software interface (Environmental Simulations) in conjunction with MODFLOW-SURFACT (Hydrogeologic).

MODFLOW-SURFACT is an advanced version of the MODFLOW code.

This version builds on previous MODFLOW SURFACT Russell Vale groundwater models and incorporates the “Pseudo Soil” option to simulate the unsaturated zone.

The groundwater model is of Moderate Complexity (under the MDBC Guidelines) with a Class 2 Confidence Level (under the NWC guidelines).

It provides an assessment of the existing groundwater system status and predicts the potential effects from extraction of the proposed workings.

The key objective of the model is to simulate the current and proposed first workings (bord and pillar) mining within the Wongawilli Seam in the Russell Vale East area, and to understand the effects to the groundwater and surface water environment in a local and regional context.

There is extensive pre-existing depressurisation from existing workings at Russell Vale, as well as the adjoining Cordeaux, Corrimal and Bulli mines as a result of mining activities over many decades starting from the late 1800s, along with a long hiatus since mining activities in the Russell Vale East area after the Balgownie Seam was mined by longwalls in the 1970s.

9.3 Model Domain

The spatial relationship of the proposed and the existing workings within the groundwater modelling domain is shown in **Figure 1-1**.

9.4 Conceptual Hydrogeological Model

A conceptual model of the Russell Vale lease area hydrogeological regime has been developed based on a review of existing hydrogeological data as described in **Section 8** and a conceptual model shown in **Figure 9-1** based on the Southern Coalfield 1:100,000 geology mapping, mine seam mapping and geological drill logs available from within the Russell Vale lease area.

It should be noted that the modelling, of necessity, requires simplification of the regional and local groundwater system in regard to strata lithological thicknesses, hydraulic properties and applied stresses including previous subsidence, rainfall infiltration, creek leakage and underground seepage.

It is assumed that any water carried by the limited extent and duration of flow in ephemeral streams would have a negligible contribution to groundwater recharge via leakage from the stream bed.

Cataract Reservoir is incised into the Bald Hill Claystone in the deepest sections of the storage adjacent to the proposed mining area, whereas the periphery, edge and banks of the reservoir are predominantly within the Newport and Garie Formations and subsequently at higher elevations, in Hawkesbury Sandstone.

The outcropping upper catchments and stream beds are sequentially incised down the stream thalweg into Hawkesbury Sandstone, Newport and Garie Formations, Bald Hill Claystone Formation and the Bulgo Sandstone.

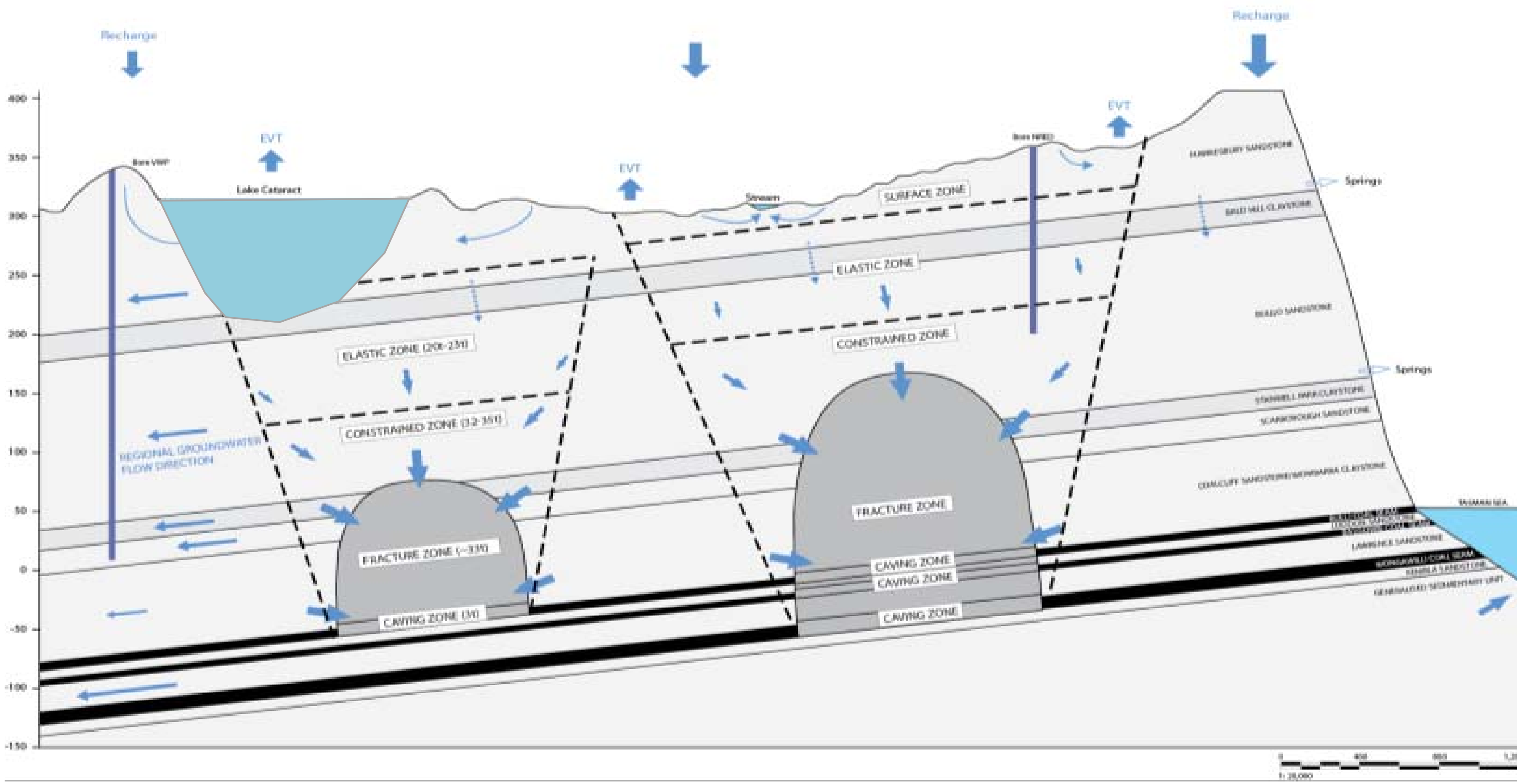


Figure 9-1 Conceptual Groundwater Model

Input data has also been gathered from geological and hydrogeological assessments undertaken for the Appin, West Cliff, Dendrobium and other Southern Coalfield mine lease areas.

Lithological layer depths and thicknesses within the Russell Vale lease area were based on in-situ piezometer and coal exploration drilling results and drilling data sourced from other Southern Coalfield projects.

Six conceptual groundwater sub-domains are present:

- intermittent to ephemeral, hydraulically disconnected (perched) upland swamps which provide limited and intermittent baseflow to local streams;
- a perched, weathered Hawkesbury Sandstone profile which provides ephemeral baseflow to the local streams.
- the deeper Hawkesbury Sandstone, which is hydraulically separated from the overlying Quaternary sediments and weathered sandstone perched aquifers as well as from the underlying Bulgo Sandstone at Russell Vale West, although not at Russell Vale East, both before and after subsidence. Following mining, as has been observed in the piezometers to the east of the reservoir, the groundwater levels exhibit a heightened response to recharge and increased recharge due to higher subsidence related secondary porosity, as well as interconnected permeability of the aquifers;
- the Narrabeen Group sedimentary lithologies, which have already been locally fractured and depressurised above the existing workings up to the mid to lower Bulgo Sandstone, and are anticipated to be fractured and partially depressurised over the proposed Wongawilli Seam longwall workings up to the mid to upper Bulgo Sandstone;
- the Illawarra Coal Measures, which contain the Bulli, Balgownie and Wongawilli Seam aquifers, which have also been fractured and depressurised by the existing workings and will be locally fractured and depressurised by the proposed workings; and
- the sedimentary sequence underneath the Wongawilli Seam.

The model was set up to represent both the existing undisturbed strata lithologies and Bulli / Balgownie Seam subsidence affected areas, as well as to account for the anticipated change in hydraulic properties following extraction of the proposed Wongawilli Seam first workings.

The existing Russell Vale Colliery workings within the model in the Bulli Seam were assumed to be partially flooded in the central southern section of the mine area to the west of Cataract Reservoir, as well as in the Cordeaux workings, and partially flooded in the Bulli Colliery bord and pillar workings. This is based on reported ponded areas within the Bulli Seam in the Russell Vale West area and estimated ponding levels within the Corrimal workings.

Drain cell stages were limited to elevations above the seam allowing for ponding to occur.

Russell Vale West drains were limited to -140m AHD and Corrimal drains were limited to -95m AHD, which has led to minor ponding within the seam and has removed dry cells from these areas. However, the levels are marginally higher than the base of the layers and have not led to wholesale flooding in any area.

Where the workings are dry, they were modelled with seepage boundaries with head levels set to the elevation of the mine floor to simulate atmospheric pressure effects.

The adjoining Cordeaux and Bulli workings were assumed to be separated from Russell Vale Colliery by at least a 40m wide intact coal barrier.

9.5 Model Layers

Nineteen layers are conceptualised for the purpose of numerical modelling as shown in **Table 3**.

The major sandstone formations (Hawkesbury and Bulgo) are split into multiple layers in order to reproduce natural or subsidence induced variations to vertical hydraulic gradients.

In the mid-reach of Cataract Creek, the Hawkesbury Sandstone and underlying Newport / Garie Formation and the Bald Hill Claystone have been eroded away to expose the Bulgo Sandstone. Where this occurs, the appropriate hydraulic parameters have been propagated into overlying layers where each unit outcrops.

As a result, although Layer 1 is dominated by the upper Hawkesbury Sandstone, it also contains the Newport / Garie Formation, Bald Hill Claystone and upper Bulgo Sandstone in the eroded reach of Cataract Creek.

Similarly, but to a sequentially lesser degree, the mid and lower Hawkesbury Sandstone in Layers 2 and 3 are also eroded in the reach of Cataract Creek near the freeway, so these layers also contain the Newport / Garie Formation, Bald Hill Claystone and upper Bulgo Sandstone.

Layer 4, which predominantly contains the Bald Hill Claystone also contains the upper Bulgo Sandstone in the eroded reach of Cataract Creek.

All subsequent underlying layers contain one lithology.

Table 3 Model Layers

Layer	Unit
1	Upper Hawkesbury Sandstone + NGF + BHCS +UBS
2	Mid Hawkesbury Sandstone + NGF + BHCS +UBS
3	Lower Hawkesbury Sandstone + NGF + BHCS +UBS
4	Bald Hill Claystone +UBS
5	Upper Bulgo Sandstone
6	Mid Bulgo Sandstone
7	Mid Bulgo Sandstone
8	Lower Bulgo Sandstone
9	Stanwell Park Claystone
10	Scarborough Sandstone
11	Wombarra Claystone
12	Coal Cliff Sandstone
13	Bulli Seam
14	Loddon Sandstone
15	Balgownie Seam
16	Lawrence Sandstone
17	Wongawilli Seam
18	Kembla Sandstone
19	Basement

NOTE: NGF = Newport / Garie Formation BHCS = Bald Hill Claystone UBS = Upper Bulgo Sandstone

9.6 Boundary Conditions

The model areal extent has been chosen so the peripheral boundary conditions are of a sufficient distance from the proposed workings to significantly reduce the potential for a change in flow conditions across the model boundaries as a result of the Project.

The boundary conditions at the periphery of the model consist of:

- general head boundaries representing active mining areas in the Wongawilli Seam including Appin (to the north) in the Bulli Seam and Dendrobium in the Wongawilli Seam in the south;
- constant head boundaries representing the coast line to the east of the escarpment and coastal plain;
- no-flow boundaries at topographic divides representing the western boundary of the model domain;
- historic mining areas, principally within the Bulli Seam, as represented by the Drain Package in MODFLOW-SURFACT, have been conceptualised to remain as regional

hydrogeological sinks, and;

- drainage channels which were simulated using the River Package. River stages (RBOT) were set 1m above base of surficial layer to allow the package to act as drainages, with their conductance set to $5m^2$/day to allow the aquifer hydraulic properties to control leakage to and from the model. While this is acknowledged as not appropriate for the upper, ephemeral reaches of Cataract Creek, it is assessed as appropriate in the perennial reaches, which is where the focus was applied to address potential changes to drainage as a result of the proposal.
- WaterNSW reservoirs, Cataract Reservoir and Cordeaux Reservoir were also simulated utilising (Steady State) River Package boundary cells with levels set at 290m AHD and 305m AHD respectively.

Groundwater head pressures in Vibrating Wire Piezometer (VWP) arrays and standing water level data from open standpipe piezometers within the Russell Vale lease area were used as a basis for initial conditions, whilst groundwater levels over the Cordeaux and Bulli workings were approximated, as no direct data was available from these locations.

Direct measurements of hydraulic parameters from bores within the Russell Vale lease area were used, and where data was unavailable, approximated parameters were sourced from other studies as starting points for calibration. Other projects include the South32 workings to the north at Appin (Heritage Computing, 2010) and to the south at Dendrobium (Coffey Geotechnics, 2012).

Underground dewatering was represented by inclusion of the proposed mine voids in the Bulli, Balgownie and Wongawilli Seams through the use of drains as well as incorporating the associated changes in overburden hydraulic parameters in the overlying sedimentary units due to subsidence.

9.7 Recharge and Evapotranspiration

Recharge was set at 4% of rainfall from BOM Silo data for Cataract Dam across the majority of the model domain and to 6% over the elevated terrain west of the escarpment and coastal plain.

Evapotranspiration was applied uniformly to the model with rate of 0.005 m/d and an extinction depth of 4m.

9.8 Grid

A variable cell size is employed across the model domain which contains a total of 1,021,183 active cells.

A grid size of 250m x 250m occupies the periphery of the model domain, reducing to 100m x 100m nearer to the Russell Vale lease area, then 50m x 50m over most of Wollongong Coal Lease area and further reduced to 50m x 25m in an east – west alignment overlying the main channel of Cataract Creek.

While the potential impacts from the mining activities relate to regional scale effects, experience has shown that providing more detailed grid discretisation has no significant impact on predicted mine inflows or groundwater levels, as long as a mine plan can be appropriately represented.

However, the adopted grid refinement allowed for improved detailing of the mine plan scheduling and increased accuracy surrounding baseflow effects in creeks overlying the Russell Vale East area.

The changes in grid size obeyed the 50% convention rule regarding changes between grid size between rows and columns with minimum ratio of cell size change being 0.75 (Environmental Simulations Inc. 2009).

9.9 Mining Schedule

The adopted mine schedule for the historic development and extraction within the Bulli and Wongawilli seams is shown in **Table 4**.

The model start date is 1/1/1993, whilst the calibration period is from 1/1/1993 to 28/2/2014.

This includes the 500 series longwalls in Russell Vale West within the Bulli seam in 1993 and the initial mine development in the Wongawilli Seam at Russell Vale East, which began in early 2011.

The interim period included a long period where no significant mining activities occurred.

The recovery period includes the subsequent 200 years to 31/12/2223.

Detailed time stepping has been used to simulate the Wongawilli Seam development and mining progression in the Russell Vale East area which is shown in **Figure 9-2**.

In order to investigate the incremental effects of mining, the predicted operational mining impacts and the post mining recovery have been assessed in accordance with the adopted schedule.

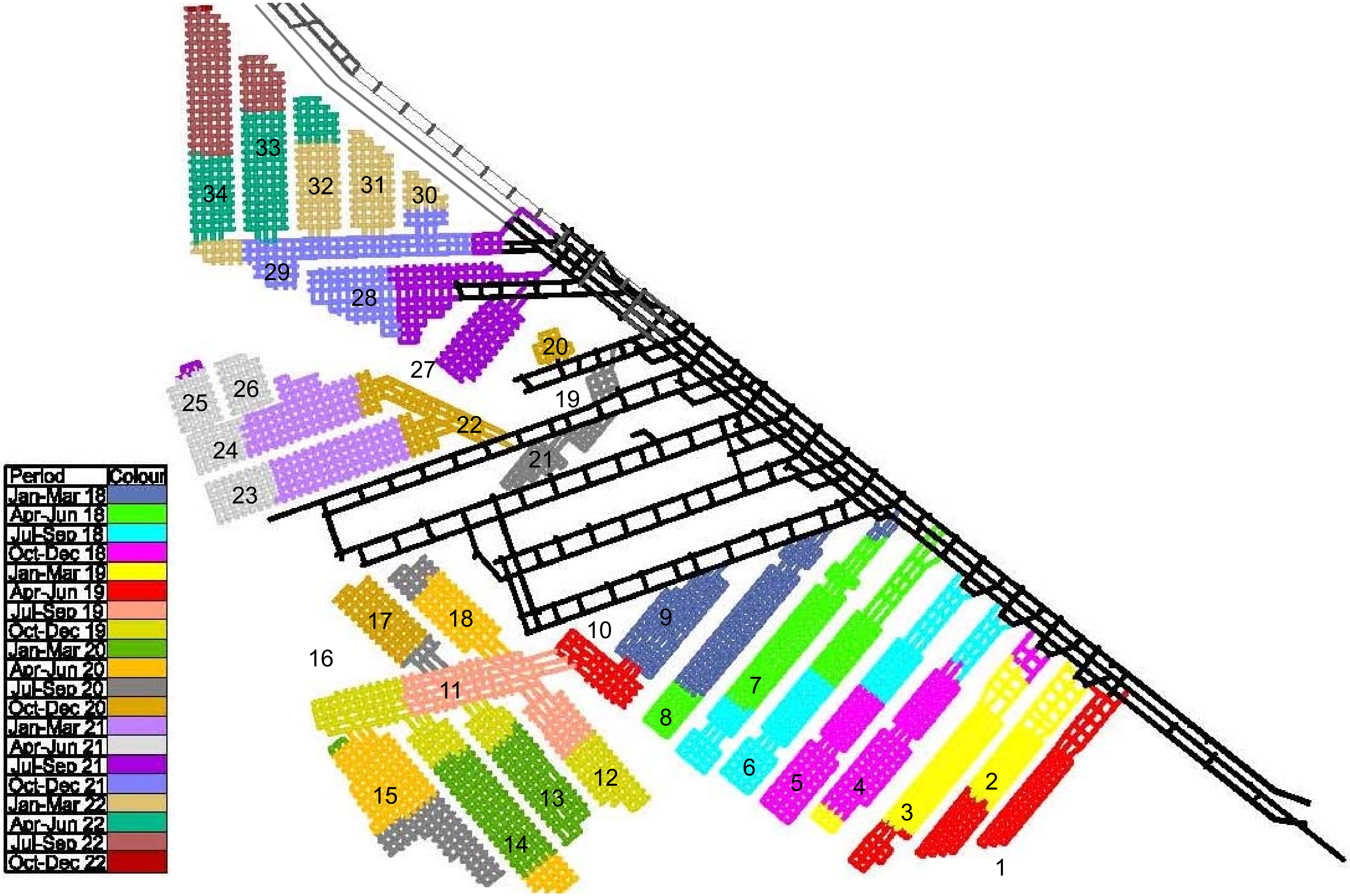


Figure 9-2 Mining Schedule in Wongawilli Seam

Table 4 Impact Assessment Mine Schedules

Model Type	Purpose	SP	SP_START	SP_END	DAYS	start day	end day	Wonga East Develop Heading	Wonga East LW Panels and FW Mining Areas	Wonga West	Cordeaux	All Other Bulli Seam Mines
Steady State	'PRE-MINING'	1	01-Jan-91	31-Dec-92	731	0	731				modelled as constant	modelled as constant
Transient Calibration	HISTORIC	2	1/01/1993	11/07/1993	192	732	923					
	HISTORIC	3	12/07/1993	13/12/1993	155	924	1078			501	Turn off DRN	Turn off DRN
	HISTORIC	4	14/12/1993	18/05/1994	156	1079	1234			502		
	HISTORIC	5	19/05/1994	28/09/1994	133	1235	1367			503		
	HISTORIC	6	29/09/1994	6/02/1995	131	1368	1498			504		
	HISTORIC	7	7/02/1995	19/06/1995	133	1499	1631			505		
	HISTORIC	8	20/06/1995	26/11/1995	160	1632	1791			506		
	HISTORIC	9	27/11/1995	16/08/1996	264	1792	2055			507		
	HISTORIC	10	17/08/1996	25/05/1997	282	2056	2337			508		
	HISTORIC	11	26/05/1997	31/12/1997	220	2338	2557			509		
	HISTORIC	12	1/01/1998	31/12/1998	365	2558	2922					
	HISTORIC	13	1/01/1999	31/12/1999	365	2923	3287					
	HISTORIC	14	1/01/2000	31/12/2000	366	3288	3653					
	HISTORIC	15	1/01/2001	31/12/2001	365	3654	4018					
	HISTORIC	16	1/01/2002	31/12/2002	365	4019	4383					
	HISTORIC	17	1/01/2003	31/12/2003	365	4384	4748					
	HISTORIC	18	1/01/2004	31/12/2004	366	4749	5114					
	HISTORIC	19	1/01/2005	31/12/2005	365	5115	5479					
	HISTORIC	20	1/01/2006	31/12/2006	365	5480	5844					

Model Type	Purpose	SP	SP_START	SP_END	DAYS	start day	end day	Wonga East Develop Heading	Wonga East LW Panels and FW Mining Areas	Wonga West	Cordeaux	All Other Bulli Seam Mines
	HISTORIC	21	1/01/2007	31/12/2007	365	5845	6209					
	HISTORIC	22	1/01/2008	31/12/2008	366	6210	6575					
	HISTORIC	23	1/01/2009	31/12/2009	365	6576	6940					
	HISTORIC	24	1/01/2010	31/12/2010	365	6941	7305					
	HISTORIC	25	1/01/2011	31/03/2011	90	7306	7395	Mains		Turn off DRN		
	HISTORIC	26	1/04/2011	30/06/2011	91	7396	7486	Mains				
	HISTORIC	27	1/07/2011	31/12/2011	184	7487	7670	MG4				
	HISTORIC	28	1/01/2012	31/03/2012	91	7671	7761	TG4				
	HISTORIC	29	1/04/2012	31/05/2012	61	7762	7822	TG5				
	HISTORIC	30	1/06/2012	31/07/2012	61	7823	7883					
	HISTORIC	31	1/08/2012	31/08/2012	31	7884	7914		LW4			
	HISTORIC	32	1/09/2012	31/10/2012	61	7915	7975					
	HISTORIC	33	1/11/2012	31/12/2012	61	7976	8036					
	HISTORIC	34	1/01/2013	14/02/2013	45	8037	8081					
	HISTORIC	35	15/02/2013	31/03/2013	45	8082	8126					
	HISTORIC	36	1/04/2013	31/05/2013	61	8127	8187					
	HISTORIC	37	1/06/2013	31/07/2013	61	8188	8248					
	HISTORIC	38	1/08/2013	14/08/2013	14	8249	8262		LW5			
	HISTORIC	39	15/08/2013	31/08/2013	17	8263	8279					
	HISTORIC	40	1/09/2013	14/09/2013	14	8280	8293	TG6				
	HISTORIC	41	15/09/2013	30/09/2013	16	8294	8309					
	HISTORIC	42	1/10/2013	14/10/2013	14	8310	8323					
	HISTORIC	43	15/10/2013	31/10/2013	17	8324	8340					

Model Type	Purpose	SP	SP_START	SP_END	DAYS	start day	end day	Wonga East Develop Heading	Wonga East LW Panels and FW Mining Areas	Wonga West	Cordeaux	All Other Bulli Seam Mines
	HISTORIC	44	1/11/2013	14/11/2013	14	8341	8354					
	HISTORIC	45	15/11/2013	30/11/2013	16	8355	8370					
	HISTORIC	46	1/12/2013	14/12/2013	14	8371	8384					
	HISTORIC	47	15/12/2013	31/12/2013	17	8385	8401					
	HISTORIC	48	1/01/2014	28/02/2014	59	8402	8460					
	HISTORIC	49	1/03/2014	30/06/2014	122	8461	8582					
	HISTORIC	50	1/07/2014	30/09/2014	92	8583	8674	TG7				
	HISTORIC	51	1/10/2014	31/12/2014	92	8675	8766	Mains	LW6			
	HISTORIC	52	1/01/2015	28/02/2015	59	8767	8825					
	HISTORIC	53	1/03/2015	30/06/2015	122	8826	8947					
	HISTORIC	54	1/07/2015	30/09/2015	92	8948	9039					
	HISTORIC	55	1/10/2015	31/12/2015	92	9040	9131					
	HISTORIC	56	1/01/2016	31/03/2016	91	9132	9222					
	HISTORIC	57	1/04/2016	30/06/2016	91	9223	9313					
	HISTORIC	58	1/07/2016	30/09/2016	92	9314	9405					
	HISTORIC	59	1/10/2016	31/12/2016	92	9406	9497					
	HISTORIC	60	1/01/2017	31/03/2017	90	9498	9587					
	HISTORIC	61	1/04/2017	30/06/2017	91	9588	9678					
Prediction	IMPACT	62	1/07/2017	30/09/2017	92	9679	9770					
	IMPACT	63	1/10/2017	31/12/2017	92	9771	9862					
	IMPACT	64	1/01/2018	31/03/2018	90	9863	9952		8,9,30			
	IMPACT	65	1/04/2018	30/06/2018	91	9953	10043		6, 7			
	IMPACT	66	1/07/2018	30/09/2018	92	10044	10135		E4, E5			

Model Type	Purpose	SP	SP_START	SP_END	DAYS	start day	end day	Wonga East Develop Heading	Wonga East LW Panels and FW Mining Areas	Wonga West	Cordeaux	All Other Bulli Seam Mines
	IMPACT	67	1/10/2018	31/12/2018	92	10136	10227					
	IMPACT	68	1/01/2019	31/03/2019	90	10228	10317		E2, E3			
	IMPACT	69	1/04/2019	30/06/2019	91	10318	10408		E1			
	IMPACT	70	1/07/2019	30/09/2019	92	10409	10500		11, 12			
	IMPACT	71	1/10/2019	31/12/2019	92	10501	10592		13, 14			
	IMPACT	72	1/01/2020	31/03/2020	91	10593	10683		15			
	IMPACT	73	1/04/2020	30/06/2020	91	10684	10774					
	IMPACT	74	1/07/2020	30/09/2020	92	10775	10866					
	IMPACT	75	1/10/2020	31/12/2020	92	10867	10958		22			
	IMPACT	76	1/01/2021	31/03/2021	90	10959	11048		23, 24			
	IMPACT	77	1/04/2021	30/06/2021	91	11049	11139		25, 26			
	IMPACT	78	1/07/2021	30/09/2021	92	11140	11231		27, 28			
	IMPACT	79	1/10/2021	31/12/2021	92	11232	11323		29			
	IMPACT	80	1/01/2022	31/03/2022	90	11324	11413		30, 31			
	IMPACT	81	1/04/2022	30/06/2022	91	11414	11504		32, 33			
	IMPACT	82	1/07/2022	30/09/2022	92	11505	11596		34			
	IMPACT	83	1/10/2022	31/12/2022	92	11597	11688					
	RECOVERY	84	1/01/2023	31/12/2073	18628	11689	30316		Turn off DRN			
	RECOVERY	85	1/01/2074	31/12/2123	18261	30317	48577					
	RECOVERY	86	1/01/2124	31/12/2173	18263	48578	66840					
	RECOVERY	87	1/01/2174	31/12/2223	18261	66841	85102					

9.10 Model Implementation of Mine Schedule

The underground mining and dewatering activity is defined using drain cells within mined coal seams, with modelled drain elevations set to 0.1m above the base of the Bulli Seam (Layer 13), Balgownie Seam (Layer 15) and Wongawilli Seam (Layer 17).

These drain cells were applied wherever workings occur and were maintained as constant within the Bulli and Wongawilli Seam and implemented in line with mine progression in the Wongawilli Seam.

Mining prior to the transient modelling period was simulated as steady state within the Bulli Seam (Layer 13) and Balgownie Seam (Layer 15).

The model set-up involved changing the parameters with time in the goaf and overlying fractured zones directly after mining of each panel, whilst simultaneously activating drain cells along all development headings.

The development headings were activated in advance of the active mining and subsequent subsidence.

Although the coal seam void is dominated by the drain mechanism, the horizontal and vertical permeabilities and specific yields were also increased to simulate the highly disturbed nature within the caved zone and overlying variable fracture zone.

Within the Wongawilli Seam, Sy was increased on host values by a factor of 150 raising Sy to 20%. Within the Wongawilli – Balgownie Interburden, Sy was increased by a factor of 20 and the Balgownie by a factor of 10.

Specific Storage (Ss) was increased by the same factors in the recovery model only.

9.11 Existing Mine Workings

Extensive abandoned mine workings occur regionally within the Bulli seam and extend the length of the escarpment within the model domain as shown in **Figure 1-1**.

Adjacent to the proposed workings are large areas of abandoned Bulli workings to the north and south of the Russell Vale lease boundary, as well as the combined Corrimal / Cordeaux complex to the south in the Bulli seam.

The model maintains active sinks using drain cells with invert levels of 0.1m representing Bulli Seam workings at the following decommissioned operations:

- Old Bulli;
- Excelsior 1, 2 and B;
- North Bulli;
- South Clifton Tunnel;
- Darkes Forest;
- Coal Cliff;
- Corrimal;
- Cordeaux, and;
- Mt Kembla.

Drain cell invert levels were set at 0.1m above the seam floor and were maintained throughout transient modelling with the exception of small areas at Russell Vale West, where drain cell invert levels were raised slightly to mimic reported ponding areas.

No flooding was indicated in any of these areas as the degree of ponding are not reported to be extensive.

The hydraulic connectivity between the Corrimal / Cordeaux complex and the older mine workings adjacent to the Wollongong Coal lease area is not known and has been assumed in the model to be constrained by hydraulic conductivities of the host strata.

Active mining within the Bulli Seam is occurring in the northern periphery of the model in the South32 Appin workings. Additionally, active mining is occurring within the Wongawilli seam at Dendrobium at the southern boundary of the model area.

9.11.1 Height of Fracturing and Associated Zone of Depressurisation

The hydraulic characteristics of the Bulli Seam and overlying or adjacent strata to the extracted Bulli, Balgownie and Wongawilli Seam workings have been altered due to subsidence that may have generated atmospheric depressurisation up to the lower Bulgo Sandstone following extraction of Longwalls 4, 5 and 6 (340m) in the Wongawilli Seam.

Where longwall extraction in all three seams has occurred, there is a potential for interaction between surface water features and the top of the depressurised groundwater zone that is recharged from rainfall and adjacent creeks.

The potential may be enhanced if there is interaction between hillslope basal shear plane/s that may be present due to lateral shearing associated with hillslope subsidence and the top of the zone of depressurisation above each longwall panel.

However, due to the modified mine plan where only first workings are proposed to be extracted, there is considered to be no potential for interaction between the zone of depressurisation and the basal shear planes in the shallower areas over the proposed first workings.

Ongoing piezometric monitoring will be used to establish the height of depressurisation as mining progresses.

To date, retrospective multi-seam height of depressurisation assessment is possible at GW1 and RV20.

GW1 is not located over the centre of a Wongawilli Seam longwall, however as it is located within the confines of the main gate and tailgate of Longwall 4, proximity mining activities makes this a valuable tool in understanding related impacts. Although GW1 was not installed until after Longwall 4 was completed, it captured the response to stresses imposed by Longwalls 5 and 6 (340m). Ongoing in-situ field assessment in RV20 has been used to determine the height of depressurisation above the southern end of Longwall 4 where three seams have been mined.

Based on mine water balance monitoring and rainfall observations, free drainage through vertically connected fracturing from the surface streams and in the overall catchment is not apparent over the existing workings at Russell Vale East (SCT Operations, 2019).

In the groundwater model, it was assumed that enhanced hydraulic conductivity after extraction of (and over) the longwalls could enable free drainage within the goaf and overlying fractured strata, with vertical connective fracturing up to the Upper Bulgo Sandstone / Lower Hawkesbury Sandstone.

Plastic deformation with bed delamination, without significantly enhanced vertical hydraulic connectivity, was interpreted to be present from the mid / upper Bulgo Sandstone to 20m below surface, where overlapping triple seam extraction was not present.

The partial "depressurisation" zone generally extends higher up into the subsided strata than the "fractured", vertically connected, enhanced hydraulic conductivity zone.

Due to limitations of the setup, capability and scale of the model, it was not possible to represent any changes in hydraulic conductivity of the thin (<2m) Quaternary alluvial / colluvial and upland swamp profiles in the upper section of model Layer 1.

In the model, it was assumed that enhanced hydraulic conductivity after extraction of (and over) the proposed first workings could enable free drainage within the goaf and overlying fractured strata, with vertical connective fracturing only extending into the upper section of the Wongawilli Seam (in areas where Balgownie or Wongawilli Seam Longwall or Bulli Seam first workings are absent).

9.12 Model Calibration

Model calibration involves comparing predicted and observed data and making modifications to model input parameters, where required, within reasonable limits defined by available data and specialist judgment, to achieve the best possible match.

Model calibration performance can be demonstrated in both quantitative (head value matches) and qualitative (pattern-matching) terms, by:

- contour plans of modelled head, with posted spot heights of measured head;
- hydrographs of modelled versus observed bore water levels;
- water balance comparisons; and
- scatter plots of modelled versus measured head, and the associated statistical measure of scaled root mean square (SRMS) value.

Due to the complex interactive depressurisation effects of the existing subsidence and adjacent workings on groundwater levels and the predominantly "dry" nature of the Russell Vale workings, model calibration focussed on matching observed and modelled groundwater levels and mine inflows, particularly during periods where mining impacts have been observed.

Scaled RMS value is the RMS error term divided by the range of heads across the site and it forms a quantitative performance indicator. Given uncertainties in the overall water balance volumes (e.g. it is difficult to directly measure evaporation and baseflow into the creeks), it is considered that a 10% scaled RMS value is an appropriate target for this study, with an ideal target for long term model refinement suggested at 5% or lower. This approach is consistent with the best practice Australian Groundwater Modelling Guidelines (SKM, 2012).

Calibration was conducted initially as steady state (i.e. calibration to assumed long-term equilibrium conditions) and subsequently transient (i.e. calibration to the impacts of time-dependent stresses such as pumping and climatic variation).

Steady state calibration was used to compare assumed long term average groundwater levels with groundwater levels prior to the transient calibration period (1993 – 2016).

Subsequent transient or "history match" calibration was conducted using the steady state model to determine initial conditions. The transient calibration period included underground mining in the Bulli Seam in the 500 Series longwalls at Russell Vale West and more recently in the Wongawilli Seam at Russell Vale East.

Transient calibration was to a degree restricted by the lack of monitoring locations within the Permian groundwater system, although sufficient locations were available for a reasonable calibration.

Attention was placed on achieving a level of inter-connection of underground mining areas to match the assessed drawdown response seen, particularly in the monitoring points over the 500 series longwall panels.

9.12.1 Calibration Targets

The model compares target values against model results and interpolates results in both space and time to compute an error or residual. A total of 32 groundwater monitoring locations including open standpipes and multi-level vibrating wire piezometers were used for steady state calibration.

A total of 64 monitored horizons from 32 monitoring locations provided a total of 832 temporal head targets which were included in the transient calibration.

The available monitoring based target points are distributed through the upper overburden layers, with no monitoring data available from beneath the Scarborough Sandstone.

Transient groundwater levels were taken from records at each borehole where data was available. A full list of the calibration targets, including the monitored layers and a comparison of actual versus modelled groundwater heads is outlined in GeoTerra / GES (2015).

Groundwater inflows to active mining areas provide a valuable calibration measure and are critical for achieving a robust calibration.

Water balance records and, particularly mine inflow records for the Russell Vale Mine lease and other adjacent mining operations, were initially not well recorded. Considerable effort has recently been undertaken by Wollongong Coal and SCT Operations (2019) to better understand water balance variables from available data from which a review of inflows led to revised groundwater make estimates, which were used in the calibration process.

9.12.2 Steady State Calibration

Steady state (or baseline 'long term') calibration was carried out as the first stage of the calibration process.

Given that the hydrogeological environment in this region is highly impacted from historical mining activities, achieving pre-mining steady state conditions was not the focus of the initial steady state modelling, rather it was focused on attaining realistic starting head conditions for transient calibration as the primary objective.

The steady state calibration allowed for initial head distributions in the model layers to be generated and to check assumptions on the conceptual hydrogeological processes.

It is acknowledged that steady state target heads were gathered from monitoring data that has considerable temporal range. However, this was the best achievable option with the available monitoring data.

Target heads were derived from numerous monitoring periods including 1992 – 1998 and 2007 – 2011. While the appropriateness of this may be questioned, the lack of any monitoring data with sufficient spatial distribution prior to the calibration period provided little opportunity to derive starting heads with sufficient confidence and hence monitoring data with a range of dates was used to derive initial heads.

The steady state model was calibrated to groundwater levels as close as possible to the beginning of 1991, assuming these to be close to long term average groundwater levels in which time there was a stable climate and preceded a period of drought.

In the Russell Vale East area, transient mining stresses have not occurred since completion of the Balgownie Seam extraction in the 1980s, and hence groundwater levels were assumed to have reached a relatively stable state, particularly within the shallower stratigraphy where most of the monitoring network is screened.

The pre-mining water levels in all piezometers have, to some extent, been influenced by the surrounding mining operations over an extended period of time. With this in mind, the steady state model calibration was principally used to provide an acceptable set of starting conditions for the transient calibration model.

9.12.3 Transient Calibration

Transient calibration against groundwater levels was carried out for the period 1993 to 2016 inclusive, utilising water head or level data from single screen standpipes and multi-level vibrating wire piezometers.

Although this period covers an extended time where limited to no significant secondary extraction occurred in the lease area from 1998 to 2010, it covers two periods where groundwater hydrographs show a response to mining influences.

Following completion of mining in the 500 series longwalls, apart from some limited areas of pillar extraction, no longwall mining was undertaken within the Russell Vale West area.

Mining was re-started at Russell Vale East with development of first workings in the Wongawilli Seam in 2011, followed by non-continuous extraction of Longwalls 4, 5 and 6 (340m) after April 2012.

The RMS value for the calibration period is 8.0m, whilst scaled root mean square (SRMS) error is 3.4%, which is within the target range of 5%.

The SRMS value is the RMS value divided by the range of heads across the site, and forms the main quantitative performance indicator. This result is consistent with the relevant groundwater modelling guideline (SKM, 2012).

A diagram of measured versus modelled potentiometric head targets is shown in **Figure 9-3**, and it can be seen that the model is reasonably well balanced against the targets (i.e. there is no systematic under or over prediction).

There are some significant departures from the matching curve, and these can be attributed to a number of reasons. These include what appears to be a delayed equilibration of vibrating wire transducers and the fact that the multilevel VWP network has been increased in the past 2 years was used within the calibration data set which could be adjusted when a longer monitoring record is available. This is, however, the key area where the model has failed to simulate observed groundwater pressures and there is, accordingly, a groundwater pressure separation between the Lower Bulgo Sandstone and the Scarborough Sandstone data.

In addition. Shallow water levels in Layer 1 show some systematic departure from absolute values although trends can be simulated reflecting recharge pattern. This is quite likely to be the result of steeper terrain and its effect on model layers where horizontal and vertical hydraulic conductivities in particular which are assigned in the model and dictate the flow calculations do not reflect actual conditions. While this is not considered to impact greatly on overall model results, further model development will focus on detail within Layer 1 where these high elevation changes occur.

Figure 9-3 illustrates both of the considerations posed above. That being, the failure to accurately simulate indicated groundwater pressures within the Stanwell Park Claystone, which in areas maintains pressures very close to, if not higher than, the Lower Bulgo Sandstone, and the complexity of the groundwater pressure response to mining activities.

In the case of GW1, the response in the Bulgo Sandstone and Stanwell Park Claystone as LW4 approached its closest point to GW1 is interpreted to be the effect of transient storage changes occurring during changing tensional and compressional stress regimes as shown in **Figure 9-4**.

The model has been unable to simulate these physical changes and the result is variability in observed pressures and lack of variability within the computed heads, resulting in 'flat lining' of heads within the observed vs. computed calibration values shown.

Quantitatively, curve matching in GW1 detracts from the calibration statistics to some degree, yet, qualitatively, the results reasonably reflect the groundwater response, with the exception of the pressures occurring in the Stanwell Park Claystone.

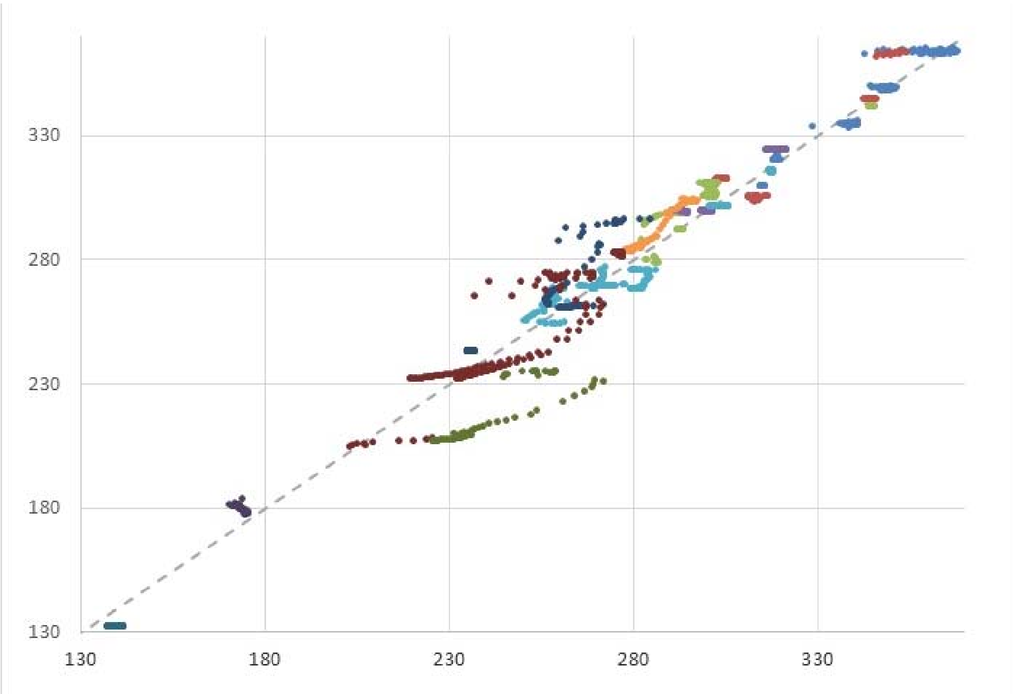


Figure 9-3 Measured Vs Modelled Potentiometric Head Targets

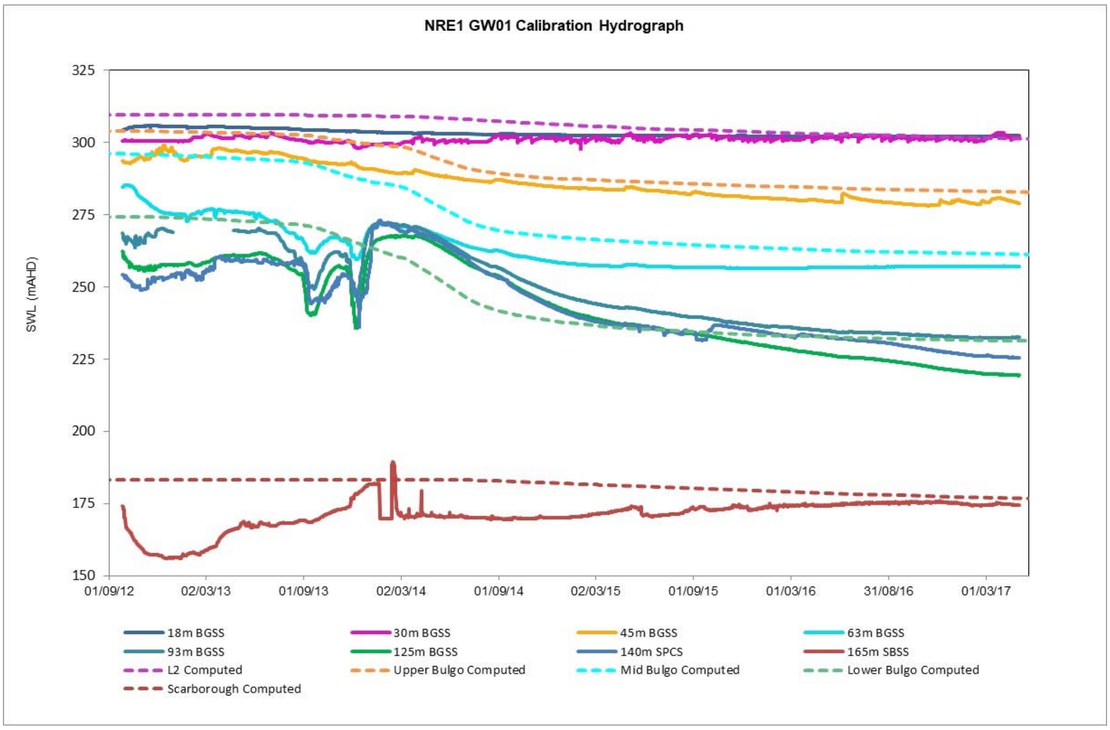


Figure 9-4 Observed vs. Computed Groundwater Levels for NRE GW1

9.13 Fracture and Depressurisation Zone Implementation

In the current model, the fracture zone design and implementation within the triple seam mined area at Russell Vale focussed in the calibration process on matching heads to key piezometer data, primarily GW1 and RV20.

The approach utilised an empirical log-linear ramp function for the simulated height of fracturing in order to calibrate the observed vertical hydraulic head profiles. This was manually adjusted in order to match data from GW1 and RV20. The post Wongawilli Seam extraction subsidence parameter distribution was based on a conceptual understanding of longwall mine subsidence geomechanics and fracture development as detailed in SCT Operations (2019).

Layer definition within the model allowed primary mined coal seams to be represented individually and for the overburden to be subdivided into multiple layers. This allowed subsidence caving and fracturing effects to be simulated to various heights above each mined seam so that the impact of progressive caving and fracturing associated with the mining could be adequately represented.

The fractured zone was simulated with horizontal hydraulic conductivity enhanced by a factor of five within all fractured zone components within the footprint of the longwall panes and extending laterally up to 100m outside the footprint in order to simulate enhanced conductivity resulting from tensional stresses. Vertical hydraulic conductivity was enhanced by a function which varied the vertical hydraulic conductivity field within the deformation zone overlying extraction areas and “weighted” the permeability changes based on layer thickness. In the caved and mined zones, horizontal hydraulic conductivity was set to 10 m/day.

The height of the caved zone was assumed to be five times the mined seam thickness, although this was increased where zones of multi-seam mining occurred and where caved zone parameters were extended to the Bulli Seam, which limited an increase in Sy into the Balgownie Seam only.

For fractured zones, the strata hydraulic parameters were changed using the Time-Varying Material Properties (TMP) package of MODFLOW-SURFACT, which allows varying property values to be applied over time.

Fracturing was instigated by altering host rock calibrated hydraulic properties in accordance with mine progression.

Layer resolution within the model allowed the mined Wongawilli Seam to be represented in Layer 17, with the other layers above it available to simulate the collapsed or caved zone and connected and disconnected fractured zones to specific heights depending on the style and cumulative impacts of seam extraction. This ensured that the impact of variable combinations of first and second workings and the progressive caving and fracturing impacts associated with the different types and combinations of extraction was adequately represented in the model.

Vertical hydraulic conductivity was set to 1m/day within the mined and caved zones in highly fractured overburden.

The vertical hydraulic conductivity in the fractured zone was enhanced according to a log-linear monotonic (ramp) function which varied the vertical hydraulic conductivity field within the deformation zone overlying mining areas and weighted the hydraulic conductivity changes on layer thickness. However, a departure from the ramp function was used to calibrate the observed pressure variations in RV20 and GW1. Limits for the variability were governed by fracture height and assigned upper and lower bounds on hydraulic conductivity in the fractured zone. Assigned fractured zone properties are presented in **Table 5**.

The vertical hydraulic conductivity of the model strata directly beneath mined areas was also increased with a uniform increase in vertical hydraulic conductivity of 100 times the host values being applied. Similarly, horizontal hydraulic conductivity of the underlying layer was increased by a factor of 2 times the host (pre-mine calibrated) values.

Specific yields (Sy) were increased to simulate the highly disturbed nature within the caved zone and overlying variable fracture zone. Specific yield (Sy) was also increased in the Wongawilli Seam to 20% in the footprint of the Wongawilli Seam longwalls, which represents the increased storage occurring in the caved zone as overburden collapses. Above the mined coal seam Sy was increased, along with an increase in porosity to 10%. Within the Wongawilli – Balgownie Interburden, Sy was increased to 10% and the Balgownie to 5%.

Specific Storage (Ss) was increased by the same factors in the mined seam and within the overlying caved zone by applying an increase in the rock porosity component of the Ss parameter, in the same degree as for Sy.

9.13.1 Calibrated Hydraulic Properties

Table 5 summarises the calibrated hydraulic properties of the modelled layers and **Figure 9-5** shows a schematic of the stratigraphic profile of the vertical hydraulic conductivity of host vs. fractured zone showing the higher relative increase of vertical hydraulic conductivity (Kv) in the lower strata above mining levels.

It also shows the heights of predicted connective cracking / height of depressurisation of the two analytical methods discussed earlier.

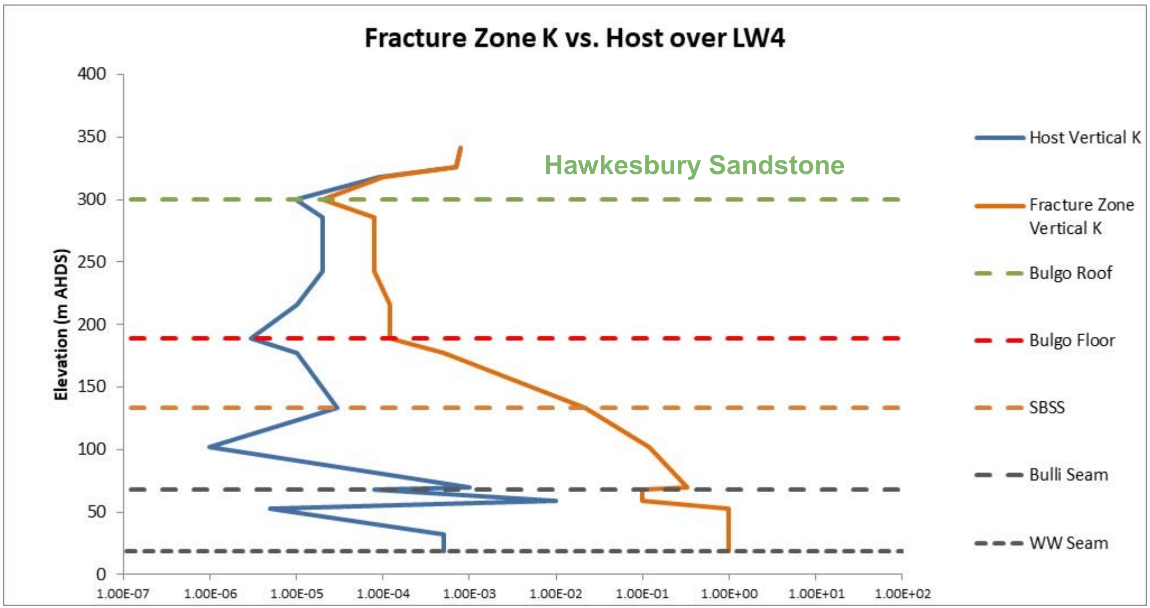


Figure 9-5 Fracture Zone Vertical K vs. Host Kv

Table 5 Calibrated Hydraulic Properties

Layer	Stratigraphic Unit	Host (kx)	Ss [1/m]	Sy	Host (Kz)	Fracture Zone Wonga West (Kz)	Fracture Zone Russell Vale East Historic Workings Bulli Seam (Kz)	Fracture Zone Wongawilli Longwalls (Kz)	Fracture Zone Wongawilli Longwalls (Kx)*
1	Upper Hawkesbury Sandstone	3.00E-02	4.00E-04	1.00E-02	1.62E-02				
1	Layer 1 (Coastal Plain)	3.03E-01	8.00E-04	1.50E-01	9.58E-02				
2	Mid Hawkesbury Sandstone	5.00E-04	6.00E-06	1.10E-01	1.00E-05				
3	Lower Hawkesbury Sandstone	5.55E-04	6.00E-06	1.10E-01	9.00E-05			6.00E-04	2.78E-03
4	Bald Hill Claystone	2.00E-05	6.00E-06	1.10E-01	9.88E-06			6.00E-05	1.00E-04
5	Mid Upper Bulgo Sandstone	6.00E-04	6.00E-06	1.10E-01	2.00E-05			2.00E-04	3.00E-03
6	Mid Lower Bulgo Sandstone	5.00E-04	6.00E-06	1.10E-01	2.00E-05			2.00E-04	2.50E-03
7	Lower Bulgo Sandstone	9.00E-04	6.00E-06	1.10E-01	1.00E-05			2.00E-04	4.50E-03
8	Lower Bulgo Sandstone	6.00E-06	6.00E-06	1.10E-01	1.00E-05			2.00E-04	3.00E-05
9	Stanwell Park Claystone	7.00E-06	6.00E-06	1.10E-01	3.00E-06			5.00E-04	3.50E-05
10	Scarborough Sandstone	7.00E-06	6.00E-06	1.10E-01	1.00E-05			2.16E-02	3.50E-05
11	Wombarra Claystone	6.00E-06	6.00E-06	1.00E-02	3.00E-05	7.00E-04	2.00E-05	1.19E-01	3.00E-05
12	Coal Cliff Sandstone	6.92E-06	2.50E-06	6.00E-03	1.00E-06	3.96E-04	3.00E-05	3.32E-01	3.46E-05
13	Bulli Seam	9.50E-03	5.00E-06	2.00E-03	1.00E-03	1.00E-01	1.00E-03	1.00E-01	4.75E-02
14	Interburden	2.10E-04	4.00E-06	8.00E-03	8.00E-05			1.00E-01	1.05E-03
15	Balgownie Seam	1.20E-02	7.00E-06	3.00E-03	1.00E-02			1.00E+00	6.00E-02
16	Interburden	8.20E-08	4.00E-06	5.00E-03	5.00E-06			1.00E+00	4.10E-07
17	Wongawilli Seam	3.00E-02	4.00E-06	5.00E-03	5.00E-03			1.00E+00	1.50E-01
18	Kembla Sandstone	5.00E-05	2.50E-06	5.00E-03	5.00E-06				
	Basement	5.32E-06	1.00E-06	1.00E-02	1.09E-06				

9.14 Mine Inflows

Based on available mine water balance records, the average daily groundwater inflow derived from strata leakage extracted from Russell Vale East Colliery was 0.2 ML/day prior to extraction of LW4 and 0.7 – 1.1 ML/day during extraction of extraction of LW4, 5 and 6 (340m) as shown in **Figure 9-6**.

Records for mine inflows prior to the extraction of LW4 are considered to be uncertain and the lack of any reported inflow during the development stage is also considered to be implausible, however more accurate mine water pumping records have been obtained since the start of LW4.

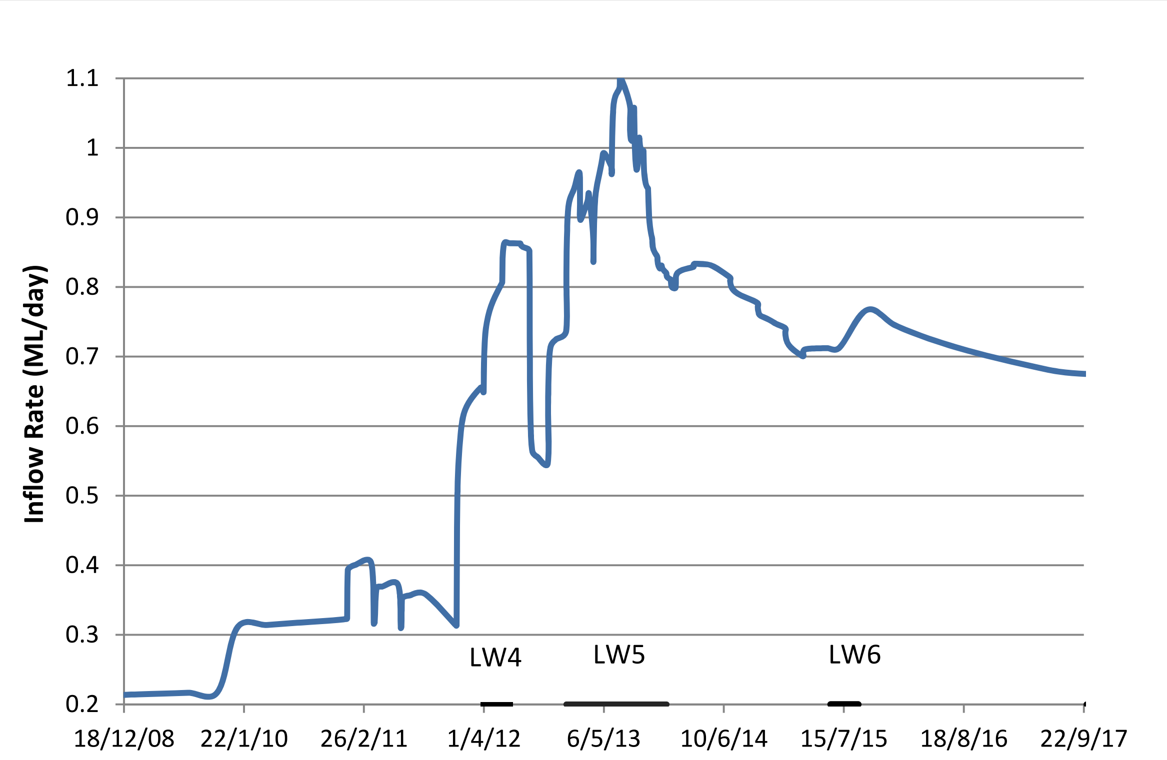


Figure 9-6 Mine Inflows During the Calibration Period

9.15 Water Balance

There are numerous opportunities for groundwater to discharge from, and recharge to, the groundwater system and into / out of the groundwater model. Those implemented in the model include:

- baseflow to major streams (represented by the river cells in MODFLOW);
- outflow / inflow to the eastern margin boundary representing the coastline, the northern margins representing the Appin mining area within the Bulli Seam and southern margin representing the Dendrobium mining area in the Wongawilli Seam (as general heads in MODFLOW), and;
- water inflows to active mining areas and the sinks caused by historical mining areas.

The average water balance over 52 stress periods from 1991 to 2015 in the transient model run up until the end of the calibration period across the entire model area is summarised in **Table 6** and includes continued mining in Russell Vale West.

The total inflow (recharge) to the aquifer system into the model domain is approximately 77ML/day, comprising rainfall recharge (approximately 80%), inflow from the head dependent boundaries on the margins (approximately 0.5%) and leakage from streams into the aquifer (approximately 22%).

The remaining 6% is accounted for with changes in storage within the overburden strata.

Table 6 Simulated Water Balance at End of Transient Calibration

	Inflow (ML/d)	Outflow (ML/d)
Storage	5.9	10.69
Constant Head	0.001	0.03
Drains (Outflow = Groundwater Entering Mine Workings)	0	1.4
Recharge (Direct Rainfall)	62.2	7.7
Et (Evapotranspiration)	0	42.6
River (Leakage/Baseflow)	8.9	14.6
Head Dependent Boundary (GHB)	0.001	0.1
Total	77.11	77.16
% Discrepancy	-0.06%	

9.16 Effect of Structures

Due to the limitations and constraints inherent with the model set up and code, as well as uncertainty in the location, stratigraphic persistence and hydraulic properties of geological structures in the Russell Vale lease area, structures are not simulated in the model.

Observations of intersections of the Corrimal Fault and Dyke D8 within the three levels of extraction have not encountered any observable water make in the workings (SCT Operations, 2015).

As a result, and as outlined in SCT Operations (2019), neither the Corrimal Fault or Dyke D8 are assessed as being able to provide a credible risk of enablng hydraulic connection between Cataract Reservoir and the underground mine workings.

10. POTENTIAL SUBSIDENCE EFFECTS, IMPACTS AND CONSEQUENCES

10.1 Stream Bed Alluvium and Plateau Colluvium

There are no anticipated subsidence effects on stream bed alluvium or plateau colluvium as there is no significant accumulation of Quaternary sediments within the Russell Vale lease area and there is no perceptible predicted subsidence or transmitted overburden depressurisation over and due to the proposed first workings extraction.

The presence of alluvial sediments is limited to the upland swamps, which have been measured up to 1.8m deep.

Where the swamps are absent in the lower catchment, the stream beds are dominated by either exposed sandstone or boulder reaches without significant alluvial deposits.

10.2 Upland Swamps

Due to limitations of MODFLOW SURFACT and the regional scale model set up, the effect of subsidence on the thin (<2m) perched groundwater in upland swamps (within the 20m thick Layer 1) with their limited and variable spatial extent was not assessed in the simulation.

It was observed that Layer 1 could go dry in some locations over triple seam longwall extraction areas, however this impact is not added to by the proposed first workings extraction.

Further discussion of the potential effects on swamps is contained in Biosis (2018).

10.3 Basement Groundwater Levels

Figures 10-1 to **10-6** show north - south and east – west cross sections of the overall modelled hydraulic head (m) and groundwater levels for modelled initial conditions, at the end of the calibration period (i.e. the end of LW6 extraction) and at the end of proposed mining at Russell Vale East.

Figures 10-1 and **10-2** show initial conditions, and de-saturated areas underlying the escarpment in the south-eastern area of the model. Zero pressures also extend into the Bulli Seam and overburden due to pre-existing mining voids from the lengthy period of mining in the region prior to the model simulation period.

Figures 10-3 and **10-4** show the same cross sections following the end of the calibration period after completion of LW6. Here early fracture zone implementation over LW4, 5 and 6 (340m) has caused a vertical propagation of the zero pressure contour. This does not propagate through to surface but positive pressures are maintained in the Upper Bulgo Sandstone. The fracture zone developed within the model is pushed into the Lower Hawkesbury Sandstone and a decline in head within the Hawkesbury Sandstone is also evident.

Figures 10-5 and **10-6** show these cross sections following completion of mining in the Wongawilli Seam where the triple seam longwall fracture zone has fully developed and caused a further vertical propagation of the zero pressure contour. However, it has not broken through to surface.

Within the process of groundwater system recovery, the adits within the Illawarra Escarpment will spill well before full recovery of the groundwater system and adit sealing will be ineffective as the low lithostatic head pressure in the strata due to the low depth of cover on the escarpment will not be able to hold the water pressure (SCT Operations, 2015B).

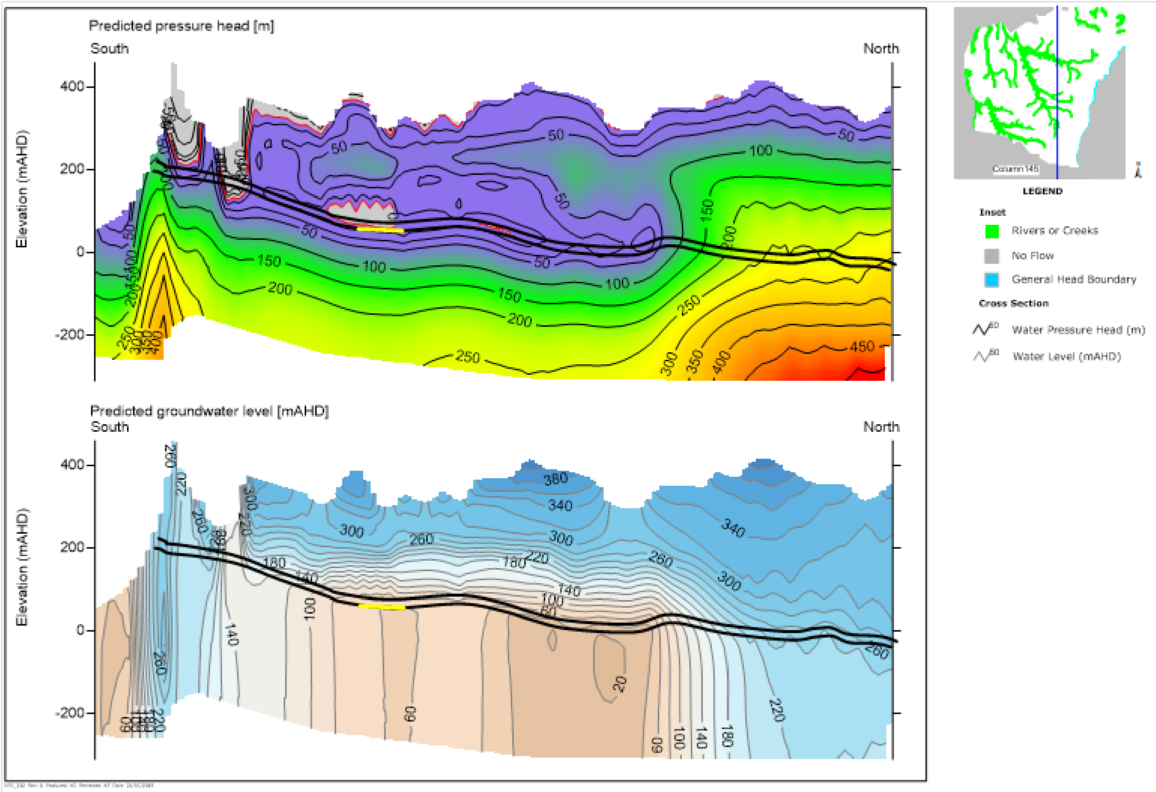


Figure 10-1 Predicted Pressure Head and Potentiometric Head Initial Conditions at Russell Vale East (North – South Cross Section on Easting 303000)

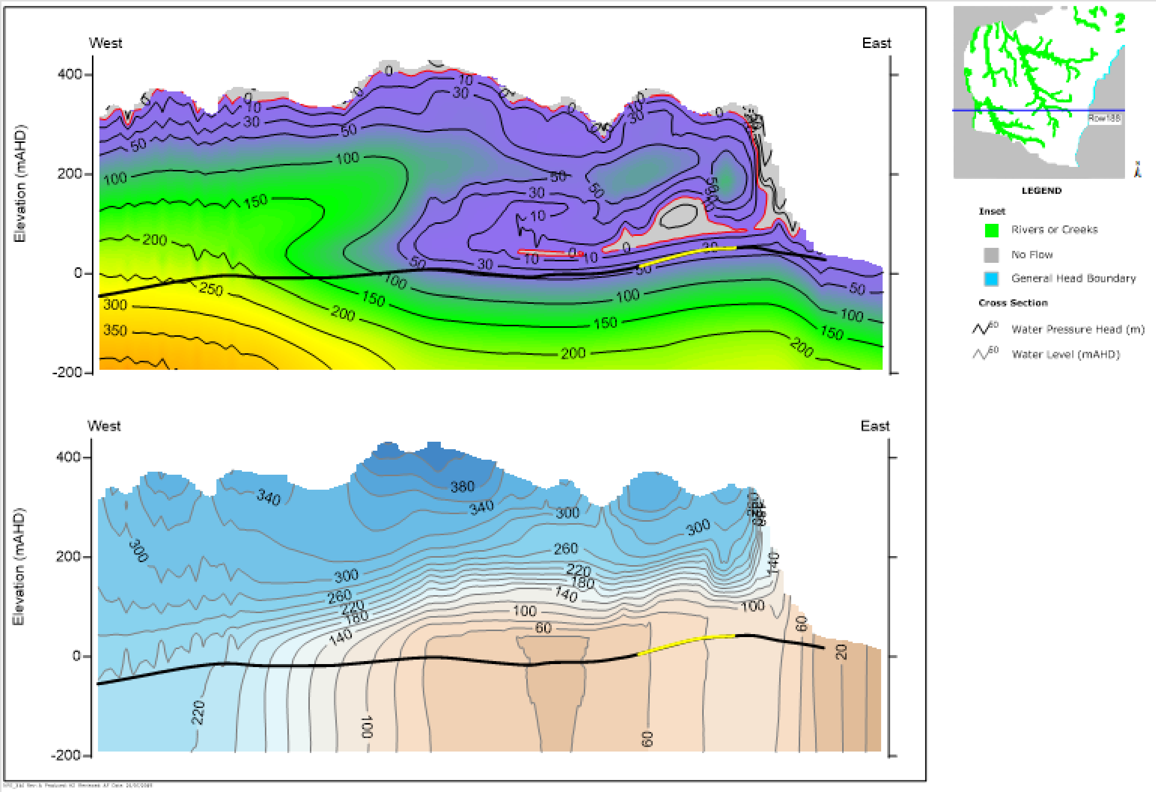


Figure 10-2 Predicted Pressure Head and Potentiometric Head Initial Conditions at Russell Vale East (East – West Cross Section on Northing 6196895)

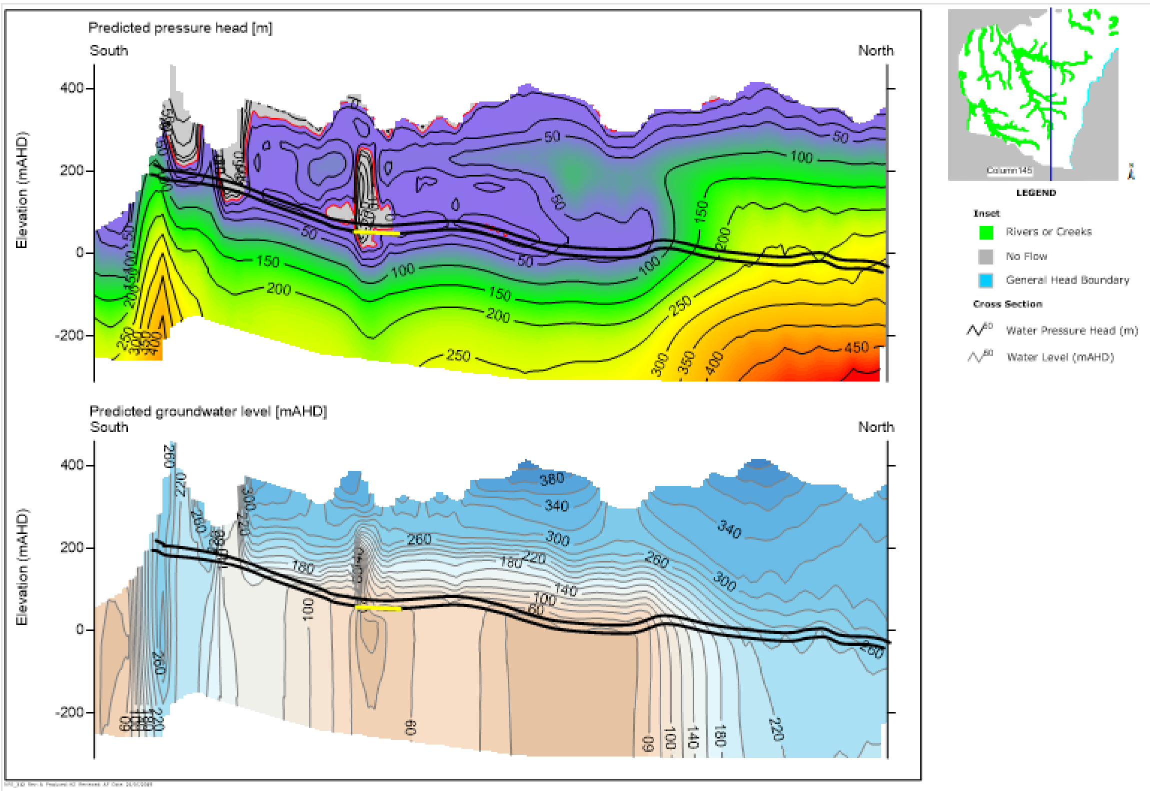


Figure 10-3 Predicted Pressure Head and Potentiometric Head at Russell Vale East at the End of LW6 (North – South Cross Section on Easting 303000) update

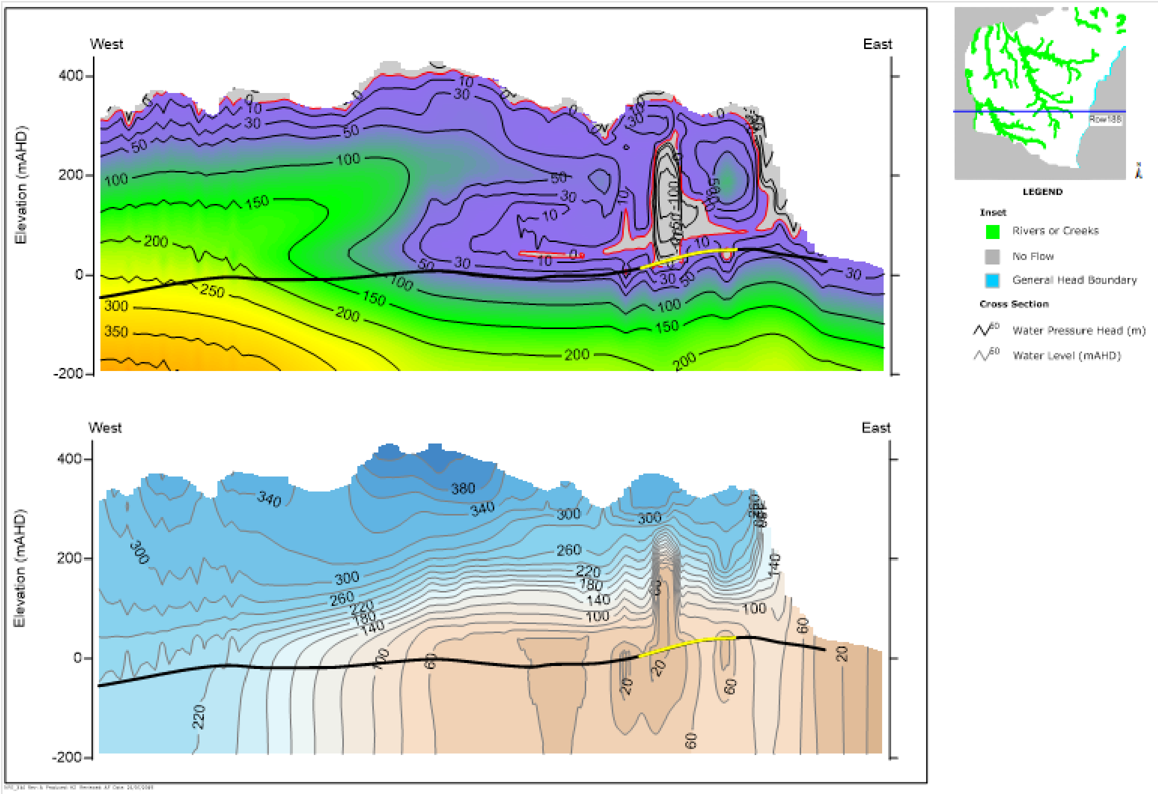


Figure 10-4 Predicted Depressurisation at Wonga at the End of LW6 (East – West Cross Section on Northing 6196895)

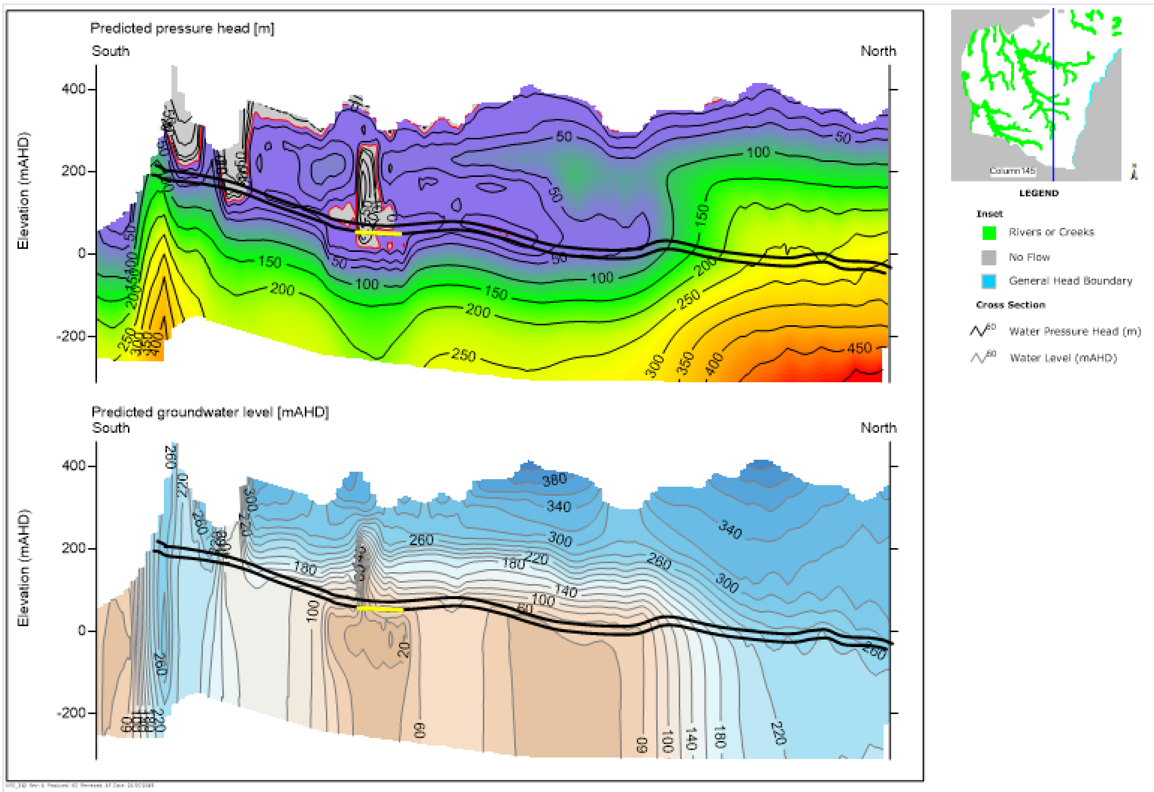


Figure 10-5 Predicted Depressurisation at Russell Vale East at the End of Mining (North – South Cross Section on Easting 303000)

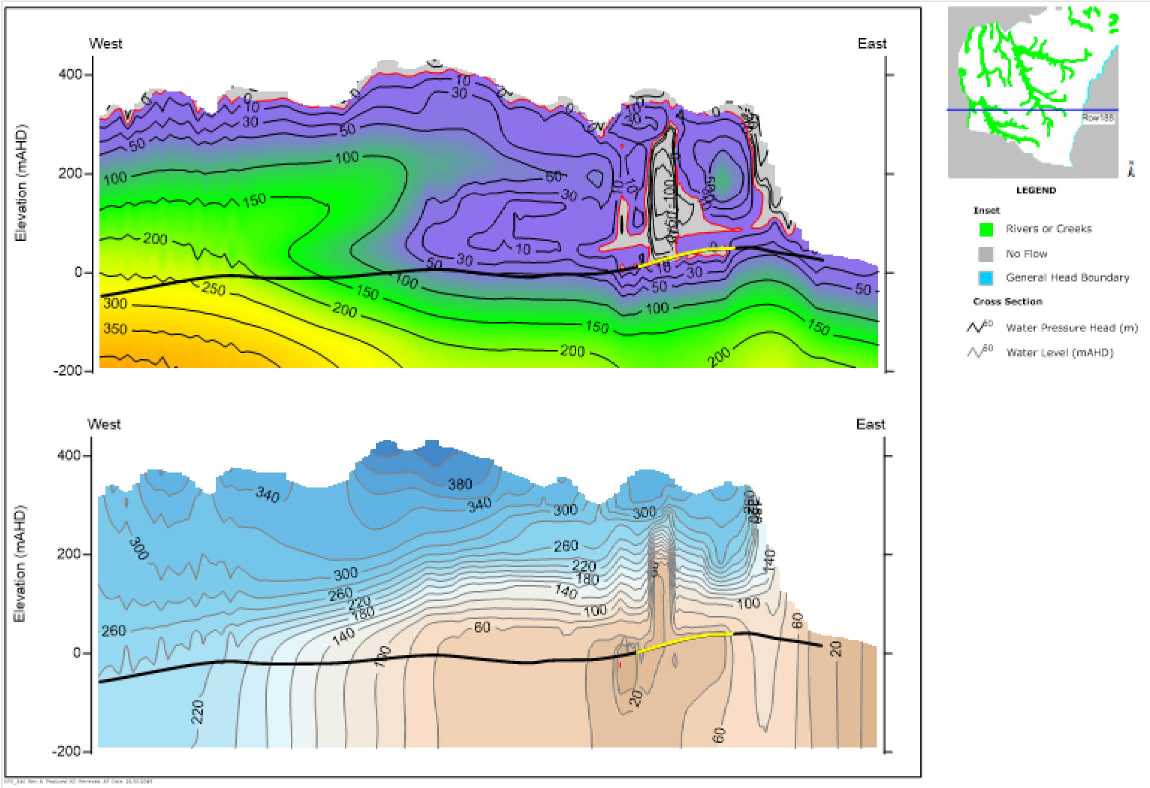


Figure 10-6 Predicted Depressurisation at Russell Vale East at the End of Mining (East – West Cross Section on Northing 6196895)

10.3.1 Shallow, Perched, Ephemeral, Hawkesbury Sandstone

Perched, ephemeral, shallow groundwater within the upper Hawkesbury Sandstone (Layer 1) could undergo a water level reduction over the proposed workings after subsidence, but as a consequence of transmitted depressurisation from the triple seam mined areas, and not due to the proposed first workings.

However, as the ephemeral shallow Hawkesbury Sandstone aquifers desiccate after extended dry periods, the effect on the mostly disconnected, perched aquifers with limited extent was not modelled.

However, it is logical to conclude that fracturing of the upper, shallow strata over the previously mined triple seam extraction areas could enhance the leakage rate from the perched aquifers into underlying strata over subsided areas, as well as enhancing rainfall recharge and subsequent seepage rate from these perched aquifers into local streams or the underlying aquifers. This impact is not perceptibly added to by the proposed first workings.

The minimal predicted subsidence of the uppermost, 20m thick Layer 1 (<100mm) due to the proposed first workings is not anticipated to have an observable effect on stream baseflow or stream water quality where the temporary aquifers seep into local catchments.

10.3.2 Upper Hawkesbury Sandstone / Regolith

The upper Hawkesbury Sandstone aquifer extends across the Application Area, with piezometer data indicating phreatic water levels range from 1 – 20m below surface within Russell Vale East.

It should be noted that the monitored water level is affected by semi-confined head pressures, whereas the first drilling water intercept, which indicates the upper bound of the aquifer varied from 17 – 48m below surface at Russell Vale East.

After a piezometer is installed, the subsequent water level measurements indicate a combination of head pressure in the aquifer, variability of recharge and other associated factors.

Based on past experience in the Southern Coalfields, the upper regional Hawkesbury Sandstone water levels can rise by up to 2m ahead of a piezometer being undermined, then reduce by up to 15m after development of cracking and additional secondary void space (porosity) in the aquifer.

Apart from GW1, all of the piezometers installed by Wollongong Coal have monitored the post mining period in the Bulli and / or Balgownie mining phases.

GW1 was installed after Longwall 4 in the Wongawilli Seam was extracted and observed a water level reduction of up to 25m, with subsequent recovery by up to 31m due to the intermittent stop /start method by which Longwall 5 was mined.

GW1 subsequently had no discernible effect from extraction of Longwall 6 (340m) between 4/5/15 and 8/7/15, although a minor recovery in the Stanwell Park Claystone was evident after extraction ceased.

Re-establishment of the pre-mining water level generally occurs over a number of years, although to date, no recovery has occurred below the lower Bulgo Sandstone, with steady state reduced levels being predominant in the GW1 overburden. Water levels may not necessarily fully recover depending on rainfall recharge in the catchment and the post subsidence outflow seepage rate, if it occurs, to local streams.

Modelling of Layer 1 (including the Hawkesbury Sandstone, Newport / Garie Formation, Bald Hill Claystone and upper Bulgo Sandstone in eroded creek bed locations) after the end of mining in Russell Vale East indicates up to 10m of drawdown as shown in **Figure 10-7** in comparison to pre Wongawilli Seam development, although there is no direct depressurisation linkage between the proposed first workings and the Layer 1 depressurisation.

Figure 10-8 shows drawdown after mining is completed in comparison to post LW6 (340m) groundwater levels.

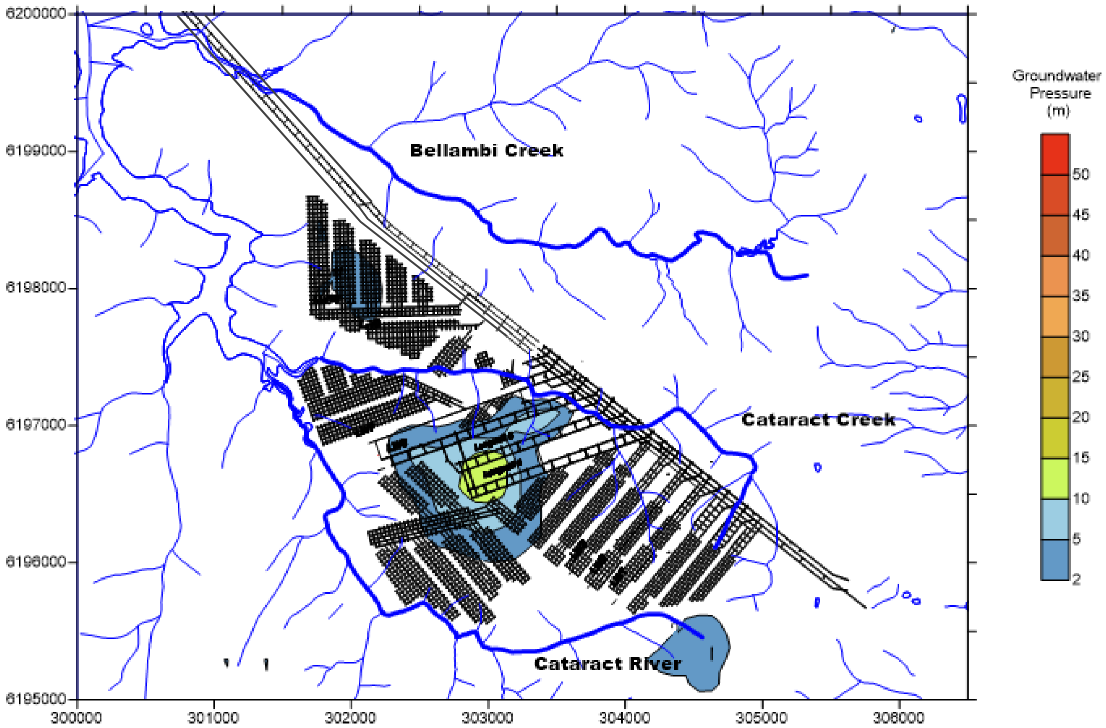


Figure 10-7 Layer 1 Drawdown after Mining the Proposed Workings Relative to the Start of Mining in Wongawilli Seam

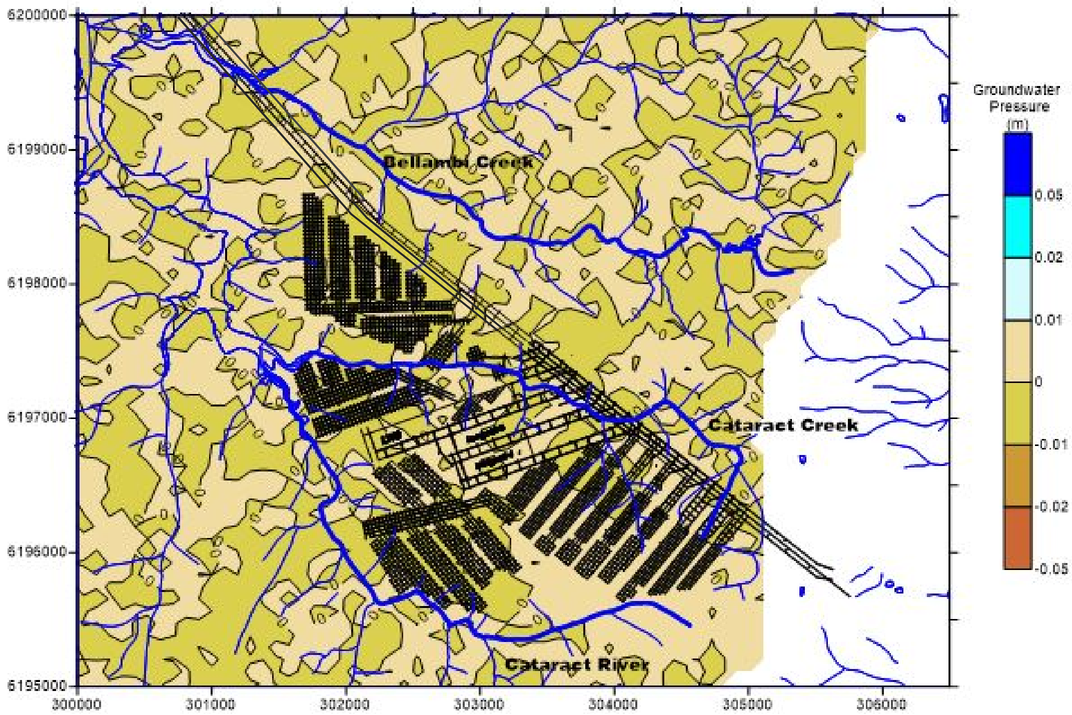


Figure 10-8 Layer 1 Drawdown after LW6 Relative to the End of the Proposed Mining

Figures 10-9 and **10-10,** which represent 40 and 200 years after completion of the proposed first workings, indicate that groundwater levels in Layer 1 continue to initially continue to fall after extraction of the previously mined Wongawilli Seam longwalls and proposed first workings. At 40 years there is up to 5m drawdown evident over Longwall 4, However, 10m of recovery occurs after 200 years.

The Layer 1 drawdown effects at both 40 and 100 years are linked to depressurisation associated with historic workings, in particular, LWs 4-6, and there is no observable Layer 1 drawdown effect associated with the proposed first workings

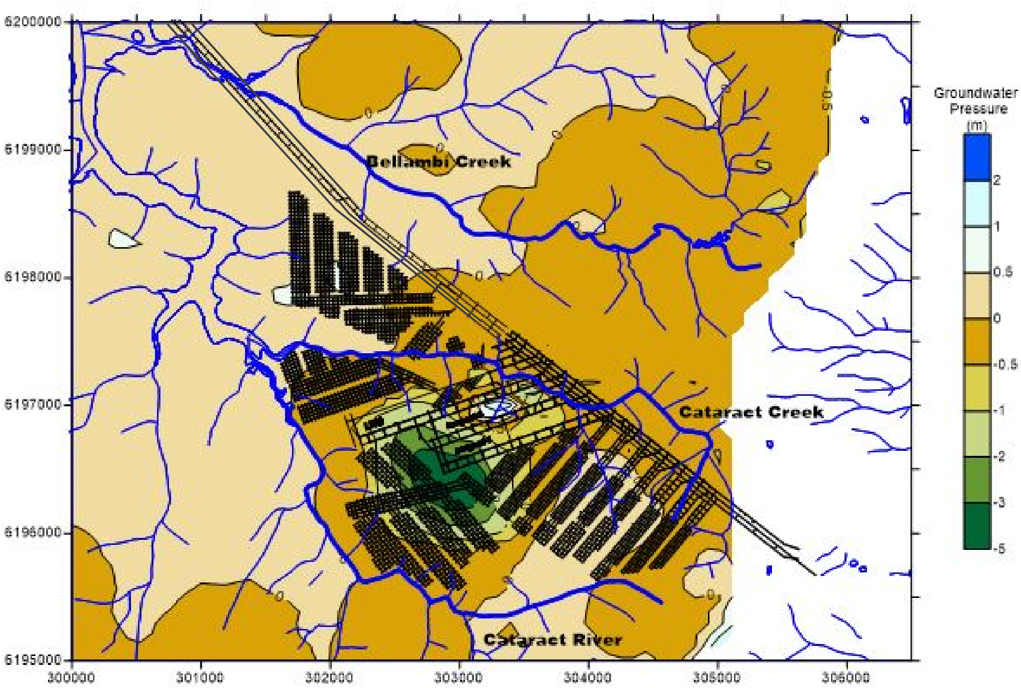


Figure 10-9 Layer 1 Recovery 40 Years After Completion of the Proposed First Workings

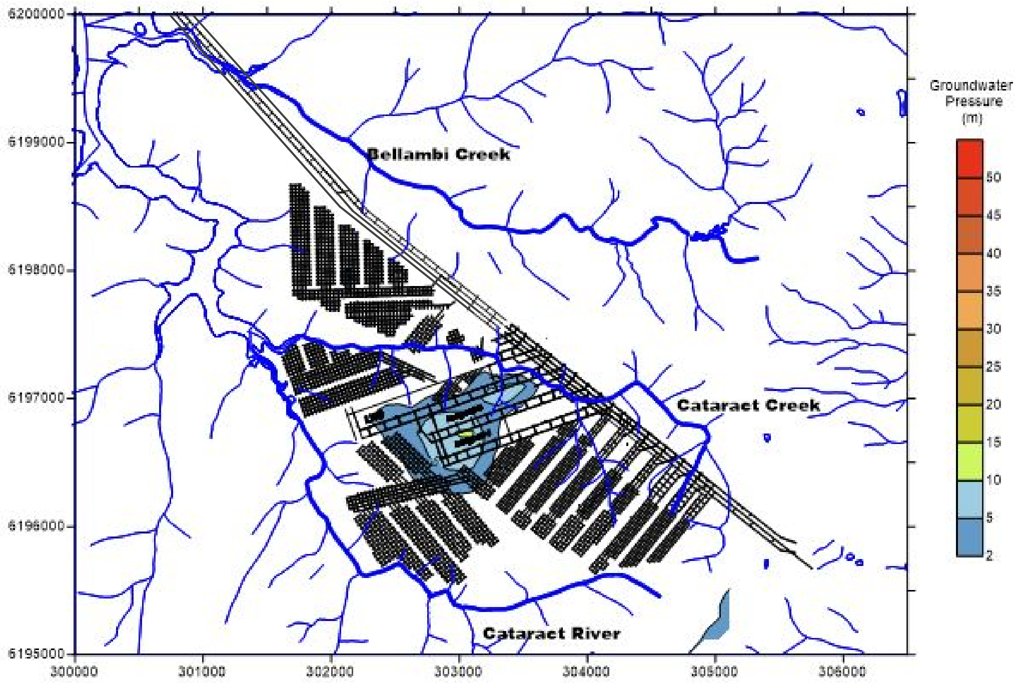


Figure 10-10 Layer 1 Recovery 200 Years After Proposed Mining at Russell Vale East

10.3.3 Hawkesbury Sandstone to Wombarra Claystone

Impacts on the Bulli Seam overburden which includes Hawkesbury Sandstone to Wombarra Claystone are not presented in this report.

This is because the previous model and this current model iterations are essentially identical as there is no influence on these layers from the proposed first workings extraction.

For commentary and figures of the impacts in this zone, refer to report GeoTerra / GES (2015).

10.3.4 Bulli Seam

The Bulli Seam over a large area regionally has been mine over a very long period of time.

Within the Russel Vale area where there is over 100 years of historical mining activity, unsaturated voids still exist and continue to be drained. As such the Bulli seam with its atmospheric pressures in the Russel Vale area separates the groundwater systems in the overburden and the underlying coal seam stratigraphy which includes the Wongawilli Seam

Bulli Seam drawdown figures are not presented in this section as the seam is generally dry at Russell Vale East.

10.3.5 Balgownie Seam

Mining in the Balgownie Seam at Russel Vale East occurred prior to the model start in 1990.

Therefore, enhanced hydraulic properties were included from the start of the model which are further impacted on from fracturing occurring in the Wongawilli Seam over LW4 and LW5 and to a lesser degree the limited longwall extraction in LW6 and is drained via connection with the Wongawilli Seam. **Figure 10-11** shows drawdown in the Balgownie Seam after completion of mining in comparison to the start of mining within the Wongawilli

Seam. High drawdown over LW4, LW5 and LW6 reflects the fracture zone.

Figure 10-12 shows drawdown in the Balgownie Seam from start of mining to end of LW6.

Figure 10-13 shows drawdown from the End of Longwall 6 to the end of proposed mining. It shows drawdown over the proposed first workings mine plan is limited to a maximum of approximately 5m.

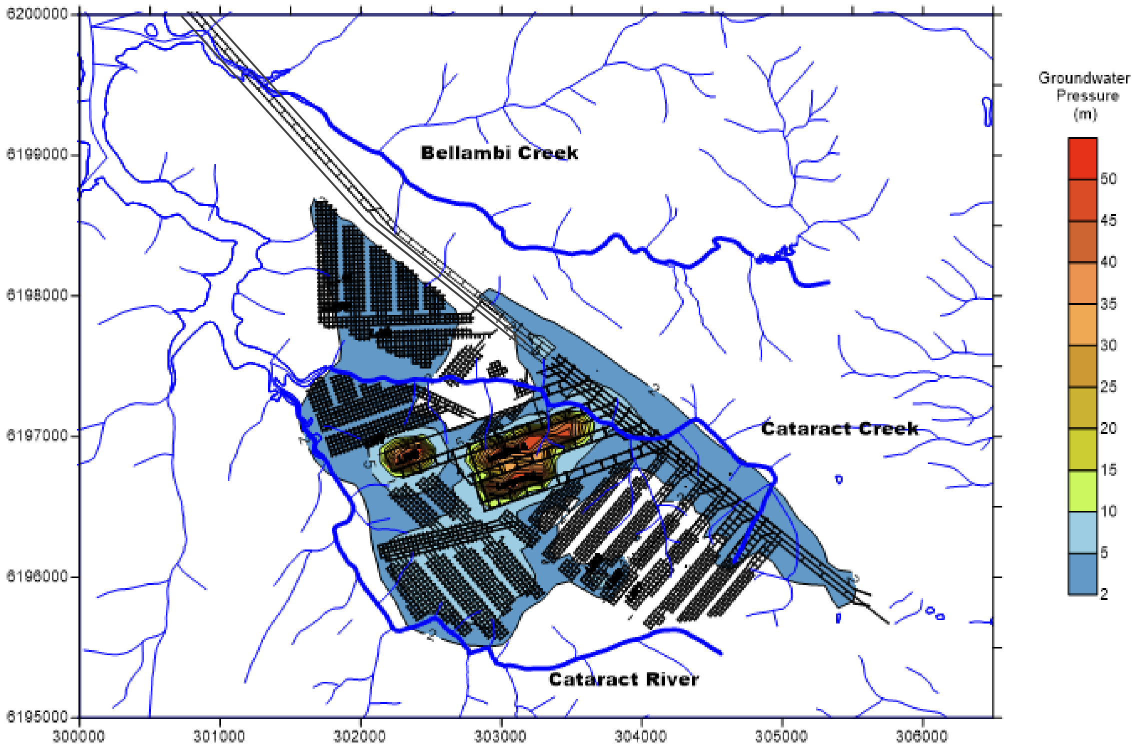


Figure 10-11 Drawdown In the Balgownie Seam after the Proposed Mining Relative to the Start of Mining in Wongawilli Seam

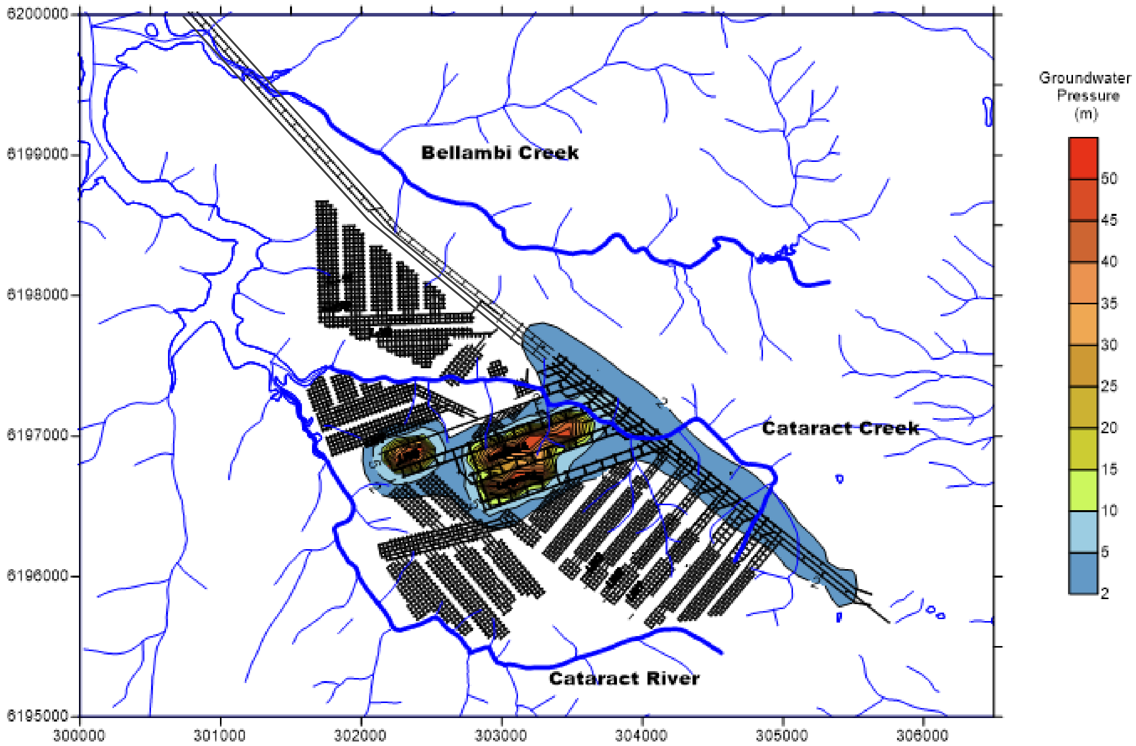


Figure 10-12 Drawdown within the Balgownie Seam after LW6 Relative to the Start of Mining in the Wongawilli Seam

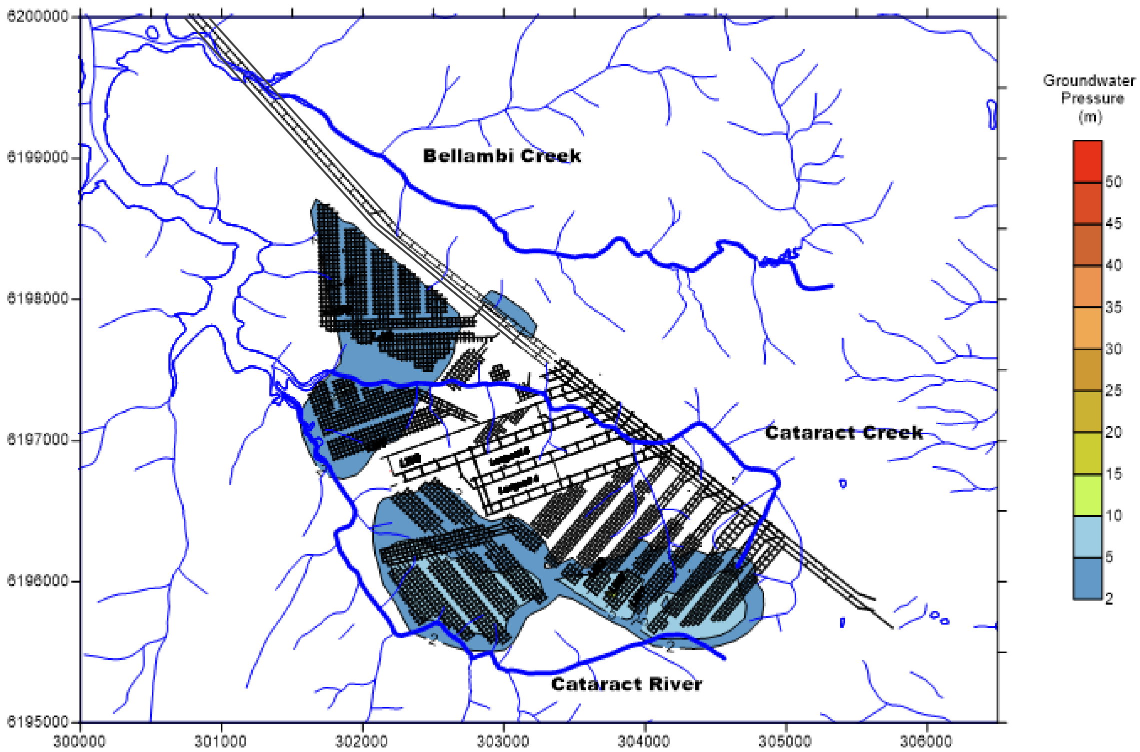


Figure 10-13 Drawdown within the Balgownie Seam after LW6 up to the end of the Proposed Mining

10.3.6 Wongawilli Seam

Drawdown occurs in the Wongawilli Seam at the end of the proposed first workings. The areal extent of the 2m drawdown contour at the end of the proposed mining extends a maximum of 0.5km to the north of the main headings as shown in **Figure 10-14**.

Figure 10-15 shows drawdown as a result of mining to date and highlights the drawdown over LW4, LW5 and LW6.

Figure 10-16 shows the drawdown resulting from the current proposal from the end of LW6 to the end of mining. Maximum drawdown of up to 50m above the Wongawilli Seam occurs just to the north of the Mains out to a distance of approximately 0.5km from the proposed workings.

As the depressurisation only progresses up to 50m above the Wongawilli Seam, there is no connective strata depressurisation up to surface as a result of the proposed workings.

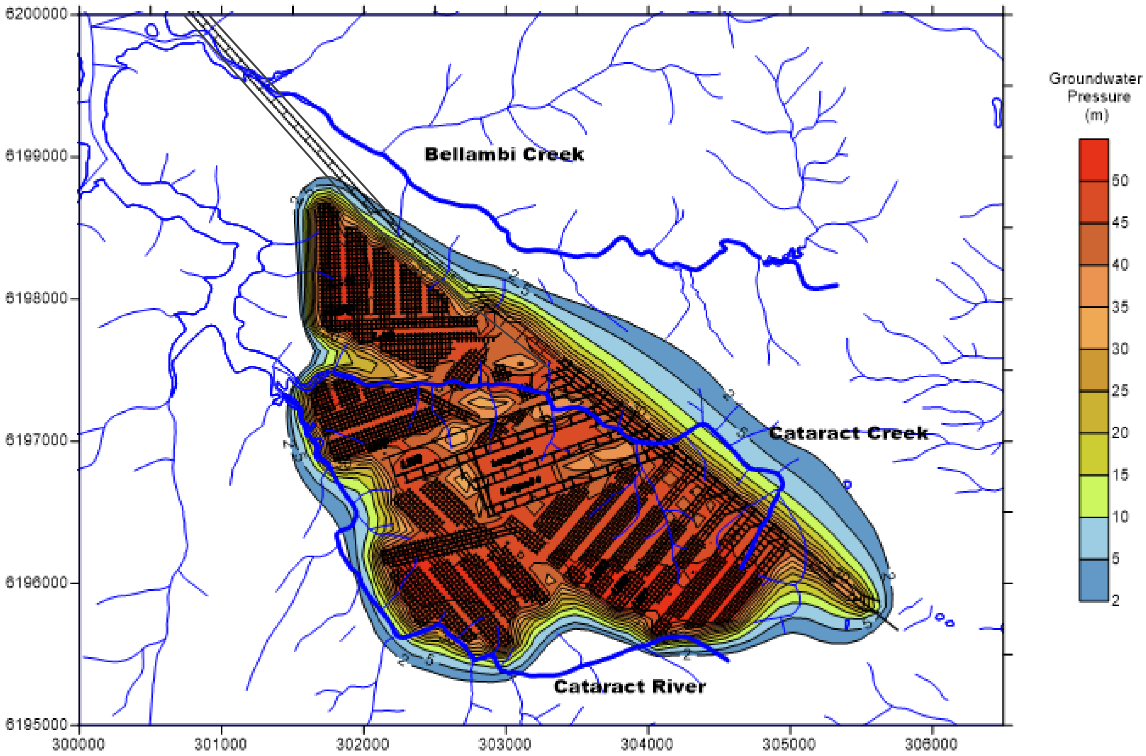


Figure 10-14 Drawdown After the Proposed Mining Compared to Pre Wongawilli Seam Development

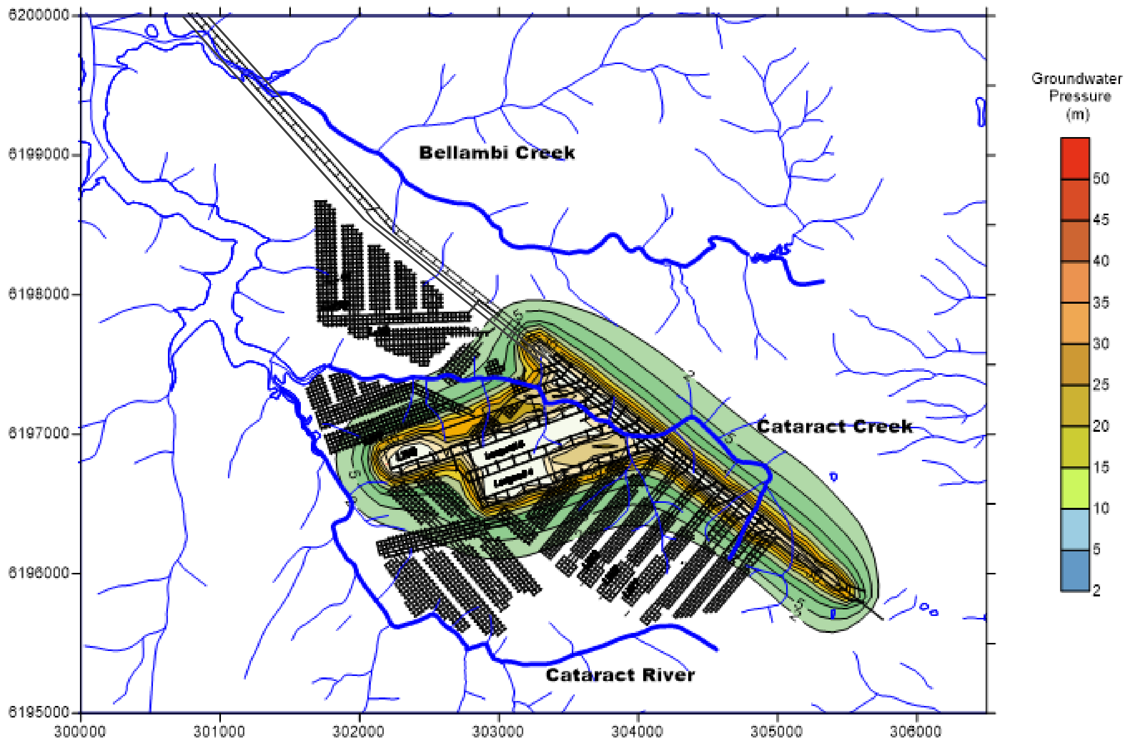


Figure 10-15 Drawdown within the Wongawilli Seam after LW6 Relative to the Start of Mining in the Wongawilli Seam

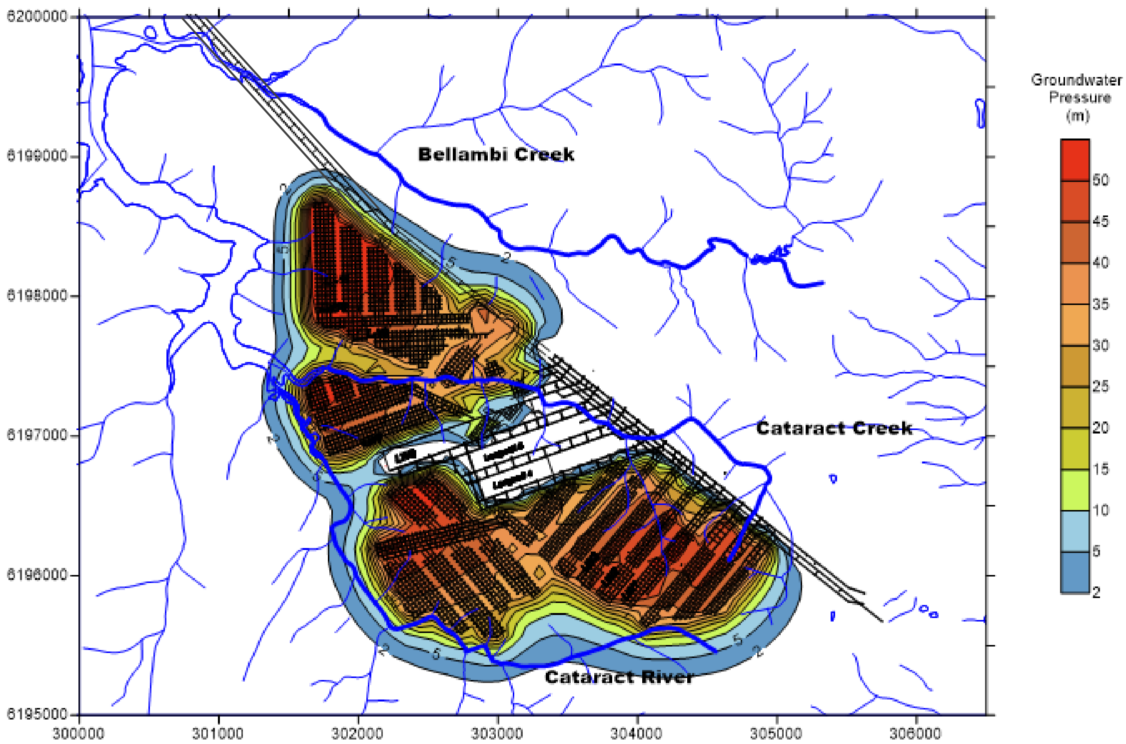


Figure 10-16 Wongawilli Seam Drawdown After the Proposed Mining Compared to the End of LW6

At 40 years after completion of mining, the Wongawilli Seam is predicted to recover by up to 45m in comparison to initial conditions over Russell Vale East as shown in **Figure 10-17** which is essentially close to a full recovery.

Groundwater levels at the escarpment are at pre-mining levels after 200 years. However, the lowest Adit entry level are at 117m AHD. Groundwater levels recover well in excess of initial conditions as shown in **Figure 10-18** as the overlying Bulli Seam is also recovering above that of initial conditions.

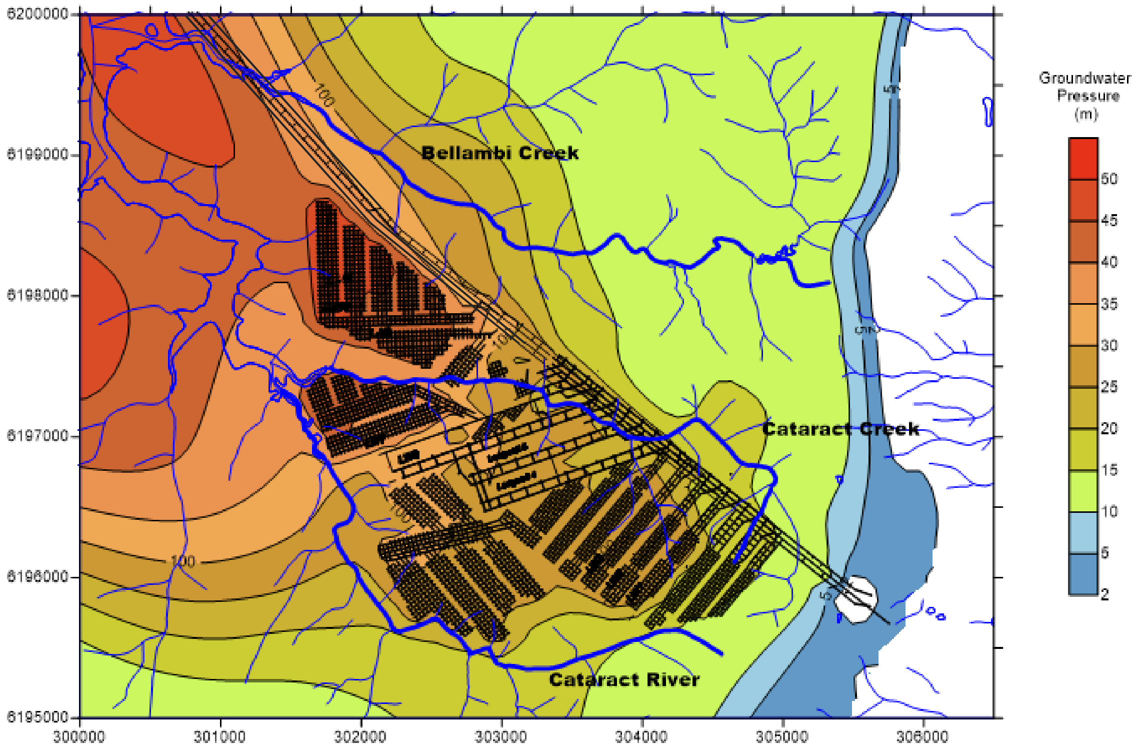


Figure 10-17 Wongawilli Seam Recovery 40 Years After Mining

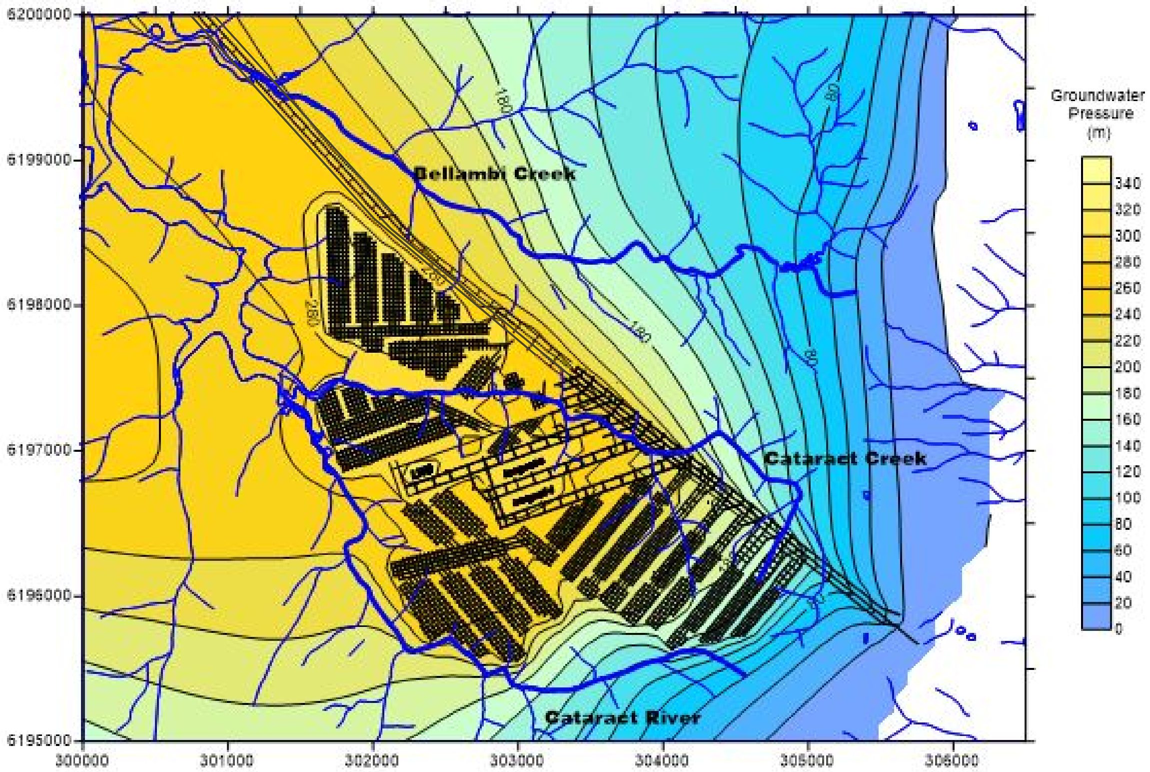


Figure 10-18 Wongawilli Seam Recovery 200 Years After Mining

Figure 10-19 shows a simulated recovery hydrograph at the location of vibrating wire monitoring bore GW1. It demonstrates the permanent dewatering evident within the strata overlying the triple seam mined areas within the Wongawilli Seam up to and including the Bulgo Sandstone.

Depressurisation associated with the proposed first workings is only evident in the Wongawilli Seam, as the predicted impacts in other seams is linked to Longwalls 4, 5 and 6

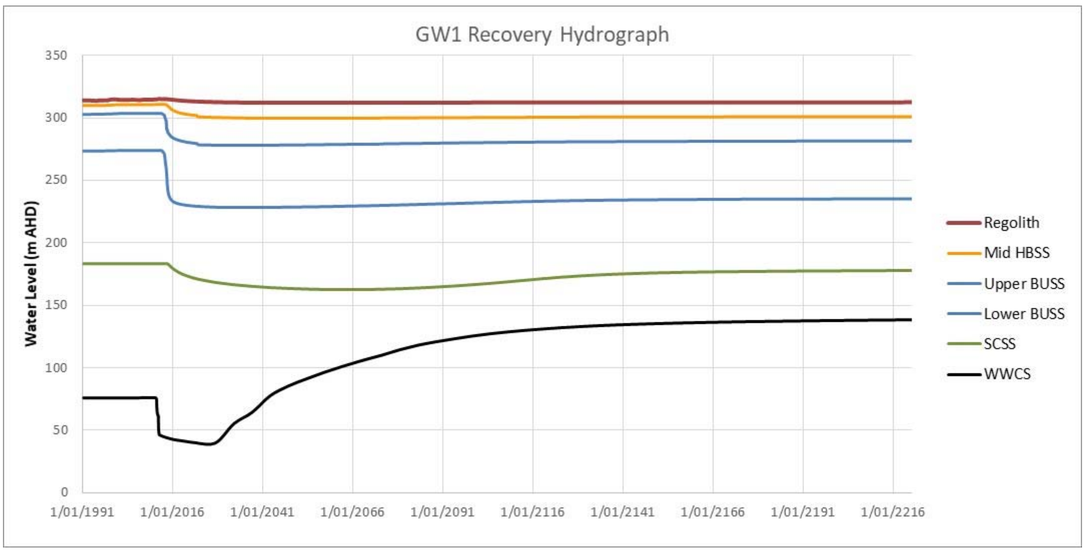


Figure 10-19 Modeled Recovery Hydrograph for GW1

10.4 Stream and Groundwater System Connectivity

A number of mechanisms can potentially occur to groundwater systems associated with streams:

- direct flow of surface water into mining induced fracture systems with vertical drainage into the shallow basement groundwater system;
- inter-connection of the depressurised strata and horizontal to sub-horizontal or "stepped" shear plane/s located beneath a stream bed and associated subsided hill slopes;
- flow of surface water from "losing" streams into the shallow groundwater system migrates along the local hydraulic gradient and re-emerges further downstream, with no hydraulic connection to the workings if there is no continuous, vertically connected fracturing;
- reversal of water transfer from the shallow groundwater system to the "gaining" streams during periods of high recharge, or;
- reduction of the perched and highly variable shallow groundwater contribution to swamps, and, subsequently, the local streams.

10.4.1 Cataract Creek

The geotechnical subsidence assessment (SCT Operations, 2015) concluded the multi-seam mined Bulli and Balgownie Seam workings at Russell Vale East diminished the spanning capacity remaining in the Bulgo Sandstone directly above the proposed Wongawilli Seam longwalls.

Observations over Longwall 4 indicate that due to the previously fractured nature of the overburden above the Bulli and Balgownie Seam workings, the subsidence "bowl" did not effectively extend outside of the longwall footprint (SCT Operations, 2019).

In the multi-seam mined area, even though horizontal bedding displacement may have extended up into the upper Bulgo Sandstone, this does not mean a direct, free vertical drainage hydraulic connection is present from the surface to the workings.

Monitoring of mine water balance (SCT Operations 2019B) has not detected any associated short term increase in mine water make from the current Russell Vale East workings following significant rain in the catchments over the Russell Vale East workings.

Monitoring of water level trends in piezometer NRE-A over the multi-seam mined area indicates the upper Hawkesbury Sandstone down to the Upper Bulgo Sandstone lithologies have an enhanced response to rainfall recharge. However, no adverse effect on stream flow has been observed as the headwater tributaries and main channel of Cataract Creek have had continuous flow throughout the monitoring period.

The bord and pillar mined areas represented by the open standpipe and vibrating wire piezometers at NRE B, C and D have a limited to minor response to rainfall recharge.

Where only Bulli seam first workings have been extracted, the proposed workings are not predicted to destabilise the Bulli seam pillars (SCT Operations 2019A) sufficiently to cause fracturing or displacement that will extend into the upper Bulgo Sandstone. This means there will be no predicted free drainage connection from surface to seam in these areas.

Beneath the plateau over the Bulli and Balgownie workings in the vicinity of Cataract Creek, extraction of the proposed first workings is modelled to not generate any observable depressurisation in Layer 1 at the end of the proposed first workings extraction.

As a result, there is no anticipated observable change in stream baseflow and seepage flow volumes to Cataract Reservoir.

It is possible, however, over the triple longwall mined area that, where they exist, or have been generated as a result of dilational movement of the hillslope after subsidence, perched and / or phreatic hillslope seepage outflow points may be relocated to lower elevations in the catchment. This would be due to the dilational fracturing of the hillslopes and associated hillslope basal shear zone movement as a result of valley closure.

No additional dilational shearing is anticipated to be generated as a result of the proposed first workings extraction.

Although the effect could not be addressed in the groundwater model due to the very thin zones of up to 10cm thickness (Mills, K.W, pers comm), the potential generation of a horizontal to sub-horizontal shear plane (or planes) in accordance with the theory of Mills (2007) in the perched hillslope aquifers and between 6 – 10m below the valley floor may lower the hillslope seepage outflow elevations. This could mean that the triple seam longwall affected baseflow seepage to the valley could occur lower down in the catchment, and could have generated a re-location in the transition point in the creek from ephemeral to intermittent / perennial flow.

It is also feasible that three stages of dilational, horizontal to sub-horizontal hillslope shear zones could have previously been generated following extraction of the secondary workings in the Bulli Seam, as well as after the Balgownie Seam Longwalls and Longwalls 4, 5 and 6 (340m) in the Wongawilli Seam.

It is anticipated that no additional incremental effect will be caused due to extraction of the proposed first workings, and they will not cause an observable change in overall stream discharge into Cataract Reservoir (in addition to any prior longwall related effects).

Mapping of the stream bed and tributaries indicates that baseflow seepage changes have probably occurred in Cataract Creek prior to extraction of Longwalls 4 to 6 (340m) in the Wongawilli Seam, based on the high degree of iron hydroxide seepage and precipitation present in the upper reaches all the way down to the Cataract Reservoir.

Due to the lack of stream bed, flow and chemistry monitoring prior to July 2008, quantification of the changes in water flow and chemistry in Cataract Creek due to mining the Bulli Seam and Balgownie Seam is not possible.

However, no observable change has been noted in the flow and chemistry of Cataract Creek due to extraction of Longwalls 4, 5 and 6 in the Wongawilli Seam (GeoTerra, 2017).

Stream flow modelling indicates the average daily stream flow from Cataract Creek to Cataract Reservoir is 13ML/d of which 4.1ML/d is baseflow, with a median baseflow of 2.9ML/d (WRM Water & Environment, 2015).

The groundwater modelling predicts a maximum of 0.027ML/day (9.91ML/year) transfer of stream flow from the stream beds to the underlying strata in the Cataract Creek, Cataract River and Bellambi Creek catchments primarily as a consequence of the combined impact of Longwalls 4 to 6 and the proposed first workings, as shown in **Table 7** and **Figure 10-20**.

It should be noted, however, that this does not mean that all of the stream flow is “lost” as flow into the reservoir, as a portion of the flow migrates to the reservoir via lower elevation, down-gradient, groundwater seeps into the lower catchments and reservoir. It is beyond the capacity of the groundwater or surface water models to specify how much of the 14.6ML will enter the reservoir via groundwater seepage from stream flows that were transferred from the stream bed into the underlying strata.

The maximum stream flow loss as a consequence of only the proposed first workings (only) is modelled to be 0.0006ML/day (0.22ML/yr) in Cataract Creek during 2073, which are essentially negligible.

10.4.2 Cataract River (Upstream of Cataract Reservoir) and Bellambi Creek

Although groundwater level reductions are predicted over the Russell Vale East workings, the majority of the changes are contained within Cataract Creek.

As such, there is anticipated to be no observable change in stream flow or groundwater seepage in the Cataract River (upstream of Cataract Reservoir) and Bellambi Creek catchments due to the very low proportion of the two catchments that may be partially depressurised as shown in **Table 7** and **Figure 10-20**.

The modelling predicts a maximum reduction in stream flow, due only to the proposed first workings, of 0.0002ML/day (0.07ML/yr) in Cataract River (upstream of Cataract Reservoir) and 0.0005ML/day (0.18ML/yr) in Bellambi Creek during 2072 to 2088.

The modelled annual changes for the Cataract River and Bellambi Creek will also be practically unobservable.

Table 7 Cataract Creek, Cataract River and Bellambi Creek Stream Baseflow Changes

	Baseflow Loss Due to ALL Mining (ML/day) / (ML/year)	Maximum Baseflow Loss Due to the Proposed First Workings (ML/day) / (ML/year)
CATARACT CREEK (Upstream of Cataract Reservoir)		
End of LW6	0.001 / 0.37	-
After Proposed Mining	0.024 / 8.76	0.0006 / 0.22 (in 2073)
CATARACT RIVER (Upstream of Cataract Reservoir)		
End of LW6	0.0014 / 0.51	-
After Proposed Mining	0.003 / 1.09	0.0002 / 0.07 (in 2083)
BELLAMBI CREEK		
End of LW6	0.000025 / 0.0091	-
After Proposed Mining	0.00014 / 0.051	0.0005 / 0.18 (in 2072)
TOTAL	**0.027 / 9.91**	**0.0013 / 0.47**

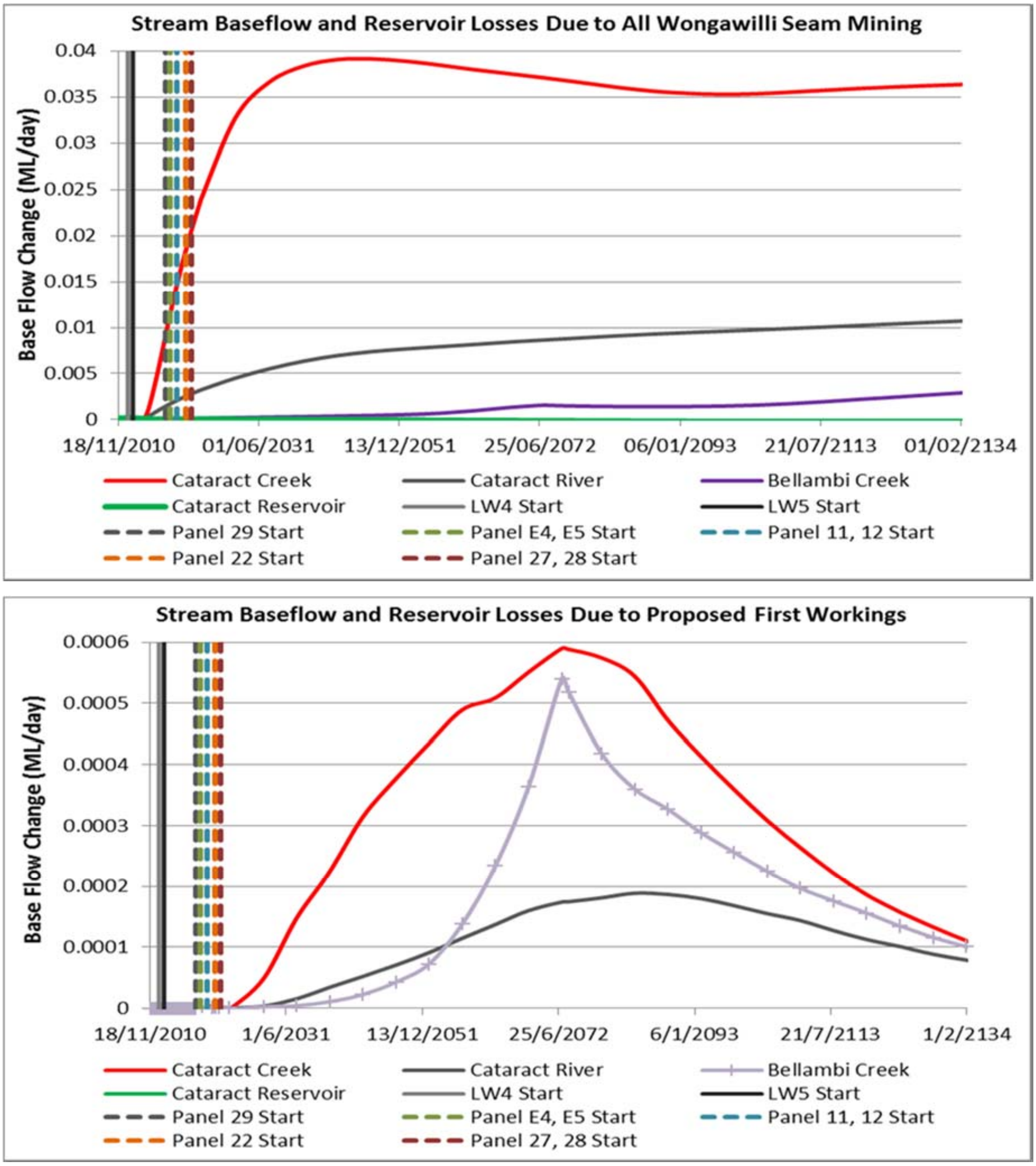


Figure 10-20 Russell Vale East Stream and Cataract Reservoir Depressurisation Related Base Flow Losses

10.4.3 Shallow Groundwater Contribution to Swamps

The volumetric contribution of shallow perched aquifer groundwater to swamps, and subsequently, as outflow drainage to the local streams is addressed in Biosis (2018) and WRM Water and Environment (2015).

Although no direct installation and monitoring of shallow ephemeral groundwater systems and their contribution to swamp water levels has been conducted to date, monitoring of piezometer water levels within swamps at Russell Vale East was assessed by Biosis (2014A), whilst their discharge outflow rates have been determined by WRM Water and Environment (2015).

Swamp water levels and outflows have subsequently been monitored by WCL (GeoTerra, 2017). This data indicates that the swamps are not, as is widely assumed, significant, long term contributors of baseflow to stream flow at Russell Vale East.

Monitoring to date (GeoTerra, 2017), indicates that tributary catchment flow sites downgradient of Longwalls 4, 5 and 6 (340m) do not have an observable baseflow reduction into Cataract Creek.

10.5 Cataract Reservoir

Cataract Reservoir has a full operating storage of 97,190ML. The lowest level of the storage as advised by Water NSW is 27,620ML or 29.3% capacity on 20 July 2006.

10.5.1 Stream Inflow

Due to the distance of the mined longwall panels (LW4, 5 and 6) and the proposed first workings from the Cataract Reservoir, and the lack of subsidence impacts from the proposed first workings, no adverse impacts on stored water quantity or quality have been observed, or are predicted to occur, as a result of the proposed first working extraction on, or in, Cataract Reservoir, based on the factors discussed in previous sections.

It is anticipated, however, that the water is currently flowing via previously developed subsurface fractures and is discharging down gradient into the lower section of the streams, and / or into Cataract Reservoir. No change is anticipated, however, due to the proposed first workings.

The potentially extremely minor stream flow loss into Cataract Reservoir associated with the existing mining impacts is very small compared to the potential evaporation off the surface of the full reservoir of 120,700ML/year.

The mechanism addressed by the groundwater model is the impact relating to regional depressurisation of the underlying aquifers, with associated groundwater level reduction.

10.5.2 Strata Depressurisation

The modelled transfer of stored water within Cataract Reservoir to the underlying groundwater system due to depressurisation of the regional groundwater system in the vicinity of the reservoir is not measureable at the end of the proposed mining as shown in **Figure 10-20** and **Table 8**.

Table 8 Cataract Reservoir Storage Changes

	Loss Due to ALL Mining (ML/day) / (ML/year)	Loss Due to Proposed First Workings (ML/day) / (ML/year)
(End of LW6)	0.000065 / 0.024	-
End of Proposed Mining	0.000065 / 0.024	0.0 / 0.0

10.6 Subsidence Interaction with Faults and Dykes

The Corrimal Fault is mapped as crossing to the south of Longwalls 4 and 5 and fades out within Longwall 6 and is not anticipated to generate a hydraulic connection to the surface water system or Cataract Reservoir. The fault has been identified as a “hinge fault” with a varying throw of approximately 25m in the east, reducing to 1.8m at Maingate 5, and is predicted to reduce to no displacement north of Longwall 6.

Intersection of the Corrimal Fault during development of the Longwall 6(340m) indicates the fault zones contains three “normal” faults with up to 0.93m displacement, and associated smaller faults, with no associated groundwater inflow (Wollongong Coal, 2014).

This indicates that the Corrimal Fault “zone” is diminishing to the north and is anticipated to fade out before it underlies the reservoir. This observation indicates that the potential re-activation or displacement of the Corrimal Fault due to subsidence and, therefore, it’s potential to cause a significant hydraulic connection between the workings and the mine, or significant drainage from the reservoir to the mine, is not considered likely.

To date, mining in the Bulli seam on both sides of the Corrimal Fault (both first and second workings), has not resulted in observable increased flows to the mine workings (Gujarat NRE Coking Coal, 2013).

SCT Operations Pty Ltd Report WCRV4466A “Assessment of Corrimal Fault and Dyke D8 at Russell Vale East as Risks to the Stored Waters of Cataract Reservoir” (SCT 2015) concluded that there is no credible risk of inflow between the stored waters of Cataract Reservoir and the mining horizons through either the Corrimal Fault or Dyke D8 as a result of the proposed UEP-PPR mining layout for longwall extraction.

SCT Operations (2015) further concluded that any effects from mining first workings roadways in the Wongawilli Seam are expected to be generally limited to a few metres around the proposed roadways. No significant subsidence impacts or environmental consequences are expected from mining through or in the vicinity of the Corrimal Fault and Dyke D8 by the proposed first workings layout. The likelihood of impacts to the Corrimal Fault is considered to be very low. The consequences of any impacts to the Corrimal fault are expected to be negligible. Any impacts on groundwater are expected to be limited to the immediate vicinity of the Wongawilli Seam and only in the area of the proposed mining.

Based on past mining experience and interpretation of the mine water balance monitoring (SCT Operations, 2019), the faults in the Bulli / Balgownie workings are essentially dry and are not anticipated to provide enhanced permeability fluid pathways in the proposed mining area.

The thin (<1m wide) highly weathered dyke D8 is located over the Russell Vale East workings, however, due to its highly weathered clay state and associated low intrinsic permeability, undermining this structure is not anticipated to enhance its permeability or potential hydraulic connection to the surface water systems (including Cataract Reservoir).

No water inrush has been observed with mining through faults or dykes in the Bulli, Balgownie or Wongawilli Seam workings (S Wilson, pers comm).

10.7 Groundwater Inflow to the Workings

The predicted modelled groundwater inflows to the Russell Vale mine are shown in **Table 9** and **Figure 10-21**.

The proposed extraction at Russell Vale East will start with Panel 8 and progress to Panel 34.

A background groundwater inflow of 0.2ML/day is currently measured from the Bulli Seam workings including the western side of Cataract Reservoir. These inflow rates are variable in the recorded flow data however the average rate for the period from 1/1/2013 – 31/12/2014 is 0.6ML/day (219ML/year). These rates decrease in Russel Vale East as groundwater makes its way vertically down to the Wongawilli Seam workings.

However, it should be noted that approximately 0.6ML/day is pumped out at Russell Vale portal which originates from the Bulli seam workings at Russell Vale West. It is assumed that this includes 0.2ML/day (73ML/year) of inflow that is generated in the up-gradient Cordeaux Colliery lease area as this area is partially flooded and there is a potential head gradient across the barrier, which means that groundwater from the Corrimal workings flows south into the WCL workings, as the western EWCL Bulli Seam workings are in the order of 40m lower than the Corrimal workings.

The groundwater taken by the upgradient Corrimal underground workings, which subsequently flows into the WCL workings, should not be required to be licensed by WCL as well, as the Corrimal Lease holders are required to have a license for groundwater inflows that are initially and primarily generated by their workings.

In addition, 0.2ML/day (73ML/year) of groundwater seepage inflow from Russell Vale East is also thought to be generated from the up-gradient Bulli Colliery.

Groundwater discharge from the adit is only predicted to occur when the groundwater elevation reaches the spill point of the adit, which is at approximately 0.3ML/day (110ML/year).

It is worth noting that net groundwater make from the combined existing and proposed underground workings is predicted to decline to approximately 110ML/year once the groundwater levels reach the adit discharge point elevation.

Table 9 Predicted Groundwater Mine Inflows

Stage	Bulli Seam Inflow (ML/day) and (ML/year)	Predicted Russell Vale East Inflow (ML/day) and (ML/year)	Total Mine Inflow (ML/day) and (ML/year)	Maximum Total Licensable Inflow (ML/year) (excluding up gradient inflow of 146ML/year)
Pre Longwall 4	0.22 / 80	-	0.22 / 80	80
End of Longwall 6	0.22 / 80	0.43 / 157	0.65 / 237	157
After Proposed First Workings	0.25 / 91	0.53 / 193.5	0.79 / 288	288

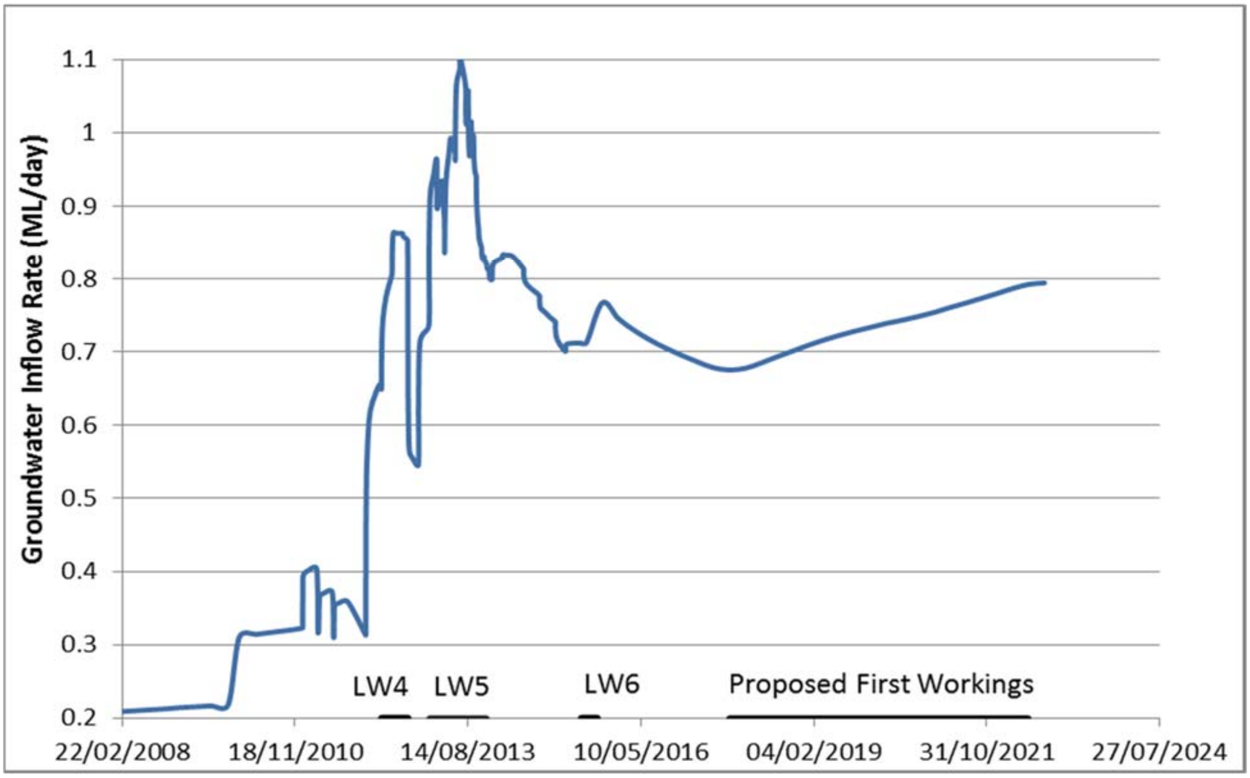


Figure 10-21 Predicted Total Groundwater Seepage Inflows

10.8 Mine Water Level Recovery

The groundwater inflow rate gradually increases during extraction of the proposed first workings as they are dewatered. After the proposed first working mining activities are completed, the pumps are turned off and the mine gradually fills up and re-pressurises the overburden.

Figure 10-22 shows a simulated recovery hydrograph at the location of the mine entry adit for the Wongawilli Seam that daylights in the Illawarra Escarpment. It shows groundwater levels in the Wongawilli Seam recover to above the LW4, 5 and 6 and the proposed first workings pre-mining levels and that they reach the 117.5m AHD elevation of the escarpment adit at around 2057.

Figure 10-23 shows the modelled discharge rate out of the adit, which gradually increases to a maximum of approximately 0.3ML/day as the mine and overburden re-saturates.

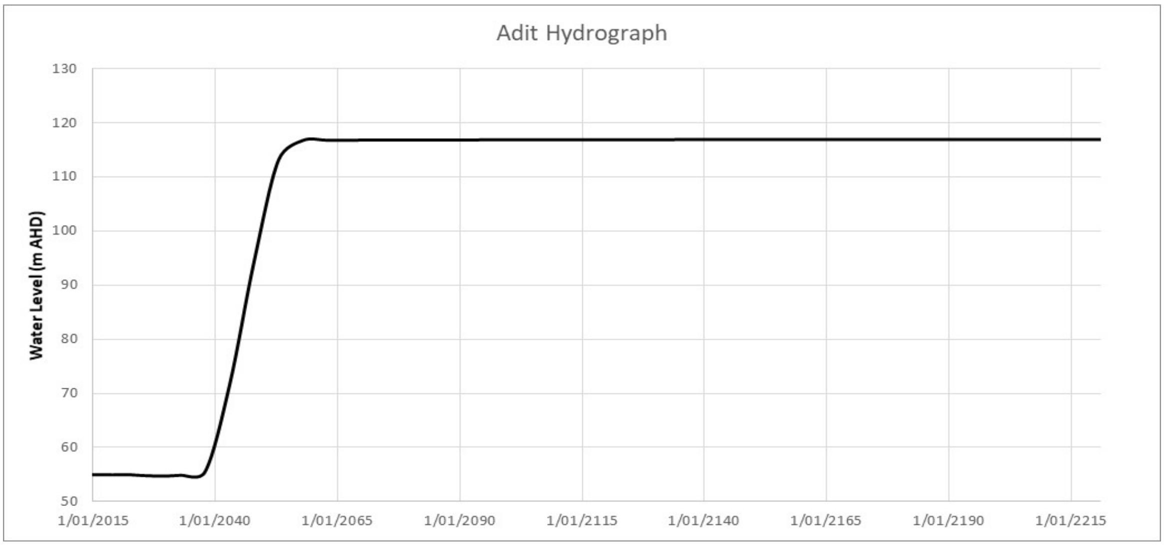


Figure 10-22 Modelled Recovery Hydrograph for Wongawilli Seam Near the Esacarpment Adit

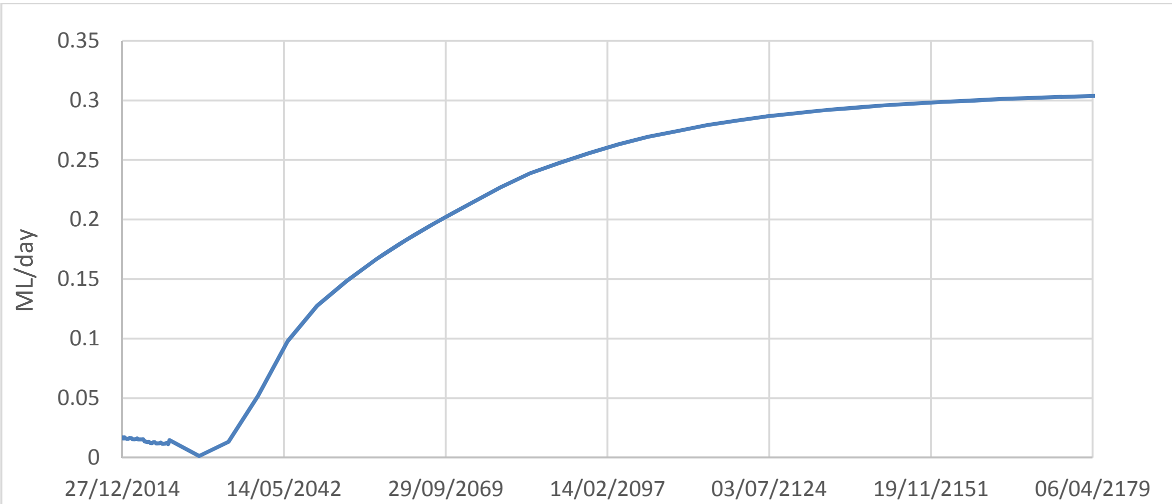


Figure 10-23 Illawarra Escarpment Adit Drainage

10.9 Groundwater Chemistry

Previous observations at Russell Vale indicate that groundwater quality within the regional groundwater system has not been adversely affected by mining, however there may be some localised increased iron hydroxide precipitation and limited lowering of pH if the groundwater is exposed to “fresh” surfaces in the strata through dissolution of unweathered iron sulfide or carbonate minerals.

In a general sense, the degree of iron hydroxide and pH change is difficult to predict, and can range from no observable effect to a distinct discolouration of the formation water. The discolouration does not pose a health hazard, however it can cause iron hydroxide precipitation at seepage points in local streams which can also be associated with algal matting and / or lowering of dissolved oxygen levels in the creek at the seepage point.

It should be noted that many Hawkesbury Sandstone aquifers in the Southern Coalfield already have significant iron hydroxide levels, and that ferruginous seeps can also be observed in previously un-subsided catchment areas.

Due to the very low level of predicted subsidence, and by association, the minimal overburden fracturing that could develop as a result of the proposed first workings, no observable pH or iron hydroxide changes are anticipated in the shallow strata layers.

Based on an extensive surface water and groundwater monitoring database, and on the observed and predicted impacts from historical and proposed subsidence, the proposal will not result in a reduction in the quality of surface and groundwater inflows to Cataract Reservoir.

10.10 Potential Loss of Bore Yield

There will be no loss of bore yield as there are no registered private bores or wells located within the Russell Vale lease area as a result of the proposed first workings.

11. CUMULATIVE GROUNDWATER RELATED IMPACTS

11.1 Upland Swamps

As outlined in Biosis (2014), no other adjoining mining operations provide a cumulative impact on, and no swamps are present downstream of, the Wollongong Coal Russell Vale lease area.

11.2 Basement Groundwater

The cumulative impact of the existing and proposed Russell Vale workings along with the surrounding mines has been assessed in the model runs by including the effects of:

- hydraulic permeability distribution over non-mining areas;
- subsidence, fracture propagation and associated hydraulic permeability distribution over bord and pillar, pillar extraction or longwalls on the regional groundwater pressure distribution;
- known or estimated degree of flooding in the adjoining workings, and;
- the separation distance from adjoining workings, where Appin / Westcliff / Northcliff / Metropolitan / Tahmoor mining areas were interpreted to be sufficiently distant from the existing and proposed Russell Vale Colliery workings to be discounted.

Groundwater modelling indicates that the influence of the proposed first workings can be broken down into the depressurisation of two separate regimes:

- within the Wongawilli Seam, and;
- overburden above the Wongawilli Seam.

The Wongawilli Seam and overburden immediately overhead would be depressurised to atmospheric pressure in the immediate footprint of the workings, however there would be minimal transgression of depressurisation above the Bulli Seam at the end of the mining period.

The overlying Balgownie and Bulli seams have previously been mined and therefore significant depressurisation has occurred historically.

The shallower surficial strata groundwater levels / pressures will be unaffected by the proposed first workings.

Regionally, the closest mining operations include those utilised for the model boundaries. The Appin Mine is located 13 km to the north-west operates within the Bulli Seam. Twelve kilometres to the south-west, Dendrobium Colliery is mining the Wongawilli Seam.

A review of the groundwater related studies undertaken for these projects indicates that regional drawdown at Appin extends approximately 2-3 km from the southern margins of the current operation (Heritage Computing 2009) and similarly at Dendrobium Colliery (Coffey Geotechnics, 2012).

Modelling conducted for this study and previous studies in the Southern Coalfield indicates there will not be any superposition of drawdown cones between the Russell Vale and Appin / Dendrobium mining areas. Therefore, there is no cumulative depressurisation resulting from the proposed first workings and other adjoining mines.

Cumulative losses include the impacts from all of the adjoining historical, decommissioned mining areas as well as depressurisation due to the proposed Wongawilli Seam first workings extraction. These impacts, however, do not expand into, or interact with, the current or proposed mining operations at Appin Mine and Dendrobium Colliery.

12. MODELLING UNCERTAINTY

The Australian groundwater modelling guidelines provide a guiding principle in relation to model uncertainty as shown below:

"Models should be constructed to address specific objectives, often well-defined predictions of interest. Uncertainty associated with a model is directly related to these objectives" (SKM 2012).

All models contain uncertainty and a groundwater model's predictive capacity is limited by the ability to simulate the Russell Vale east mining domain within the overall Application Area at a sufficiently detailed scale.

In the previous modelling exercise, sensitivity to various physical parameters was analysed with a focus on the possible connection of surface water features to a potential subsidence generated depressurisation field and subsequent depletion of stream flow. Details of this analysis is outlined in GeoTerra / GES 2015.

Review of the previous model iteration highlighted the key uncertainty being associated with the fracture zone height and physical hydraulic parameters within the fracture zone causing potential connection with surface features.

The first workings proposal has no potential for hydraulic depressurisation connection with the surficial layers due to the minimal subsidence associated with the proposal.

13. MODEL LIMITATIONS

The adopted model has been designed to simulate the propagation of both near-field and far-field depressurisation effects throughout the regional aquifer system.

The model has not been designed to simulate the localised effects of near-surface tensile stream bed cracking due to valley closure and valley uplift effects on stream flow, nor has it been designed to assess subsidence effects on swamp water levels or discharge volumes.

The model does not include specific assessment of structural features such as faults and dykes which have the potential to compartmentalise or connect facets of sub-regional aquifers and also potentially surface water features to sub-surface strata.

However, as outlined in SCT Operations (2015) the potential impacts and environmental consequences of interaction with structures such as the Corrimal Fault are likely to be negligible.

The model has not assessed geological faults and structures due to the uncertainty in their location, vertical persistence, hydraulic parameters and their resultant attributes as post subsidence barriers or transmissive conduits.

The model has been designed with the main objectives being to simulate water level variability to mining stresses, to assess groundwater seepage to underground mining areas and to assess the potential impact with surface water features.

Outcomes from the model heavily relied on calibration against targets such as groundwater levels and mine water pumping rates which were supplied by the proponent and were recently reviewed and updated, but still have a degree of uncertainty due to their short (<2 year) reliable data records.

14. WATER LICENSING

14.1 Groundwater

The Project is covered by the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (Groundwater WSP), which applies to 13 groundwater sources.

The current Water Access Licence (WAL) under the *Water Management Act, 2000* is held by Wollongong Coal Ltd for 515 ML (units)/year (Licence No. WAL36488) and is located within Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source.

For the purposes of the Act, an 'aquifer' is defined as *"a geological structure or formation, or an artificial landfill that is permeated with water or is capable of being permeated with water"*. Abandoned workings are not geological structures or formations and as such, do not constitute aquifers. Therefore, water make sourced from abandoned workings does not constitute the taking of water from the water source, whereas the Wongawilli coal seam and overburden satisfy the definition of 'aquifer" and the mining effects on them are deemed to be a water "take".

Since the Groundwater WSP applies to all aquifers, Wollongong Coal will require WALs for all groundwater taken in the course of mining from, excluding any up-gradient sources that have been already taken by adjoining lease areas. The total licensing entitlement required will be the maximum mine water make, which will include the water taken from each formation as a result of the proponent's proposed and existing workings.

Based on the predicted maximum groundwater inflow make into the WCL workings of 288ML/year, Wollongong Coal currently hold a sufficient quanitity of units in their WAL.

For licensing requirements, the 288ML/year is max inflow that requires licensing by WCL, although the long term groundwater make is predicted to reduce to around 110ML/year.

The Sydney Basin Nepean Groundwater Source WSP limits the total share component for aquifer licences in this water source to 16,283 unit shares.

14.2 Surface Water

The Project is located within the area covered by the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* (Unregulated River WSP). The Unregulated River WSP includes six water sources, with the Project situated entirely within the 'Upper Nepean and Upstream Warragamba Water Source".

Clause 4 of the Unregulated River WSP states that these water sources include all water:

- *Occurring naturally on the surface of the ground shown on the Registered Map; and*
- *In rivers, lakes, estuaries and wetlands in these water sources.*

Wollongong Coal currently does not hold any licences for surface water use for the region covering the proposed mining area and will need to obtain WALs for the total volume of surface water taken from the Upper Nepean and Upstream Warragamba Water Source.

The WSP limits the total share component for unregulated river licences in this water source to 15,540.2 unit shares.

Impacts that would give rise to licensing requirements include:

- reduction in base flows to streams due to drawdown;
- additional runoff that infiltrates into the groundwater system via subsidence induced shallow cracking;
- leakage from swamps; and
- loss of water from Cataract Reservoir due to depressurisation.

Cracking of streams may result in a reduction of stream flow through re-directing water into the bedrock. Although this water may re-emerge downstream, the water is deemed to have been "taken" as it is diverted from above to below the ground surface. Section 60I of the WM Act indicates that the water is deemed to be taken even if it is returned to the water source. Section 60I states:

"a person takes water in the course of carrying out a mining activity if, as a result of or in connection with, the activity or a past mining activity carried out by the person, water is removed or diverted from a water source (whether or not water is returned to that water source) or water is re-located from one part of an aquifer to another part of an aquifer".

The maximum predicted loss of stream baseflow due to basement depressurisation under the Cataract Creek, Cataract River and Bellambi Creek catchments within Management Zone 2 of the Sydney Basin Nepean Groundwater Source, as a result of the cumulative impacts from mining at Russell Vale, including the proposed first workings mining, is 9.91ML/yr at the end of mining as shown in **Table 10**.

Table 10 Surface Water Licensing Requirements

Surface Water Source	Predicted Cumulative Surface Water "Take" (ML/year)
Russell Vale East Stream Baseflow	9.91
Cataract Reservoir Leakage	0.13
(TOTAL)	**10.04**

Volumetric assessment of potential annual stream flow changes due to valley closure related cracking and transfer to sub-surface flow cannot be assessed by the groundwater model, nor can it be predicted by any other method as the response of a stream bed to valley closure and compressional / tensional cracking is highly site specific and highly variable within a stream bed due to up to 36 variable factors (Kay, D.R, Waddington, A.A, 2014) and (Barbato, J et al, 2014). It is noted however that the proposed first workings are not predicted to result in any subsidence related impacts in this regard.

Under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources, which encompasses the overall Application Area and is contained within the Sydney Basin Nepean Groundwater Source Area, Wollongong Coal will require a WAL for the annual take of up to10.04 ML/yr of stream baseflow resulting from depressurisation of deeper aquifers.

15. NSW AQUIFER INTERFERENCE POLICY MINIMAL IMPACT CONSIDERATIONS

The Aquifer Interference policy (AIP) prescribes minimal impact considerations which must be satisfied.

The minimal impact considerations for a water source vary depending on the nature of the water source (i.e. alluvial, coastal, fractured rock etc) and whether it is "highly productive groundwater" or "less productive groundwater".

The minimal impact considerations for less productive porous rock water sources are presented in **Table 11** and for the perched, ephemeral aquifers in **Table 12**.

The aquifers are not considered to be "highly" productive as although they contain total dissolved solids of less than 1500mg/L in the Hawkesbury Sandstone, there are no water supply works that yield water at a rate greater than 5L/sec in the Russell Vale East area.

Table 11 NSW Minimal Impact Considerations for Less Productive Porous Rock Water Sources

Minimal Impact Consideration	Proponent Response
Water Table – Level 1 Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan variations, 40m from any: a) high priority groundwater dependent ecosystem, or b) high priority culturally significant site listed in the schedule of the relevant water sharing plan, or A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.	There are no: • high priority groundwater dependent ecosystems, or; • high priority culturally significant sites listed under Schedule 4 of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The swamps above the mine plan are not classified as Temperate Highland Peat Swamps on Sandstone (which is high priority GDE). There are no water supply works (i.e. groundwater bores) in the Wonga East proposal area that will undergo more than a 2m decline.
Water Table – Level 2 If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site listed in the schedule of the relevant water sharing plan then appropriate studies will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Level 2 does not apply as Level 1 criteria is not exceeded
Water Pressure – Level 1 A cumulative pressure head decline of not more than 40% of the "post-water sharing plan" pressure head above the	There are no water supply works (i.e. groundwater bores) in the Wonga East proposal area that will undergo a greater than 40% post water sharing plan pressure head decline above the

base of the water source to a maximum of a 2m decline, at any water supply work.	base of the water source, and no water supply work will undergo greater than 2m decline
Water Pressure – Level 2 If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Level 2 does not apply as Level 1 criteria is not exceeded
Water Quality – Level 1 a) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity, and b) No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a "reliable water supply" is not an appropriate mitigation measure to meet considerations 1(a) and 1(b) above. c) No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a "reliable water supply".	The beneficial use category of the groundwater source will not be changed beyond 40m from the Wonga East proposal area. There are no highly connected surface water sources (alluvial aquifers) in the Wonga East proposal area There are no highly connected alluvial surface water sources defined as a reliable water supply within the Wonga East proposal area
Water Quality – Level 2 If condition 1(a) is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works. If condition 1(b) is not met then appropriate studies are required to demonstrate to the Minister's satisfaction that the River Condition Index category of the highly connected surface water source will not be reduced at the nearest point to the activity. Condition 1(c) does not apply as there are no river bank or high wall instability risks and no need for low permeability barriers between the site and highly connected surface waters	Level 2 does not apply as Level 1 is not exceeded

Table 12 NSW Minimal Impact Considerations for Perched Ephemeral Aquifer Water Sources

Minimal Impact Consideration	Proponent Response
Water Table – Level 1 Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan variations, 40m from any: c) high priority groundwater dependent ecosystem, or d) high priority culturally significant site listed in the schedule of the relevant water sharing plan, or A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.	There are no: • high priority groundwater dependent ecosystems, or; • high priority culturally significant sites listed under Schedule 4 of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The swamps above the mine plan are not classified as Temperate Highland Peat Swamps on Sandstone (which is high priority GDE). There are no water supply works (i.e. groundwater bores) in the Wonga East proposal area that will undergo more than a 2m decline.
Water Table – Level 2 If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: c) high priority groundwater dependent ecosystem, or d) high priority culturally significant site listed in the schedule of the relevant water sharing plan then appropriate studies will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Level 2 does not apply as Level 1 criteria is not exceeded
Water Pressure – Level 1 A cumulative pressure head decline of not more than 40% of the "post-water sharing plan" pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.	There are no water supply works (i.e. groundwater bores) in the Wonga East proposal area that will undergo a greater than 40% post water sharing plan pressure head decline above the base of the water source, and no water supply work will undergo greater than 2m decline
Water Pressure – Level 2 If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Level 2 does not apply as Level 1 criteria is not exceeded

<u>Water Quality – Level 1</u> d) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity; and	The beneficial use category of the groundwater source will not be changed beyond 40m from the Russell Vale East proposal area.
e) No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a “reliable water supply” is not an appropriate mitigation measure to meet considerations 1(a) and 1(b) above.	There are no highly connected surface water sources (alluvial aquifers) in the Russell Vale East proposal area
f) No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”.	There are no highly connected alluvial surface water sources defined as a reliable water supply within the Russell Vale East proposal area
<u>Water Quality – Level 2</u> If condition 1(a) is not met then appropriate studies will need to demonstrate to the Minister’s satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works. If condition 1(b) is not met then appropriate studies are required to demonstrate to the Minister’s satisfaction that the River Condition Index category of the highly connected surface water source will not be reduced at the nearest point to the activity. Condition 1(c) does not apply as there are no river bank or high wall instability risks and no need for low permeability barriers between the site and highly connected surface waters	Level 2 does not apply as Level 1 is not exceeded

16. ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979 ASSESSMENT

16.1 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

Clause 10 of the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011(Drinking Water SEPP) provides that:

a consent authority must not grant consent to the carrying out of development under Part 4 of the Act on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on water quality.

This is known as the Neutral or beneficial effect (NorBE) test.

As a Part 3A Project, the Drinking Water SEPP does not formally apply, however the NorBE test has been held by the NSW Land and Environment Court to be a relevant (but not mandatory) consideration for the Minister (or delegate) when determining a Part 3A Application.

As discussed in the following section in relation to the WaterNSW Principles for Mining and Coal Seam Gas Activities in Declared Catchment Areas, the Revised Preferred Project is predicted to have no (or a neutral) impact on water quality in the Cataract Reservoir and its tributaries.

Clause 11A of the Drinking Water SEPP is also relevant in that sets the context for the NorBE test in relation to existing mining operations where an application to extend mining is lodged prior to the expiry of the right to mine.

In these circumstances, the NorBE test considers the predicted impacts of the proposed project on water quality compared to the adverse impact that the continuing development would have if it were extended or expanded under similar conditions as the existing development consent.

As with clause 10, the application of this test is not mandatory to the Project in that it is a Part 3A Project application, however it is noted that the continuation of longwall mining is likely to have had a significantly greater adverse impact on water quality in Cataract Reservoir than the proposed project due to the potential impacts on swamps and creek systems that longwall mining in this area.

Table 13 presents an assessment of the impact against the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*, in accordance with WaterNSW (2015).

Table 13 Neutral or Beneficial Effect Test Impact Assessment

Assessment Condition	Compliant	Impact Assessment
"A neutral or beneficial effect on water quality is satisfied if the development: (a) has no identifiable potential impact on water quality, or	Yes	the Revised Preferred Project is predicted to have no (or neutral) impact on water quality in the Cataract Reservoir and its tributaries
(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or	Yes	The Revised Preferred Project will not result in any groundwater within the mine entering the Sydney Drinking Water Catchment. Outflows from the adit following re-pressurisation up to the elevation of the adit will be at a rate similar to currently approved operations. The predicted rate of outflows from the adit (approximately 0.3ML/day) are capable of being treated to an appropriate quality prior to any discharge to Bellambi Gully if reuse for industrial or other uses is not required
(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority."	Yes	Not applicable

Accordingly, the Revised Preferred Project is considered to satisfy the NorBE Test as applied under clause 11A of the Drinking Water SEPP.

17. WATER NSW PRINCIPLES FOR MANAGING MINING AND COAL SEAM GAS IMPACTS IN DECLARED CATCHMENT AREAS

The Water NSW principles prescribing minimal impact considerations which must be satisfied in declared catchment areas for mining and coal seam gas activities and the proponent's response are outlined in **Table 14**.

Table 14 WaterNSW Principles for Mining and Coal Seam Gas Activities in Declared Catchment Areas

WaterNSW Principles for Mining and Coal Seam Gas Activities in Declared Catchment Areas	Proponent's Response in Regard to the Proposed First Workings Extraction of the Wongawilli Seam at Russell Vale East	Relevant Report Section
must not result in a reduction in the quantity of surface and groundwater inflows to storages or loss of water from storages or their catchments	The proposal will not result in an observable reduction in the quantity of surface or groundwater inflows to, or loss of water from, Cataract Reservoir	10.1, 10.4
must not result in a reduction in the quality of surface and ground water inflows to storages	The proposal will not result in a reduction in the quality of surface and groundwater inflows to Cataract Reservoir	10.9
must not pose increased risks to human health as a result of using water from the drinking water catchments	The proposal will not pose an increase in risk to human health as a result of using water from Cataract Reservoir	Section 5.2 – 5.3 of the revised preferred project.
The integrity of the WaterNSW's water supply infrastructure must not be compromised	The proposal will not compromise the integrity of WaterNSW water supply infrastructure	SCT
The ecological integrity of the Special Areas must be maintained and protected	The proposal will maintain and protect the ecological integrity of the Cataract Reservoir Special Area	Section 5.5 Biosis
Information provided by proponents, including environmental impact assessments, must be detailed, thorough, scientifically robust and holistic. The potential cumulative impacts must be comprehensively addressed	Information provided in this assessment is detailed, thorough, scientifically robust and holistic and the potential cumulative impacts have been comprehensively addressed	11.0

18. MONITORING, CONTINGENCY MEASURES & REPORTING

Wollongong Coal will prepare a Water Management Plan in accordance with conditions of Project Approval.

The Water Management Plan will include a groundwater monitoring program, which will include monitoring of groundwater levels, water quality, pumping volumes and stream flows.

The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model, as required.

18.1 Groundwater Levels

Piezometers to be included in the monitoring suite are shown in **Table 15**.

The suite is divided into standpipe and vibrating wire piezometers, with water level transducers and vibrating wire piezometers used to monitor standing water levels or pressure heads twice daily to assess variations in the colluvial and basement formations.

Table 15 Groundwater Level Monitoring Suite

	Piezometer Type
Basement	
NREA, C, D, E, G, NRE3, GW1A, RV18, 19, 21, 22A, 23A	Open Standpipe
NREA, B, D, NRE3, GW1, RV16, 17, 20, 22, 23	VWP

NOTE: VWP = vibrating wire piezometer

Monitoring will also involve bi-monthly manual standing water level measurement in all open standpipe piezometers, at which time the loggers will be downloaded and re-initiated as shown in **Table 16**.

Table 16 Standing Water Level Monitoring Method and Frequency

Monitoring Site	Sampling Method	Frequency / Download	Units
Open standpipe piezometers	Water level logger / dip meter	twice daily / bi-monthly	mbgl
Vibrating wire piezometer arrays	Vibrating wire piezometer	twice daily / quarterly	m head pressure

NOTE: mbgl = meters below ground level

18.2 Groundwater Quality

Tables 17 and **18** present the parameters to be measured, frequency of monitoring and sampling method for groundwater quality monitoring, with monitoring to continue for 12 months after mining has ceased.

Table 17 Groundwater Quality Monitoring Parameters

ANALYTES	Units	FREQUENCY
EC, pH	µS/cm, pH units	Bi - monthly
(EC, pH) + TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, hardness, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd (metals filtered)	mg/L	Start / finish of panel for piezometers adjacent to a panel, or in an active mining area, otherwise 1 sample per year

The frequency of monitoring will be reassessed after mining is complete as it may be possible, depending on results, to lengthen the intervals. The frequency of monitoring and the parameters to be monitored may be varied by DPI-W once the variability of the groundwater quality is established.

Groundwater samples should be collected at the start and finish of each panel from piezometers either adjacent to an active panel, or within an active mining area, and should be analysed at a NATA registered laboratory for major ions and selected metals. Piezometers not within an active mining area should be sampled and analysed once per year.

It is anticipated that the groundwater monitoring program will be maintained in its current status, with a review of the program at the end of each AEMR reporting period all monitoring data has been conducted or in the event of TARPs triggers being exceeded.

Additional piezometers may be added to the existing suite if required.

The groundwater monitoring program is anticipated to be extended beyond the active mining period in order to assess the potential long term change in groundwater level recovery and quality changes for 12 months after completion of mining.

Table 18 Groundwater Quality Monitoring Method and Frequency

Monitoring Site	Sampling Method	Frequency
Open Standpipe Piezometers	Pumped field meter readings	Bi-monthly
Open Standpipe Piezometers	Pumped sample for laboratory analysis	Start / finish of each panel for piezometers adjacent to a panel or in an active mining area, otherwise 1 sample per year

18.3 Surface Water and Groundwater Connectivity

The potential for surface water and groundwater system hydraulic connectivity will be assessed through monitoring of stream flows in and near actively mined areas, as well as through monitoring and interpretation of the basement groundwater open standpipe and vibrating wire piezometers water levels / pressures and mine inflow changes.

18.4 Mine Water Pumping

The volume of water pumped into and out of the Russell Vale Colliery workings will be monitored daily to enable the differential groundwater seepage into the workings to be assessed.

In addition, completion of the pump calibration tests, ongoing QA / QC and regular assessment of the pumping data will be required to enable reliable assessment of mine groundwater make due to extraction of the proposed workings.

18.5 Cataract Reservoir Water Storage

Water stored within Cataract Reservoir and any potential adverse effects from the proposed mining will be managed through monitoring of the mine inflow volumes and piezometer water levels / heads between the proposed workings and the reservoir.

Any potential changes to the water quality of the reservoir will be monitored through assessment of the discharging stream water quality in Cataract Creek (Site CC8 and / or CC9) and in Cataract River at Site CR3 or CR4, depending on the height of the reservoir at the time of monitoring, along with at Site CD1 within the reservoir.

Specific details of the reservoir monitoring and management will be provided in a detailed monitoring and management plan that will be prepared and approved prior to commencement of the proposed mining.

18.6 Ground Survey

The ground surface over the proposed underground workings will be surveyed in accordance with the Extraction Plan (to be prepared in accordance with the conditions of Project Approval).

18.7 Rainfall

Daily rainfall data will be obtained from a local weather station for the duration of mining in the proposal catchment area.

18.8 Ongoing Monitoring

All results will be reviewed annually via the AEMR process and an updated monitoring and remediation program will be developed, if required, in consultation with DI-W and DRE.

18.9 Quality Assurance and Control

QA/QC should be attained by calibrating all measuring equipment, ensuring that sampling equipment is suitable for the intended purpose, using NATA registered laboratories for chemical analyses and ensuring that site inspections and reporting follow procedures outlined in the ANZECC 2000 Guidelines for Water Quality Monitoring and Reporting.

18.10 Impact Assessment Criteria

18.10.1 Groundwater Levels

Impact assessment criteria investigation trigger levels should be initially set where a groundwater level reduction exceeds more than 10% of the saturated aquifer thickness over a 12 month period, compared to the minimum height within the last 12 months of data, excluding any short term recharge peaks. Should the trigger be exceeded, the actual rate of change of water levels should be investigated to determine whether the change is solely subsidence induced or due to a range of other potential factors.

If a significant increase in the rate of water level decline is noted, based on interpretation by a qualified hydrogeologist, then an assessment should be conducted to determine the cause of the change (such as variation in climate or effects from adjacent mining operations) and to consider potential contingency measures that may be adopted.

18.10.2 Groundwater Quality

Proposed groundwater quality impact assessment investigation triggers are shown in **Table 19.**

Table 19 Groundwater Quality Impact Assessment Investigation Triggers

Indicator	Investigation Trigger
pH	Short term reduction in pH outside of baseline variability, with the effect not persisting after a significant rainfall recharge event
Conductivity / TDS	Short term increase in salinity / TDS outside of baseline variability, with the effect not persisting after a significant rainfall recharge event compared to previous data
Total Nitrogen	Short term increase in Total Nitrogen outside of baseline variability, with the effect not persisting after a significant rainfall recharge event compared to previous data
Total Phosphorus	Short term increase in Total Phosphorous outside of baseline variability, with the effect not persisting after a significant rainfall recharge event compared to previous data

A trigger to assess the cause and effects of adverse groundwater quality changes should be implemented when there is a prolonged and extended non-conformance of the outlined criteria at a particular piezometer. If a field parameter (pH, conductivity) is outside the designated criteria for at least six months in a sequence, or alternatively, exceeds its previous range of results by greater than a 10% variation for at least 4 months, then the cause should be investigated, and a remediation strategy should be proposed, if warranted.

The triggers should be reviewed after each 12 month block of data is interpreted and may be modified as appropriate, depending on the results.

If the impacts on the groundwater system resulting from future underground operations are demonstrated to be greater than anticipated, the proponent should:

- assess the significance of these impacts;
- investigate measures to minimise these impacts; and
- describe what measures would be implemented to reduce, minimise, mitigate or remediate these impacts in the future to the satisfaction of the Director-General, DPI-W and Water NSW.

18.11 Contingency Procedures

Contingency procedures should be developed as required, with the measures to be developed being dependent on the issue that requires addressing.

The procedures should be used to manage any impacts identified by monitoring that demonstrate the groundwater management strategies may not have adequately predicted or managed the groundwater system's anticipated response to mining.

Activation of contingency procedures should be linked to the assessment of monitoring results, including water quality, aquifer hydrostatic pressure levels and the rate of water level changes.

18.12 Piezometer Maintenance and Installation

The current network should be maintained by protecting the wellhead from damage by animals and scrub fires by maintaining their steel sealed wellheads.

If required, the piezometers may be cleaned out by air sparging if they become clogged.

In the event that any new piezometers are required, they should be installed by suitably licensed drillers after obtaining any required approvals from Water NSW and DPI-W.

18.13 Reporting

Following completion of each AEMR review, which should summarise all relevant monitoring to date, the report should also outline any changes in the groundwater system over the relevant mining area in the relevant prior period.

The report should contain an interpretation of the data along with:

- a basic statistical analysis (mean, range, variance, standard deviation) of the results for the parameters measured;
- an interpretation of water quality and standing water level changes supported with graphs or contour plots; and
- an interpretation and review of the results in relation to the impact assessment criteria.

18.14 Adaptive Management

An adaptive management plan should be developed to use the monitoring program to detect the need for adjustment to the mining operation so that the subsidence predictions are not exceeded and so that subsidence impacts creating a risk of negative environmental consequences do not occur.

The adaptive management procedures should be implemented to provide a systematic process for continually detecting impacts, validating predictions and improving mining operations to prevent further adverse impacts on the swamp and basement groundwater systems overlying the proposed mining domains.

Monitoring, evaluation, and reporting on management performance and ecological impact should be integrated into the site's core management systems to progress the technical understanding and predictive capability of subsidence effects, impacts and consequences on surface water systems.

An evidence-based approach should be used to validate the extent to which outcomes are being achieved, with the monitoring results being related to, and demonstrating how management strategies have been achieved or where improvements can be made.

Data gained from monitoring a suite of extensometers, vibrating wire piezometer arrays and open standpipe piezometers as well as geochemical monitoring of groundwater and surface water and stream flow regimes over the panels would then be able to be used to update the current geotechnical, hydrogeological and hydrological assessments for the proposed mining and to incorporate, if required, adaptive management measures for future mining.

Additional groundwater related monitoring that could be used to enhance the adaptive management process may include:

- continuation of the existing mine water pump monitoring and updating the mine water balance;
- additional drilling, with a range of vibrating wire piezometers and core testing to establish the mechanical and hydraulic properties of the overburden in proximity to water dependent systems in the catchments (including swamps);
- installation of additional deep vibrating wire piezometers and extensiometers to assess/quantify the impacts of fracturing within the subsidence zone;
- installation of paired shallow piezometers (where appropriate) targeting swamps and the underlying shallow Hawkesbury Sandstone aquifer to assess their hydraulic

connection and climatic implications;

- sediment profiling in swamps to characterise type, thickness and sensitivity to differential subsidence; and
- updating of the numerical modelling when sufficient additional data becomes available to enhance the prediction of subsidence zone fracture distributions, connectivity and groundwater transmissivity capacities.

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The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site / sites in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site / sites at all points. Should information become available regarding conditions at the site, GeoTerra / GES reserve the right to review the report in the context of the additional information.

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APPENDIX 3

Surface Water Assessment

Inspired people | Dedicated team
Quality outcomes

SURFACE WATER IMPACT ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

July 2019

SURFACE WATER IMPACT ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

Prepared by
Umwelt Pty Limited
on behalf of
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1.0 Introduction

1.1 Project Overview

Russell Vale Colliery, located in Russell Vale north of Wollongong in New South Wales (NSW), has been operating since the 1880s (refer to **Figure 1.1**). Russell Vale Colliery is an underground coal mine that has previously undertaken mining in three coal seams (top to bottom): the Bulli Seam, Balgownie Seam and Wongawilli Seam. Russell Vale Colliery is operated by Wollongong Coal Limited (WCL) and is currently in 'care and maintenance'. There has been no underground mining at Russell Vale since 2015.

An application seeking an extension of underground workings at Russell Vale Colliery in the Wongawilli Seam (the Underground Expansion Project (UEP)) was made by WCL under the then Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The UEP was initially intended to provide an 18 year life of mine approval for Russell Vale; this proposal included long wall mining in both the Wonga East and Wonga West areas.

The NSW Planning Assessment Commission (PAC) identified a number of issues with the UEP that were required to be addressed for the PAC to have confidence that mining in the Wongawilli Seam could be approved without significant risk of impacts to water in the Cataract Reservoir (part of Sydney's water supply system). Potential subsidence and (associated) groundwater/surface water impacts are the key drivers of many of the potential impacts associated with the mine plan proposed as part of the 2009 original UEP application.

Following submissions on the originally proposed UEP application, a Revised Preferred Project (herein referred to as the Revised Project) was developed which limited the UEP to the Wonga East area. The Revised Project was referred to the PAC who recommended that further work and assessments need to be undertaken before a determination could be made. The now Revised Project seeks approval for the extraction of approximately 3.7 Million tonnes (Mt) run of mine (ROM) at a production rate of up to 1 Mt per annum (Mtpa). The mine plan has a notional 5 year life of mine. The objective for the Revised Project was to gain access to sufficient resources to enable mining to recommence and occur over a sufficient time frame to undertake the necessary assessments to prove up a mine plan in the Wonga West area that would extend the life of Russell Vale Colliery.

The mine plan for the Revised Project (refer to **Figure 1.2**) has been designed as a non-caving first workings mining system using continuous miners to limit potential for environmental impact and damage to the existing overlying/underlying longwall workings and existing and proposed surface infrastructure. The proposed layout with pillars based on a width to height ratio of 8 to 10 is designed to be long-term stable.

ROM coal will be transported from the underground workings via the existing underground conveyor system. Coal will be transported from the underground workings to the surface via a decline conveyor which transports coal from the portal to the stockpile area. ROM coal will be fed from the stockpile into an underground coal reclaim by bulldozer, and then conveyed to the screening and sizing station where oversize material is removed. From the screening and sizing station, coal will be transferred by conveyor to the surge bin which will feed the new Processing Plant. The Coal Processing Plant will comprise a coal sizing plant that will remove rock material using crushing and heavy media cyclone methods. No washing of coal will occur on site. Rocky material that is separated by the Processing Plant will be transferred to a rejects stockpile by the rejects conveyor from where it will be either loaded onto road trucks to be sold as VENM fill material, transferred to the mine portal and emplaced underground or used in site rehabilitation.

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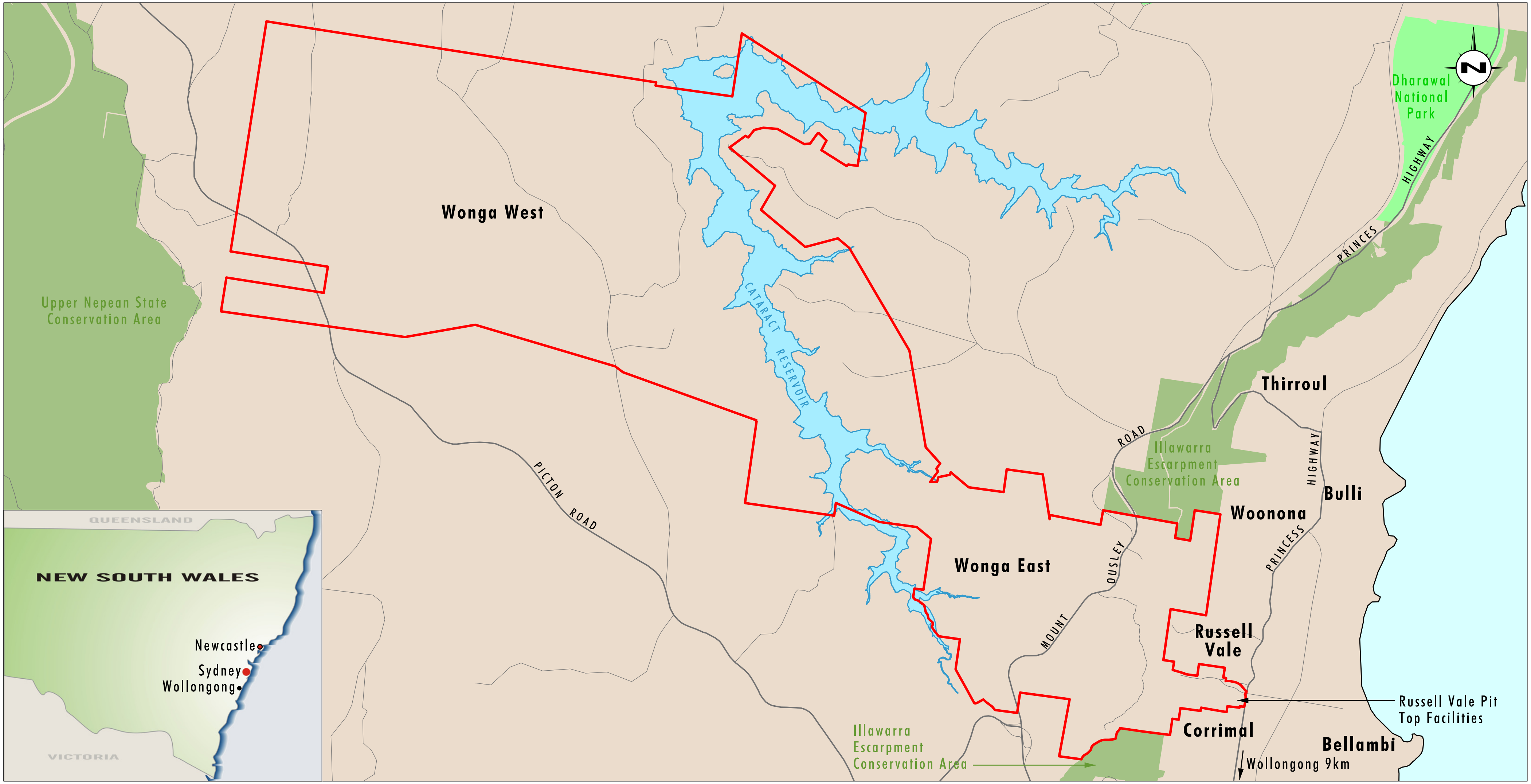

Data Source: OEH (2016)

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Legend

UEP Project Application Area

FIGURE 1.1

Russell Vale Colliery and UEP Application Area

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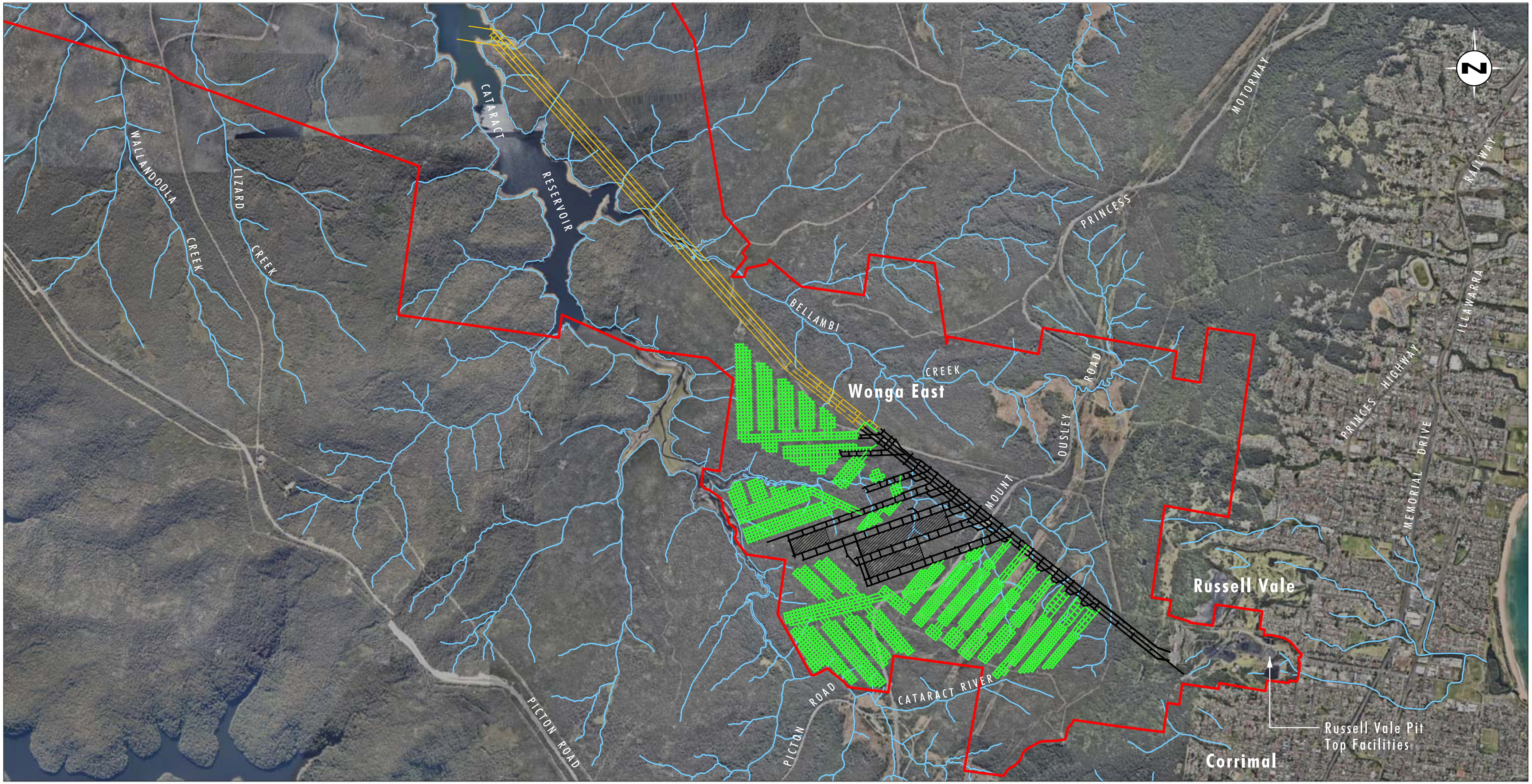

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

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1:50 000

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line

FIGURE 1.2

Proposed Wongawilli Workings

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20190124 15.51

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Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

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Legend

UEP Project Application Area

FIGURE 1.3

Surface Facilities

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20190708 14.18

1.2 Potential Surface Water Impacts

As the mine plan for the Revised Project is not predicted to result in any subsidence there will be no new impacts on the surface catchments and streams above the proposed mine workings. As such, the scope of this Surface Water Impact Assessment (SWIA) has been limited to the Russell Vale Surface Facilities (Surface Facilities) (refer to **Figure 1.3**).

The following are the key aspects of the Revised Project that have the potential to impact on surface water resources:

- restoration and upgrade of Surface Facility Water Management System (WMS) infrastructure
- changes to the water balance associated with the Revised Project, and
- discharges to surface waters.

The key aspects listed above have the potential to impact on the following surface water characteristics:

- flow volumes in downstream watercourses
- flooding, including flow rates, velocities and depths
- water quality in downstream watercourses
- geomorphological and hydrological values of watercourses, including environmental flows
- riparian and ecological values of watercourses, and
- water users, both in the vicinity and downstream of the Surface Facilities.

An assessment of these potential impacts has been undertaken for the Revised Project (refer to **Section 6.0**).

1.3 Report Structure

The key components of the SWIA for the Revised Project are included in the following sections:

- Surface water context, including regulatory framework, existing watercourses, catchment context and water quality: **Section 2.0**.
- Existing WMS and Proposed WMS: **Section 3.0**.
- Water balance: **Section 4.0**.
- Predicted impacts of the Revised Project, including consideration of cumulative impacts: **Section 6.0**.
- Summary of mitigation and management measures: **Section 6.0**.
- Monitoring, licensing and reporting: **Section 7.0**.

2.0 Surface Water Context

2.1 Regulatory Framework

2.1.1 Water Extraction

Extraction of water in NSW is managed under two legislative acts: *Water Act 1912* (Water Act) and *Water Management Act 2000* (WM Act).

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 by defining water access and water sharing strategies within NSW. The WM Act supersedes the provisions of the Water Act in regard to water take when a Water Sharing Plan (WSP) is in place and in regards to works adjacent to or within watercourses. Where WSPs have not commenced the provisions of the Water Act continue to apply.

WSPs have been developed across NSW to protect the fundamental environmental health of water sources, whilst at the same time securing sustainable access to water for all users in the long-term. The WSPs specify maximum water extractions and allocations and provide water users with a clear picture of when and how water will be available for extraction.

The Russell Vale Colliery Pit Top facilities are located within the area regulated by the WSP for the Greater Metropolitan Region Unregulated River Water Sources. Water use from surface and alluvial waters in and adjacent to the Surface Facilities is therefore governed by the WM Act.

2.1.1.1 Licensing of Extraction

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% of the average regional runoff from a landholding. Basic landholder rights are exempt from volumetric licensing requirements however water extracted under basic landholder rights must be taken into consideration when assessing 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 (ML) per year. The share components of high security, general security and supplementary WALs are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWDs) as specified by the Department of Industry – Water (DoI Water).

There are currently no WALs related to surface or alluvial water held by WCL.

2.1.2 Environment Protection Licences and Discharges

The *Protection of the Environment Operations Act 1997* (POEO Act) is a key piece of environment protection legislation in NSW. Scheduled activities or other activities that do or may lead to pollution of waters (refer to Section 120 of the POEO Act) in NSW are required to be licensed under the POEO Act and are regulated by the NSW Environment Protection Authority (EPA). Where discharge of water is permitted, it is strictly 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 Environment Protection Licence (EPL) if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act).

Coal mining and coal works are scheduled activities and WCL holds an EPL (EPL 12040) which licenses these activities at the Russell Vale Colliery, including four existing licensed water discharge points (LDPs), three of which are relevant to the Revised Preferred Project (**Figure 2.3**) and this SWIA (4th LDP is outside Revised Preferred Project boundary), and two ambient water quality monitoring points (**Figure 2.3**). The relevant EPL discharge and monitoring points are presented in **Section 2.3.4.2**.

2.1.3 Existing Project Approval

The most recent existing project approval includes a range of conditions relating to surface water management. A list of the existing project approval conditions relevant to the SWIA are presented in **Appendix A**.

2.2 Project Assessment Requirements

Director General's Requirements (DGRs) for the UEP were originally issued in 2009. As such this SWIA has been prepared to address the DGRs and to respond to agency submissions relevant to surface water resources for the Revised Preferred Project. **Table 2.1** presents the 2009 DGRs, relevant agency submissions and the section within this SWIA where the assessment requirement is addressed.

As part of the updated environmental assessment for the Revised Project and Response to the PAC Second Review Report, a detailed groundwater impact assessment has been prepared by GeoTerra and is provided in full in Appendix 2 of the environmental assessment report.

A Section 75W Modification to Project Approval MP10_0046 for the Russell Vale Colliery Preliminary Works Project was submitted in March 2018 (Modification 4 (MP 10_0046 MOD 4)) seeking approval to retain the existing Bellambi Gully Diversion Pipeline (refer to **Section 3.2.1**). A Further Response to Agency Submissions has been submitted in June 2019.

Table 2.1 Assessment Requirements

Requirement/Submission	Section Addressed
Director General's Requirements	
Soil and Water – including: - A detailed assessment of the potential impacts of the Revised Project on the quantity, quality and long-term integrity of the surface and ground water resources in the project area, paying particular attention to the Upper Nepean River sub-catchment (Metropolitan Special Area), the discharge of mine water and the surface runoff into the Bellambi Gully Creek and Bellambi Lagoon	Refer to **Sections 1.2, 2.1.1, 3.0, 4.0** and **6.0** of this report.
- Site water balance, including a detailed description of the measures that would be implemented on site to minimise the water use of the Revised Project	Refer to **Section 4.0**

Requirement/Submission	Section Addressed
PAC Second Review Report	
S 4.7 Bellambi Creek - Flood Management The Commission is satisfied that the issue raised in the First Review Report has been adequately addressed and supports, if the project were to be approved, the inclusion of a condition of consent that requires the implementation of flood mitigation measures recommended in the Cardno 2015 Report within 12 months of the date of approval. It also supports the draft recommended condition requiring the installation of a swale alongside the stockpile access road, which should improve water management on the site, though it is noted that the discharge of dirty water from the site is regulated by the EPA under the site's EPL.	Refer to Part B, Section 14 of the Revised Preferred Project and Response to PAC Second Review Report.

2.3 Catchment Context

2.3.1 Topography and Drainage

The Surface Facilities are located approximately 8 km north of Wollongong within the catchment of Bellambi Gully Creek on the lower slopes and foothills of the Illawarra Escarpment (refer to **Figure 2.1**). The escarpment is characterised by steep heavily vegetated slopes and reaches up to an elevation of 400 mAHD (BECA, 2011) descending to foothills at approximately 30 mAHD. The underground lease lies to the west of the surface facilities and escarpment under the Woronora Plateau.

Runoff originating from the escarpment flows toward the Surface Facilities where some sections of Bellambi Gully Creek have been replaced by pipe and channel infrastructure. This arrangement is intended to allow clean water runoff to bypass the stockpile area. Downstream of the Surface Facilities, Bellambi Gully Creek runs through urban areas comprising residential developments, recreational/sporting facilities, commercial and light industrial facilities and main road transport routes via culverts, vegetated creek bed and concrete lined channel. Bellambi Gully Creek flows around Bellambi Lagoon and into the ocean approximately 3 km downstream of the site.

Bellambi Gully Creek has a total catchment of approximately 693 hectares (ha), including the contributing catchment of Farrahars Creek which joins Bellambi Gully Creek downstream of the Surface Facilities, and a length of approximately 4.3 km from the upper catchment boundary to the ocean (WBM, 2006). The Surface Facilities occupy approximately 45 ha (excluding an upslope catchment area of approximately 35 ha that is directed through the Bellambi Gully Diversion Pipeline) of the Bellambi Gully Creek catchment.

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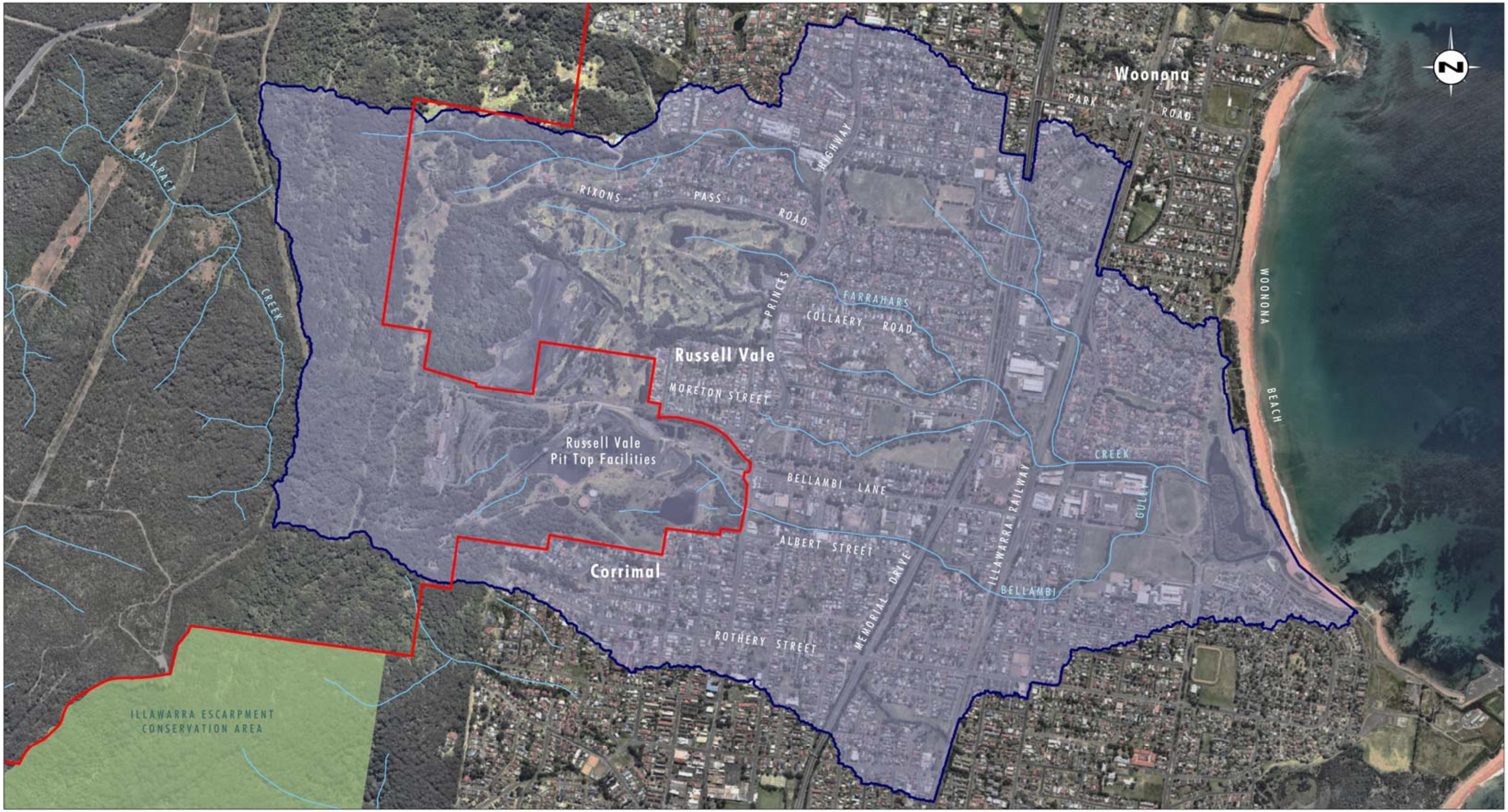

Image Source: NearMap (Oct 2016)
Data Source: Wollongong Coal (2016), NSW Environment Planning Industry (2018)

0 0.25 0.5 1.0km
1:20 000

FIGURE 2.1

Catchment Context

Legend

- UEP Project Application Area
- Bellambi Gully Creek Catchment

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20181218 16.27

2.3.2 Soils

There are two soil landscapes mapped (eSpade https://www.environment.nsw.gov.au/espade2webapp/) in the Surface Facilities catchment (refer to **Figure 2.2**), including the Illawarra Escarpment (9029ie) and Gwynneville (9029gw). The majority of the Surface Facilities are within the area mapped as Illawarra Escarpment (9029ie) with only minimal sections at the eastern end of the site within the area mapped as Gwynneville (9029gw). A NSW Soil and Land Information System Soil Essentials Report (OEH, 2018) for a soil profile collected in 1983 at a location immediately to the south of the present Stormwater Control Dam location provides the following description of the soil:

- Layer 1 (0.0 -0.3 m) – very dark brown loam with strong pedality and a field pH of 5.0
- Layer 2 (0.3 – 0.55 m) – dark brown clay loam with moderate pedality and a field pH of 4.5
- Layer 3 (0.55 – 0.65 m) – light clay with moderate pedality and a field pH of 4.0

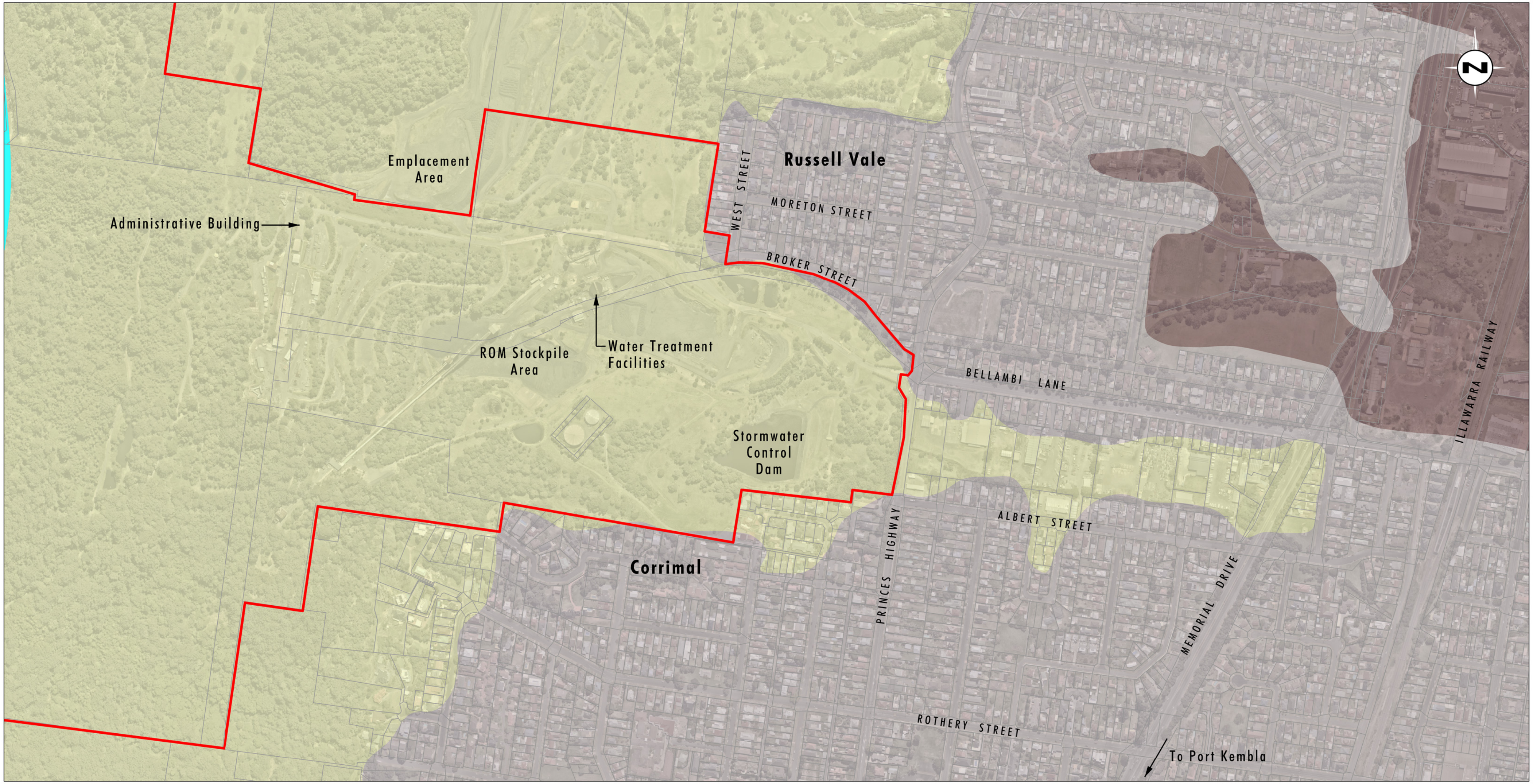

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

0 100 250 500m
1:10 000

Legend

UEP Project Application Area

Soil Landscapes:

- Fairy Meadow
- Gwynneville
- Illawarra Escarpment
- Warragamba

FIGURE 2.2

Soil Landscapes Russell Vale Pit Top

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20190115 15.24

2.3.3 Climate

The Revised Project is within a warm temperate region with significant variation to the west in temperature and precipitation due to topographic effects and proximity to the Illawarra Escarpment and the coast.

There are three Bureau of Meteorology (BoM) rainfall stations that lie within close proximity to Russell Vale Colliery: Station 68108 Woonona (2.1 km); Station 68228 Bellambi (3.7 km); and Station 68131 Port Kembla (11.9 km). Of these three BoM rainfall stations Woonona is considered most representative of rainfall conditions at the Revised Project due to its topographical location, close proximity and also the duration and completeness of the data set.

Daily rainfall has been recorded at Woonona (Station 68108) since 1930. Rainfall is typically higher over the first six months of the year. **Table 2.2** presents the rainfall statistics for the Woonona BoM station (station 68108).

The Sydney Airport AMO BoM station was identified as the nearest representative monitoring station with daily evaporation data (station 66037) for the period 1974 to present. Average pan evaporation rates, as used in the water balance model (refer to **Section 4.0**), of approximately 1,827 mm/year exceeds average rainfall for all months of the year except May and June. **Chart 2.1** presents the monthly average rainfall (station 68108) and evaporation (station 66037).

Table 2.2 Annual Rainfall Statistics (1930 to 2017) - Woonona BoM Station 68108

Statistic	Rainfall
Minimum	578
10th %ile	803
50th %ile	1,255
90th %ile	1,882
Maximum	2,733

Source: Bureau of Meteorology, 2018

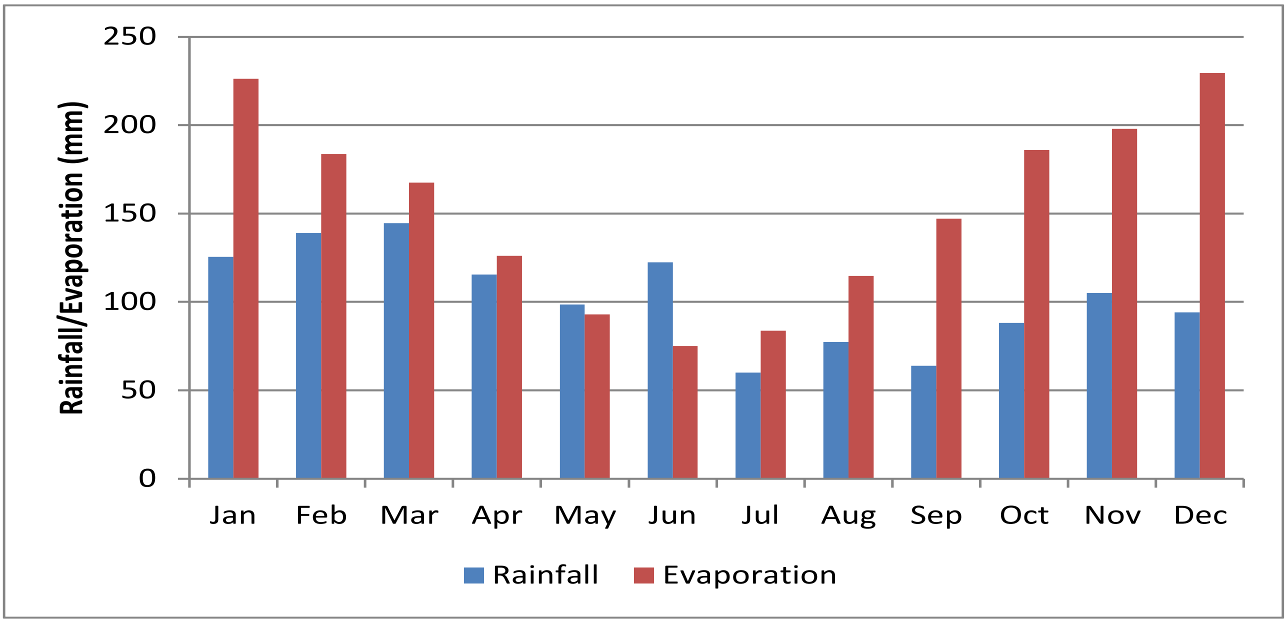

Chart 2.1 Monthly Rainfall and Evaporation

Source: Bureau of Meteorology, 2018

2.3.4 Existing Water Quality and Discharge Volumes

2.3.4.1 NSW Water Quality Objectives

The NSW Water Quality Objectives (WQOs) have been developed to guide plans and actions to achieve healthy waterways. Up to eleven WQOs apply and are based on providing the right water quality for the environment and the different uses people have for water. The WQOs are based on measurable environmental values for protecting aquatic ecosystems, recreation, visual amenity, drinking water and agricultural water. The WQOs for the Illawarra Catchment area where the Surface Facilities are situated have been developed to achieve suitable water quality for the protection of:

- aquatic ecosystems
- visual amenity
- recreation (Primary and Secondary contact)
- aquatic foods.

Based on a review of the Surface Facilities locations, the relevant WQO trigger values (https://www.environment.nsw.gov.au/ieo/LakeIllawarra/report-02.htm#P184_17838) for the water uses listed above and the potential water quality impacts associated with the Surface Facilities operation (refer to **Section 1.2**), the water quality parameters presented in **Table 2.3** are considered to be applicable to the UEP. The relevant WQOs are considered to be those for protection of aquatic ecosystems and visual amenity in Bellambi Gully Creek and the protection of primary contact recreation where Bellambi Gully Creek discharges into the ocean at Bellambi Beach.

The default trigger values presented in **Table 2.3** are those presented in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council (ANZECC, 2000)) for the protection of aquatic ecosystems. While the ANZECC Guidelines have been superseded by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018) (ANZG), the default trigger values presented in **Table 2.3** are yet to be updated in the ANZG and therefore remain valid.

Table 2.3 Relevant Illawarra Catchment Water Quality Objectives

Parameter	Units	Default Trigger Value Range
pH[1]	-	6.5 – 8.5
Electrical Conductivity (EC)[1]	µS/cm	125 – 2,200
Turbidity[1]	NTU	6 – 50
Total Nitrogen (TN)[1]	mg/L	0.350
Total Phosphorus (TP)[1]	mg/L	0.025
Visual clarity and colour[2,3]	-	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.

Parameter	Units	Default Trigger Value Range
Surface films and debris[2,3]	-	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
Nuisance organisms[2]	-	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.
Algae and blue-green algae[3]	cells/mL	15,000

Source: https://www.environment.nsw.gov.au/ieo/LakeIllawarra/maptext-03.htm#wq04

Notes: [1] Aquatic ecosystem protection for lowland rivers
[2] Visual amenity protection
[3] Primary contact recreation protection

2.3.4.2 Environment Protection Licence Monitoring

WCL undertakes a range of water quality and volume monitoring in accordance with the site EPL (EPL 12040). The latest monitoring conditions on EPL 12040 (May 2019) are noted below:

- remove two water quality monitoring locations:
    - Point 10 – outlet from the Bellambi Gully Diversion pipeline (refer to **Section 2.3.4** and **Figure 2.3**)
    - Point 13 – in the Stormwater Control Dam (SWCD) adjacent to the spillway (refer to **Section 2.3.4** and **Figure 2.3**)
- remove monitoring requirements for two of the licensed discharge points (LDPs):
    - LDP 3 – seepage through SWCD wall (refer to **Section 2.3.4** and **Figure 2.3**)
    - LDP 9 – SWCD spillway (refer to **Section 2.3.4** and **Figure 2.3**)

Table 2.4 presents the EPL monitoring locations which are also shown in **Figure 2.3**.

Table 2.4 Environment Protection Licence Monitoring Locations

Point	Description	Monitoring Requirements	Frequency	Limit Conditions
2	Licensed Discharge: Treated water outlet from the 1.2 ML thickener discharging from a 200 mm steel pipe into the 1,800 mm Bellambi Gully Creek diversion pipe.	pH Total Suspended Solids Turbidity Electrical Conductivity Volume	Monthly during discharge Continuous for turbidity	6.5 – 9.2 50 mg/L - - 2,500 kL/day[1,2,3]
3	Licensed Discharge: Seepage through the SWCD wall into Bellambi Gully Creek.	-	-	-
9	Licensed Discharge: The SWCD gabion spillway discharging to Bellambi Gully Creek.	-	-	-

Point	Description	Monitoring Requirements	Frequency	Limit Conditions
11	Monitoring: Bellambi Gully ambient water quality west of Princes Highway.	Turbidity Electrical Conductivity	Continuous	
12	Monitoring: Bellambi Gully upstream ambient water quality.	Turbidity Electrical Conductivity	Continuous	

Note:

1. The volume of wastes discharged from Point 2 on any day must not exceed 2,500 kL under dry weather conditions, but may exceed this volume under wet weather conditions provided all practical measures are taken to minimise additional pollution caused by the wet weather.
2. Dry Weather Conditions is defined as less than 10 mm of rain falling within a 24 hour period measured at a point on the premises. Wet Weather Conditions means anything other than Dry Weather Conditions (i.e. equal or greater than 10 mm of rain falling within a 24 hour period measured at a point on the premises).
3. Dry Weather Conditions discharge limit. Volume limit may be exceeded during Wet Weather Conditions for up to 72 hours following these conditions provided all practical measures are taken to minimise additional pollution.
4. Special Frequency 1 means daily during discharge for 3 consecutive days commencing within 12 hours of "wet weather conditions" occurring. "Wet weather conditions" are defined in condition L3.2 of this licence.

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

0 50 100 200m
1:5 000

Legend
UEP Project Application Area
Ambient Monitoring Location
Licensed Discharge Point
Former Monitoring Location

FIGURE 2.3

Environment Protection Licence Monitoring Locations

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20190701 9.55

2.3.4.3 Site and Receiving Water Quality Results

Table 2.5, **Table 2.6**, **Table 2.7** and **Table 2.8** present the water quality statistics for pH, Electrical Conductivity (EC), Total Suspended Solids (TSS) and Turbidity derived from the EPL monitoring undertaken for the period January 2016 to June 2019.

Table 2.5 Site and Receiving Water – pH, January 2016 – June 2019

Location	Number of Results	Minimum	20th Percentile	Average	80th Percentile	Maximum
Site Water Quality						
2	114	6.1	8.4	8.7	9.1	9.8
3	173	4.8	6.7	7.3	7.9	10.0
9	6	8.8	8.9	9.0	9.0	9.2
13	173	6.5	8.4	8.7	9.0	10.3
Receiving Water Quality						
10	172	6.0	8.0	8.5	8.9	10.6
11	171	6.5	7.9	8.4	8.8	10.7
12	162	5.3	7.2	7.6	8.2	9.0

Table 2.6 Site and Receiving Water – Electrical Conductivity (µS/cm), January 2016 – June 2019

Location	Number of Results	Minimum	20th Percentile	Average	80th Percentile	Maximum
Site Water Quality						
2	75	718	1,223	1,777	2,487	3,229
3	172	545	1,182	1,475	1,705	2,961
9	6	681	685	725	763	775
13	173	322	1,265	1,853	2,468	3,158
Receiving Water Quality						
10	172	292	1,001	1,671	2,308	3,329
11	171	408	948	1,585	2,201	3,245
12	162	213	437	578	690	1,344

Table 2.7 Site and Receiving Water – Total Suspended Solids (mg/L), January 2016 – June 2019

Location	Number of Results	Minimum	20th Percentile	Average	80th Percentile	Maximum
Site Water Quality						
2	40	5	8	18	23	100
3	72	5	16	27	35	117
9	6	117	156	235	252	446
13	172	6	44	149	203	948
Receiving Water Quality						
10	150	5	9	29	28	554
11	144	5	8	24	27	172
12	109	5	7	28	37	213

Table 2.8 Site and Receiving Water – Turbidity, January 2016 – June 2019

Location	Number of Results	Minimum	20th Percentile	Average	80th Percentile	Maximum
Site Water Quality						
2	72	5	16	27	35	117
3	165	4	18	105	180	909
9	6	708	768	861	964	1,018
13	165	19	146	421	745	1,314
Receiving Water Quality						
10	162	0	11	108	116	4,940
11	165	0	8	47	59	590
12	150	0	3	34	50	330

The following observations are made with respect to the existing site and receiving water quality results:

- All water discharged from LDP 2 from January 2016 to June 2019 was below the oil and grease EPL limit (data not presented) with a maximum recorded concentration of 7 mg/L.
- Several pH results were recorded above of the EPL limit in 2017 and 2018. However, no pH results have been recorded above the EPL limit since February 2018.
- Two pH results were recorded below the EPL limit in late 2018. However, no pH results have been recorded below the EPL limit since December 2018.
- There was one recorded exceedance of the EPL TSS limit during the period January 2016 to July 2018.
- Site waters (LDPs 2, 3 and 9 and EPL point 13) exhibit higher pH compared to Bellambi Gully Creek upstream pH except for seepage from the SWCD (LDP 3), which is lower and comparable to Bellambi Gully Creek upstream (EPL 12). This indicates that the pH of the water is being impacted by the materials in the SWCD wall, however, the majority of results are still within the EPL pH range.
- Site water (LDPs 2, 3 and 9 and EPL point 13) EC results are typically higher than Bellambi Gully Creek upstream results (EPL 12). Although EC results for SWCD spillway discharges (LDP 9) are substantially lower than other site water results. As the SWCD will only discharge via the spillway during high or prolonged rainfall events the water samples collected during discharge will be diluted by large volumes of rainfall runoff. The high ECs in the site water are a result of the higher EC of groundwater extracted from the underground workings and transferred to the site dirty water management system.
- On average, receiving water EC results are within the NSW WQO range.
- SWCD TSS and turbidity results are typically high with even higher concentrations recorded at the SWCD spillway during discharge as a result of sediment entrainment during high or prolonged rainfall events.
- Bellambi Gully Creek upstream (EPL point 12) pH, EC and turbidity results are typically lower than downstream Bellambi Gully Creek (EPL points 10 and 11) results. However, average TSS concentrations in the upstream and downstream monitoring locations are comparable.
- The elevated turbidity results evident at the outlet from the Bellambi Gully Diversion Pipeline (EPL point 10) may be attributable to the historical ingress of turbid water into the pipeline (refer to **Section 3.1**).

Table 2.9 presents a summary of nutrient water quality results obtained during 2010 and 2011 in Bellambi Gully Creek upstream of the Surface Facilities, in water discharged to Bellambi Gully Creek from the WTP via Licensed Discharge Point 2 (LDP 2) and downstream of the Surface Facilities.

Table 2.9 Historical Water Quality – Nutrients (mg/L), 2010 and 2011

Location	No. of Results	Total Kjeldahl Nitrogen (TKN)			Total Phosphorus (TP)		
		Minimum	Average	Maximum	Minimum	Average	Maximum
Bellambi Gully Creek Upstream	3	0.4	0.5	0.6	<0.01	0.04	0.04
LDP 2	5	<0.1	0.6	1.1	0.03	0.11	0.21
Bellambi Gully Creek Downstream	8	0.3	0.5	0.9	<0.01	0.09	0.13
NSW WQO	-	-[1]			0.025		

Source: *Surface Facilities Water Management Plan* (WCL, 2017)
Note: [1] There is no WQO for TKN which does not account for nitrate and nitrate (NOx) in the sample. The WQO for Total Nitrogen, which accounts for NOx, is 0.35 mg/L.

The results presented in **Table 2.9** indicate that nutrient concentrations in the water discharged from LDP 2 are comparable to those in Bellambi Gully Creek upstream and downstream of the Russell Vale Surface Facilities. While the TP concentrations for the site and receiving waters are above the NSW WQO, the elevated concentrations are not unexpected. Bellambi Gully Creek is an urban creek that may be considered highly disturbed based on measured water quality parameters and the contributing urban catchment. The creek receives stormwater runoff from minor and major roads, residential areas, recreational/sporting facilities and commercial and light industrial facilities in addition to discharges from the Russell Vale Colliery and elevated nutrient concentrations are typical in urban runoff.

2.3.4.4 Licensed Discharge Volumes

The average daily discharge from LDP 2 to the Bellambi Gully Diversion Pipeline ranged from 224 kL to 2,243 kL for the period January 2016 to June 2019. The site Supervisory Control And Data Acquisition (SCADA) system is programmed to cease discharges when the total flow on any given day reaches 2,450 kL ensuring that the discharge volume limit (refer to **Table 2.4**) is not exceeded.

3.0 Water Management

3.1 Existing Water Management System Overview

The existing Surface Facilities WMS catchment is approximately 45 ha in area and consists of the following sub catchments:

- Rehabilitated and undisturbed natural catchments.
- Disturbed catchments including the pit top area and coal handling infrastructure.
- Hardstand areas including the maintenance workshop area, administration offices, access roads and car parking.

The existing WMS allows for two categories of water:

- clean, comprising runoff from undisturbed and fully rehabilitated areas, and
- dirty, comprising runoff from any area disturbed by mining operations, runoff from areas where coal is stockpiled and handled and groundwater extracted from the underground workings.

Figure 3.1 presents a plan of the existing WMS and **Figure 3.2** presents a process flow schematic of the WMS.

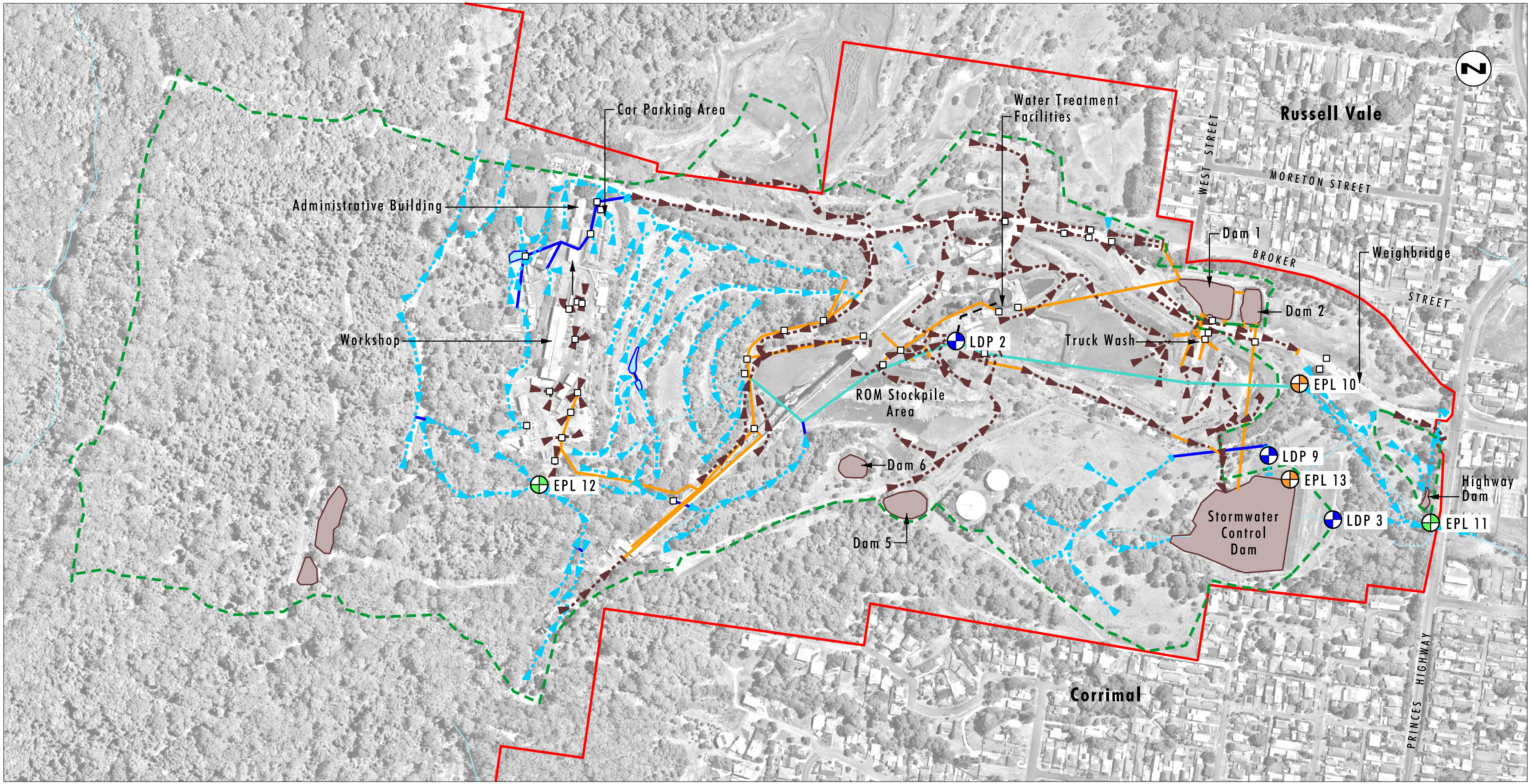

Image Source: Nearmap (Dec 2018)

0 100 200 400m
1:7000

Legend

- UEP Project Application Area
- WMS Boundary
- Pit/Sump
- Clean Water Dam
- Dirty Water Dam
- Clean Water Diversion Drain
- Dirty Water Diversion Drain
- Clean Water Pipe/Culvert
- Dirty Water Pipe/Culvert
- Existing Drainage Line
- Bellambi Creek Pipeline
- Thickener Discharge Pipe
- EPL Point is Ambiant Monitoring Location
- EPL Point is Licensed Discharge Point
- Former Monitoring Location

FIGURE 3.1

Existing Water Management System Plan

File Name (A4): R09/3687_056.dgn
20190717 10.52

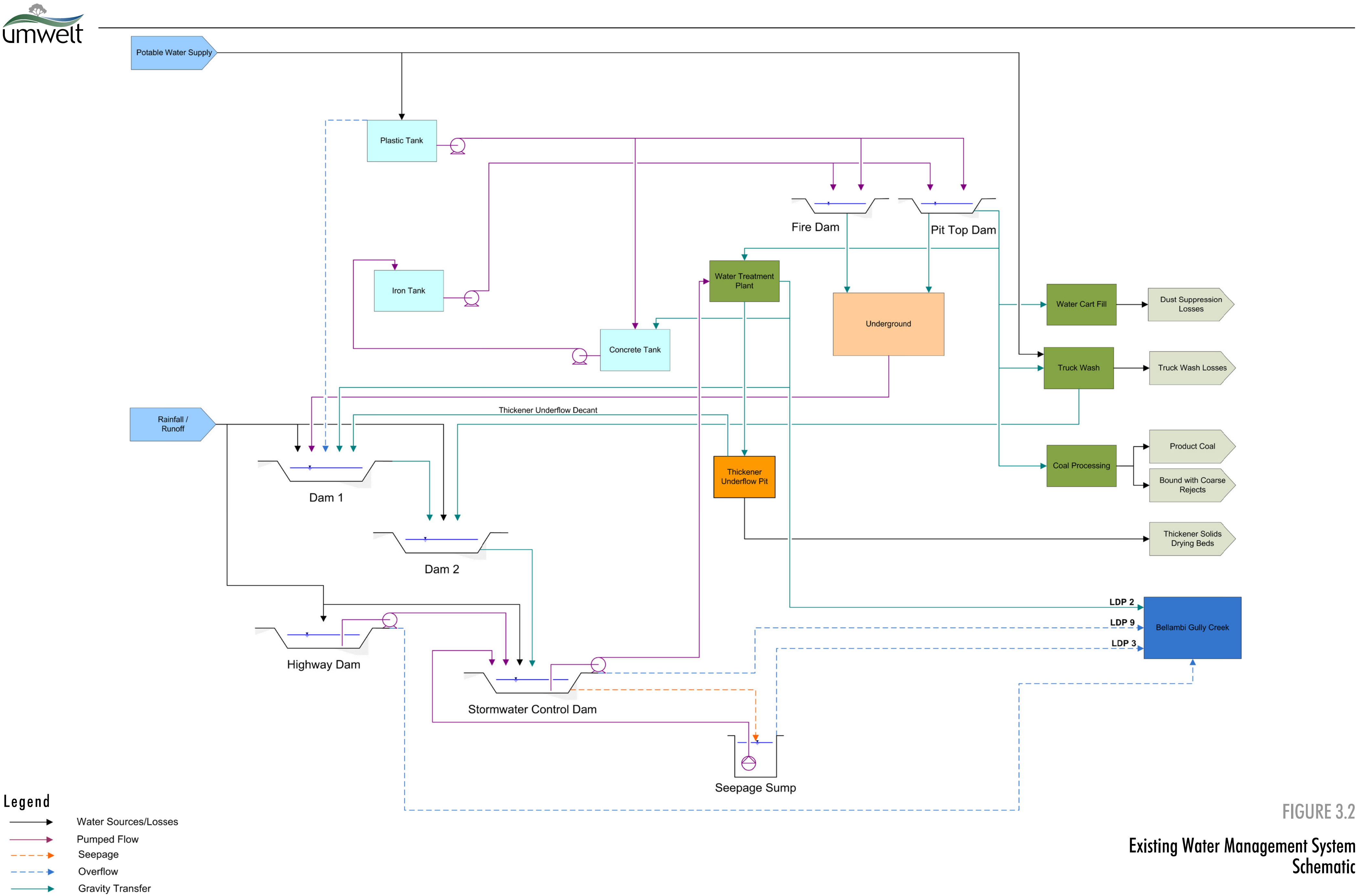

FIGURE 3.2

Existing Water Management System Schematic

File Name (A4): R09/3687_057.dgn
20190716 17.20

3.1.1 Clean Water and Flood Management

Clean water upslope of the surface facilities flows through the natural Bellambi Gully Creek water course which connects with a 1,800 mm diameter stormwater diversion pipe (refer to **Figure 3.1**). The 1,800 mm diversion pipe is approximately 610 m long and conveys stormwater under the Surface Facilities where it discharges into Bellambi Gully Creek at the eastern end of the site. Runoff from the centre of the site and northern access roads is collected in a 600 mm diameter pipe that connects to the 1,800 mm diversion pipe immediately south of the ROM conveyor. Clean water runoff from the north western upslope catchment is directed to the north around the Surface Facilities (refer to **Figure 3.1**).

In August 1998 the Wollongong Local Government Area (LGA) suffered major flooding throughout the region as did the wider Sydney basin as a result of a rare interregional storm event. During this event, flood borne debris accumulated at the entrance of a clean water culvert upslope of the Russell Vale Colliery site. The blockage resulted in the level of water at the culvert inlet to increase to a level where it overflowed into the Russell Vale Colliery site. As a consequence of flood waters flowing through the Russell Vale Colliery stockpile area, a significant quantity of coal from the mine's ROM stockpile being entrained in the flood flows. Some of the entrained ROM coal was transferred off-site into the industrial residential area in Bellambi Lane and the downstream sections of Bellambi Gully Creek. Three separate flood studies have been undertaken to identify and assess options to minimise the risk of coal washout events occurring in the future (refer to **Section 3.2**).

3.1.2 Dirty and Mine Water Management

Runoff from the stockpile and coal handling area drains to Dam 1, which functions as a primary sediment basin, before flowing into Dam 2 (refer to **Figure 3.1**). Dam 2 also receives excess water from the truck wash system. Runoff from the maintenance and laydown areas flows to the First Flush system to remove entrained sediments. Dirty water discharge from the First Flush system flows to Dam 1. The First Flush system directs flows to the dirty water system during the early stages of a runoff event, specifically to the inlet of a 100 mm pipe that is located in a weir in the lower section of the outlet pipe from the maintenance and laydown area drainage system. For higher rainfall events where the volumetric flow of runoff exceeds the capacity of the 100 mm pipe capacity, stormwater overflows the weir into the clean water system.

Surplus water from the underground mining operation (groundwater and excess process water transferred to the underground) is also transferred to Dam 1. Water from Dam 2 overflows to the SWCD via a 1,050 mm diameter pipe.

In addition to water transfers from Dam 2, the SWCD collects runoff from approximately 7.5 ha of undisturbed upslope catchment and receives transfers from the Highway Dam (refer to **Figure 3.1**). The Highway Dam collects runoff from a small catchment between Bellambi Lane and Bellambi Gully Creek that is primarily vegetated but also includes unsealed roadway.

Dam 5 and Dam 6 are located to the south of the stockpile area are not presently used for the care and maintenance operation (refer to **Figure 3.1**). Both dams have minimal catchment areas and spill to the SWCD. Dam 5 is overgrown with vegetation and unlikely to be used as part of any future operation. Pumped water transfers between Dam 6 and the SWCD are still possible, however, are unlikely to be part of any future operation as the capacity of the other site water storages is adequate to service site operations.

Water from the SWCD is transferred to the Water Treatment Plant (WTP) (refer to **Figure 3.1**) which incorporates a 1.2 ML thickener to remove suspended solids prior to either reuse as process water or discharge to the Bellambi Gully Creek Diversion Pipeline via LDP 2 (refer to **Figure 3.1**). The site SCADA system is programmed to cease discharges when the total flow on any given day reaches 2,450 kL ensuring that the discharge volume limit (refer to **Table 2.4**) is not exceeded. WCL continuously monitor the turbidity of the supernatant discharge from the thickener, Bellambi Gully Creek upstream (EPL point 12, refer to **Table 2.4**) of the Surface Facilities and the Bellambi Gully Diversion Pipeline outlet (EPL point 10, refer to **Table 2.4**) which is downstream of LDP 2. Should the discharge from the thickener exceed a turbidity of 60 NTU discharge is ceased and the supernatant is diverted to the SWCD. In the event that the turbidity at the outlet of the Bellambi Gully Diversion Pipeline exceeds a turbidity of 100 NTU WCL implement a Trigger Action Response Plan (TARP) to investigate the cause of the elevated turbidity and respond accordingly to mitigate any potential contributions from colliery operations. The TARP is presently in draft format and WCL with a view to validating draft TARP parameters based on water quality data collected across a range of rainfall events. This process is presently ongoing in consultation with the EPA to finalise the turbidity trigger values and responses. Concentrated slurry is periodically drained from the thickener underflow pipe into a pit adjacent to the WTP. The slurry is allowed to settle further with the supernatant water decanted and transferred to Dam 1. The settled solids either remain in the pit to dry or are transferred from the pit to an earth bunded drying bed in the stockpile area.

Water is also discharged from the SWCD to Bellambi Gully Creek via LDP 3 (also referred to herein as EPL 3) that accounts for seepage through the dam wall which is designed to be permeable and via LDP 9 (also referred to herein as EPL 9) which is the SWCD spillway into Bellambi Gully Creek (refer to **Figure 3.1**). The SWCD is registered with the NSW Dams Safety Committee and is a “Prescribed” dam under the *NSW Dams Safety Act 2015*. **Section 3.1.3** provides:

- general details relating to the SWCD structure and operation
- the monitoring requirements for the SWCD
- the condition of the SWCD based on the most recent monitoring undertaken.

Seepage through the SWCD wall is collected in the Seepage Sump, along with any runoff from the small Seepage Sump catchment, and returned via a submersible pump to the SWCD. During periods of high rainfall, the combined seepage and runoff inflows to the Seepage Sump may exceed the submersible pump capacity. During these rainfall events excess water will spill to Bellambi Gully Creek from the Seepage Sump, however, any discharge will be greatly diluted by the high flows from the broader catchment within Bellambi Gully Creek. Historically, the seepage rate through the SWCD wall was measured at the outlet of the sump which incorporated a v-notch weir. However, in response to Pollution Reduction Program (PRP) 8 imposed by the EPA in March 2013 on the site EPL (EPL 12040), the v-notch weir was concreted in and the seepage collected in the sump returned to the SWCD. PRP 8 is presented below:

> **U1 PRP 8 - Stormwater Turbidity Reduction Program**
>
> U1.1 AIM:
>
> The aim of this Pollution Reduction Program (PRP) is to reduce the level and occurrence of grey/brown coloured water that is discharged from the premises during and after high volume rainfall events.
>
> BACKGROUND:
>
> Turbid stormwater that contains fine suspended matter is discharged from the main stormwater control dam (SWCD) during and after high volume rainfall events. The water has a grey/brown colour and may flow from point 3 (SWCD wall seepage) and point 9 (SWCD wall overflow) into Bellambi Gully creek.

The quality of water discharged into Bellambi Gully creek will improve if stormwater is pre-treated in dams 1 and 2 prior to entry into the SWCD. Pre-treatment of stormwater will also improve the effectiveness of the existing water treatment plant that discharges to Bellambi Gully via discharge point 2.

Discharge of turbid water has also occurred from fractures and poorly sealed connections in the Bellambi Gully stormwater diversion pipe and the coal wash emplacement area clean water collection system.

The condition of the stormwater pipe networks should be reviewed to determine whether maintenance is required to prevent cross contamination with turbid groundwater.

Stormwater Pipelines

The licensee must arrange for inspections of the 'Bellambi Gully Diversion Pipe' and the 'Russell Vale Emplacement Area' clean water collection system by an independent person or organisation. The inspection must be undertaken to determine the condition of the pipe network and whether maintenance is required to prevent ingress of turbid water. A report must be prepared for both pipe networks outlining any recommended works.

Stormwater Treatment

'Pre-Treatment Stormwater Dams 1 and 2'. The Licensee must employ water quality consultants to develop a proposal to pre-treat storm water in dams 1 and 2 before it enters the SWCD. 'Stormwater Control Dam - Seepage LDP3'. The Licensee must also assess options to treat, capture, recirculate or restrict the discharge of turbid water from point 3 (SWCD wall seepage) following high rainfall events.

WCL completed the PRP studies in October 2018 and is presently in the planning stage to implement pre-treatment of dirty water using flocculant block at the inlet to Dam 1 to aid settling of solids prior to overflowing into Dam 2. A remote closed circuit television (CCTV) inspection of the Bellambi Gully Diversion Pipeline in June 2017 identified a number of areas where there is the potential for ingress of turbid water. All identified turbid water ingress points have been subsequently remediated.

3.1.3 Stormwater Control Dam

The SWCD was constructed in 1993, has a volume of 62 ML with a homogenous fill embankment dam wall approximately 150 m in length and 9 m in height and an internal drainage system (Douglas Partners, 2017). The 24 m wide open channel spillway (rock filled gabion baskets) has been designed to pass the Probable Maximum Flood. During dry periods, the dam level is kept to a minimum so as to maximise the storage available to capture stormwater runoff. Seepage through the dam wall is collected in an internal slotted PVC pipe and directed to a collection sump that was previously equipped with a v-notch weir to monitor seepage flow rate (refer to **Section 3.1.2**). However, in response to PRP 8 imposed by the EPA (refer to **Section 3.1.2**), WCL now return water seeping through the SWCD wall to the SWCD and the v-notch weir has been concreted in. As such, seepage flows can now be estimated using sump pump capacity and sump pump run times.

A Dambreak and Consequence Category Assessment has been prepared for the SWCD by Hatch Associates Pty Ltd (2014). The SWCD is near the Princes Highway and downstream industrial and residential development. The dam has “High B” Sunny Day Consequence Category and “High C” Flood Consequence Category. The NSW Dams Safety Act 2015 requires that a Type 2 Surveillance Report for the dam is prepared and submitted to the Dams Safety Committee every 5 years.

The most recent Type 2 Surveillance Report for the SWCD was prepared by Douglas Partners in 2017 and found that the dam "is well maintained and in good working order" and provided a list of maintenance items together with guidelines for future inspections and ongoing monitoring expectations. Douglas Partners recently prepared the *Dam Safety Emergency Plan - Storm Water Control Dam WCL No. 1 Colliery Russell Vale Site* (2019) (DSEP) and was based on the NSW Dam Safety Committee's (DSC's) requirements as outlined in *DSC 2G Emergency Management for Dams* (2010) and the Australian National Committee on Large Dams (ANCOLD) document *Guidelines for Dam Safety Management* (2003). The DSEP details:

- methodology for identification, evaluation and classification of potential emergency conditions;
- access and communication procedures;
- potential consequences; and
- preventative actions.

As part of the Modification 4 commitments, WCL will undertake a review and update of the dam break modelling and consequence category assessment for the Storm Water Control Dam (SWCD) should the modification be approved.

3.1.4 Water Sources and Demands

Inflows to the WMS include rainfall on dams, runoff from WMS catchments, groundwater extracted from the underground workings and imported water from the Sydney Water supply.

Outflows include evaporation, dust suppression losses, product coal moisture, licensed discharges and spills during high or prolonged rainfall events that exceed WMS infrastructure capacities. Wastewater from on-site amenities is discharged to sewer.

3.2 Proposed Improvements to the Water Management System

WCL is currently seeking approval modify the existing Preliminary Works Approval (MP 10_0046 Modification 4) to retain the existing Bellambi Gully Diversion Pipeline to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek as originally identified in the Bellambi Gully Flood Study (Cardno, 2015) and further refined by recent more detailed investigations by Engeny (2018).

In summary, these improvements will include:

- Construction of a levee upstream of the stockpile area to minimise clean water runoff entering the stockpile and laydown areas from upslope drainage systems.
- Extending the existing noise bund on the northern side of the Russell Vale Pit Top approximately 35 m to the west to reduce the volume of upslope runoff entering the stockpile area.
- Minor regrading of the laydown area to convey flows to the east and limit spilling to Bellambi Lane.
- The laydown area east of the current truck wash will be utilised as a dry detention basin with a low flow channel conveying overflows to the SWCD.
- Construction of a low flow channel from the Dry Detention Basin to allow ponded water to spill to the SWCD and minimise flows to Bellambi Lane when the capacity of the pipes to Dams 1 and 2 are exceeded.

- Construct easy-to-maintain debris control structures at the Bellambi Gully Creek diversion pipe inlets.
- Measures to control and manage turbid water ingress to the Bellambi Gully Diversion Pipeline and manage pipeline loading/capacity.
- The existing and proposed flow control structures will be included in regular maintenance schedules.

The proposed improvements to the WMS will continue to allow for the management of the following two categories of water:

- clean, comprising runoff from undisturbed and fully rehabilitated areas
- dirty and mine, comprising runoff from any area disturbed by mining operations and groundwater extracted from the underground workings.

A plan of the proposed WMS is presented in **Figure 3.3** and a flow schematic of the proposed WMS is presented in **Figure 3.4**

3.2.1 Clean Water and Flood Management

The clean water management strategy for the Revised Project will be consistent with the existing strategy of limiting the quantity of clean catchment runoff entering the Surface Facilities WMS. However, the Revised Project will incorporate changes to the clean water management system to further reduce the quantity of clean catchment runoff entering the Russell Vale Surface Facilities WMS. These changes will include upgrades and formalisation of drains as well as improvements to maintenance practices.

Clean water management system blockages have in the past allowed runoff from upslope catchments to enter the Surface Facilities WMS resulting in flooding of the stockpile area and washout of coal into residential areas and Bellambi Gully Creek. Three independent flood studies have been undertaken to identify the most appropriate and feasible options to mitigate the risk of future stockpile area flooding and washout events. The *Gujarat NRE Stormwater Hydrology Review* (BECA, 2010) proposed the realignment of Bellambi Gully Creek via a bypass channel around the stockpile area as an alternative to the existing 1,800 mm stormwater diversion pipe. This strategy was accepted by PAC in 2015 and included in the *Russell Vale Colliery – Underground Expansion Project Review Report* (PAC, 2015) as Recommendation 11:

> ***Flooding/Bellambi Creek***
>
> 11. *Any new approval should retain the existing requirement to realign Bellambi Creek or a full justification why this is no longer necessary to provide protection to the creek downstream from the pit top surface area.*

In 2014 Cardno was commissioned to undertake a flood study to enable a better understanding of existing flood conditions at the Surface Facilities and identify alternate mitigation measures to those presented in the BECA report (2010). The *Bellambi Gully Flood Study* (Cardno, 2015) focused on identifying measures to ensure major stormwater runoff from the stockpile area is directed to Bellambi Gully Creek rather than entering Bellambi Lane and assessed three different degrees of blockage in the existing stormwater conveyance system; 100% blockage, 20% blockage and fully functional. Peak flows estimated in the BECA flood study (2010) for the 5 year, 10 year and 100 year Average Recurrence Interval (ARI) storm events were used in the hydraulic modelling completed by Cardno. Flood modelling results for all three blockage scenarios predicted the overtopping of the stockpile access road into Bellambi Lane for the 100 year ARI storm event. Cardno proposed the mitigation measures listed below to eliminate flooding in Bellambi Lane.

1. Upgrading the stockpile area access road and installing a 6 m span culvert to convey the site runoff across the access road, into a proposed grass-lined swale before discharging into Bellambi Creek.

2. Implementing a debris control structure at the inlet(s) to the 1800 mm diameter pipe to reduce probability of blockage within the system due to debris from the upstream catchment.

3. Formalising the swale in the vicinity of the existing 600 mm clean water inlet. This would provide increased temporary storage for stormwater which helps to manage peak flows from the upstream catchment and to ensure all the clean water runoff is captured before entering the stockpile area.

4. Upgrading the existing 600 mm diameter clean water pipe to an 825 mm diameter pipe, although the other proposed mitigation measures did not rely on this upgrade (and it was not modelled by Cardno in the proposed scenario model).

5. Appropriate maintenance should be carried out immediately upstream and downstream of the existing debris control structures within the Bellambi Gully to minimise the potential for blockage of the system.

6. Culverts may be installed across the access road along the northern boundary of the site to direct flows towards Bellambi Creek and reduce clean water runoff conveyed into the stockpile area.

Flood modelling was undertaken by Cardno for the scenario where only mitigation measure 1 (listed above) would be implemented. A 25% blockage was applied to the proposed 6 m span culvert while all upstream culverts were assumed to be 100% blocked. Cardno's modelling predicted that the during a 100 year ARI storm event flows from the stockpile area will overtop the proposed 6 m span culvert and flow across the access road at the low point before discharging into the proposed swale downstream preventing flooding on Bellambi Lane. The Cardno strategy was accepted by the PAC in 2016 as documented in the *Russell Vale Colliery – Underground Expansion Project Second Review Report* (PAC, 2016).

A Section 75W Modification to Project Approval MP10_0046 for the Russell Vale Colliery Preliminary Works Project was submitted in March 2018 seeking approval to retain the existing Bellambi Gully Diversion Pipeline to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek. The OEH submission regarding the proposed modification, dated 29 March 2018, provided a series of recommendations for appropriate assessment of water related impacts in regards to both floodplain risk management and water quality advice.

Later in 2018, Engeny completed a flood assessment for Bellambi Gully Creek to provide a response to the floodplain risk management and water quality advice comments provided by OEH. The assessment considered both the existing flood behaviour as well as proposed solutions to assist in flood/stormwater management at the site including the range of options proposed by Cardno (2015). Modelling was undertaken using a two-dimensional hydraulic model to a level of detail not undertaken in previous modelling by BECA and Cardno.

Engeny's (2018) modelling predicted that Cardno's proposed mitigation measures would not eliminate overtopping of the stockpile area into Bellambi Lane in a 100 year ARI event. Further modelling was undertaken to identify mitigation measures that would minimise Bellambi Lane flooding while not worsening flooding at the Princes Highway culvert downstream of the Surface Facilities. The Surface Facilities flood management measures recommended by Engeny (2018) and proposed as part of the Revised Project are:

- **Separation of clean and dirty water systems:**
  - Construction of upstream levee to detain and divert upslope catchment runoff through the Bellambi Gully Diversion Pipeline.
  - Construct self-cleaning debris control structures at the inlets to both the 1800 and 600 mm pipes.

- **Control of flows through dirty water areas:**
  - Regrade eastern laydown area to form a dry detention basin with an effective capacity in the order of 2.1 ML.
  - Construct channel from laydown area to SWCD to manage and divert flows in excess of the capacity of Dam 1 and Dam 2 and the new dry detention basin in the laydown area to the SWCD.
- **Maintenance**
  - The above structures and existing controls will be included on regular maintenance schedules.

In addition to the measures proposed by Engeny (2018), Cardno (2015) recommended that the 600 mm diversion pipe should be upgraded to an 825 mm pipe. Modelling undertaken by Engeny, which is more detailed than the previous study, does not indicate that the 600 mm pipe needs to be upgraded. Further, Cardno (2015) proposed an upgrade of road drainage along Bellambi Lane, including the installation of a 6 m span culvert to convey site runoff across the access road. As with the 600 mm pipe upgrade, the Engeny (2018) modelling does not indicate the need for this measure to reduce Bellambi Lane flooding impacts, and in fact shows there may be increased flood impacts at the Princes Highway.

Any flood mitigation works within waterfront land will be undertaken in accordance with the *Guidelines for Controlled Activities on Waterfront Land* (DoI, 2012).

3.2.2 Bellambi Gully Creek Diversion Pipeline Structural Integrity

In May 2018 WCL engaged Engeny to review loading conditions for the Bellambi Gully Diversion Pipeline to assist WCL in managing potential risks associated with the structural integrity of the pipeline. The *Russell Vale Colliery Bellambi Gully Pipeline Review* report (Engeny, 2018) details:

- The pipe loading analysis undertaken.
- Recommendations for stockpiling operating methodology in proximity to the pipeline to limit overloading.
- Identification of potential further works to assess the structural capacity of the pipeline and bedding should a more accurate assessment be required to reduce the risk of future damage to the pipeline.

Due to the absence of detailed pipeline design and installation data it was not possible to accurately determine the structural capacity of the pipeline. As such, Engeny's assessment (2018) was limited to identifying historical loads that had been applied to the pipeline, reviewing CCTV pipeline inspection images and estimating conservative future maximum load limits that should be applied to the pipeline. The Engeny report (2018) provides a number of recommendations with respect to:

- Stockpile height limits above the pipeline.
- Areas above the pipeline where mobile plant should not operate.
- Ongoing monitoring and maintenance of the pipeline.
- Potential methods to determine the structural capacity of the pipeline.
- Undertake a Pipeline Condition Assessment and develop a Pipeline Integrity Management Strategy, as detailed in Appendix 5 of the Further Response to Submissions document (Umwelt, 2019).

Provided WCL adheres to the conservative load limits and the inspection and maintenance regime recommended in Engeny's assessment (2018), the Bellambi Gully Creek Diversion Pipeline is considered by WCL to be adequate for continued use as the clean water diversion pipeline for the Surface Facilities.

3.2.3 Dirty Water and Mine Management

Dirty and mine water will be managed in accordance with existing practices. However, the changes to the clean water and flood management detailed in **Section 3.2.1** will reduce the volume of stormwater draining into the dirty water management system. Further, the pre-treatment of inflows to Dam 1 and changes to the management of water seeping through the SWCD wall (refer to **Section 3.1.2**) will improve the operation and outflows for the dirty water system.

3.2.4 Water Extraction and Discharges

There are no proposed changes to the site's licensed discharge arrangements set out in EPL 12040 (refer to **Section 3.2**).

WCL do not propose to modify the current site water supply (refer to **Section 3.1.4**) for the Revised Project.

3.2.5 Hazardous Materials Storage

Hazardous materials, including diesel fuel, water treatment chemicals and hydraulic fluid emulsions will be stored in appropriately sized bunds. All hydrocarbon storage and handling will be undertaken in accordance with *AS1940-2017: The storage and handling of flammable and combustible liquids*.

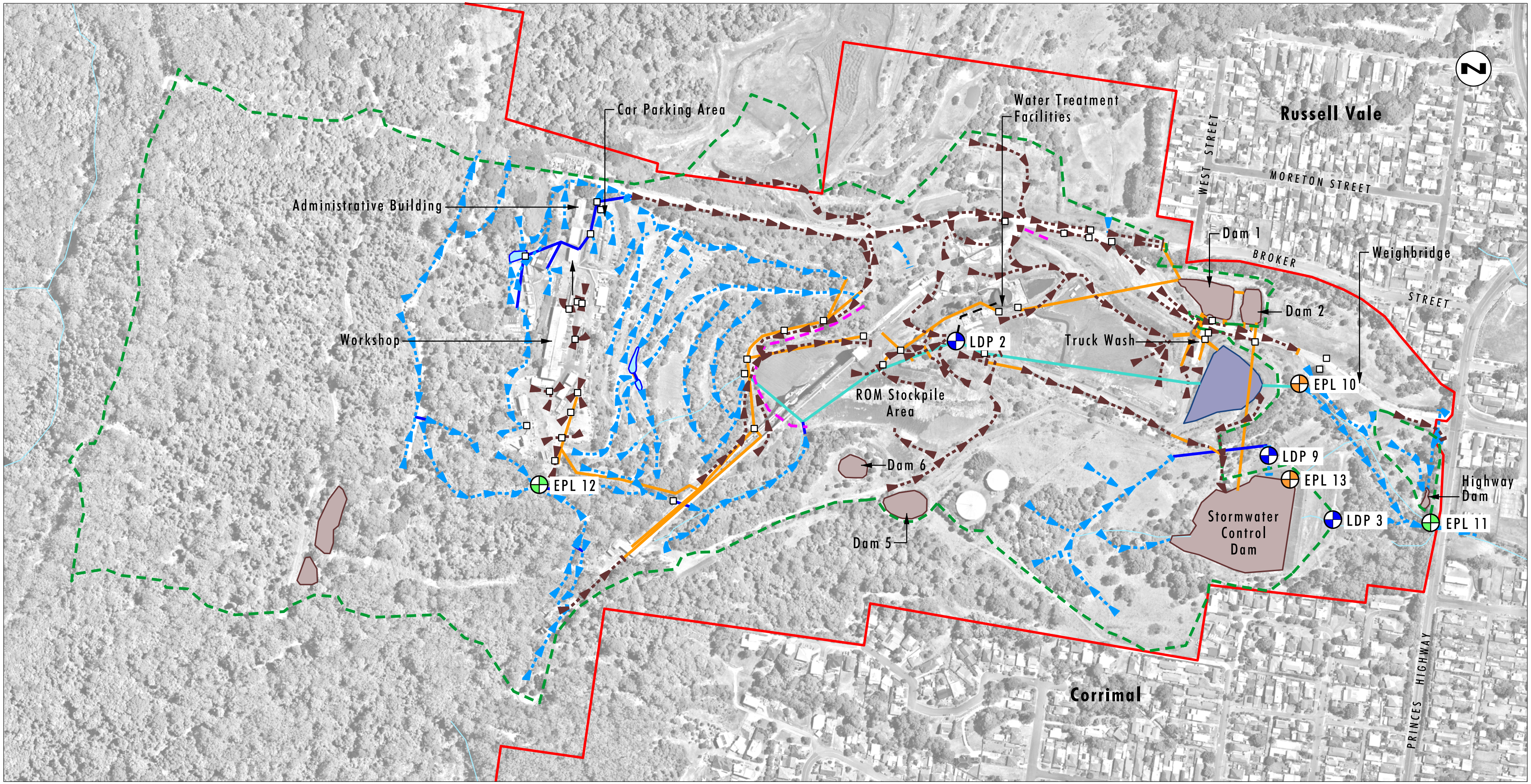

Image Source: Nearmap (Dec 2018)

0 100 200 400m
1:7000

Legend

- UEP Project Application Area
- WMS Boundary
- Pit/Sump
- Clean Water Dam
- Dirty Water Dam
- Clean Water Diversion Drain
- Dirty Water Diversion Drain
- Clean Water Pipe/Culvert
- Dirty Water Pipe/Culvert
- Dry Sediment Basin
- Bund/Levee
- Existing Drainage Line
- Bellambi Creek Pipeline
- Thickener Discharge Pipe
- EPL Point is Ambiant Monitoring Location
- EPL Point is Licensed Discharge Point
- Former Monitoring Location

FIGURE 3.3

Proposed Water Management System Plan

File Name (A4): R09/3687_058.dgn
20190717 10.54

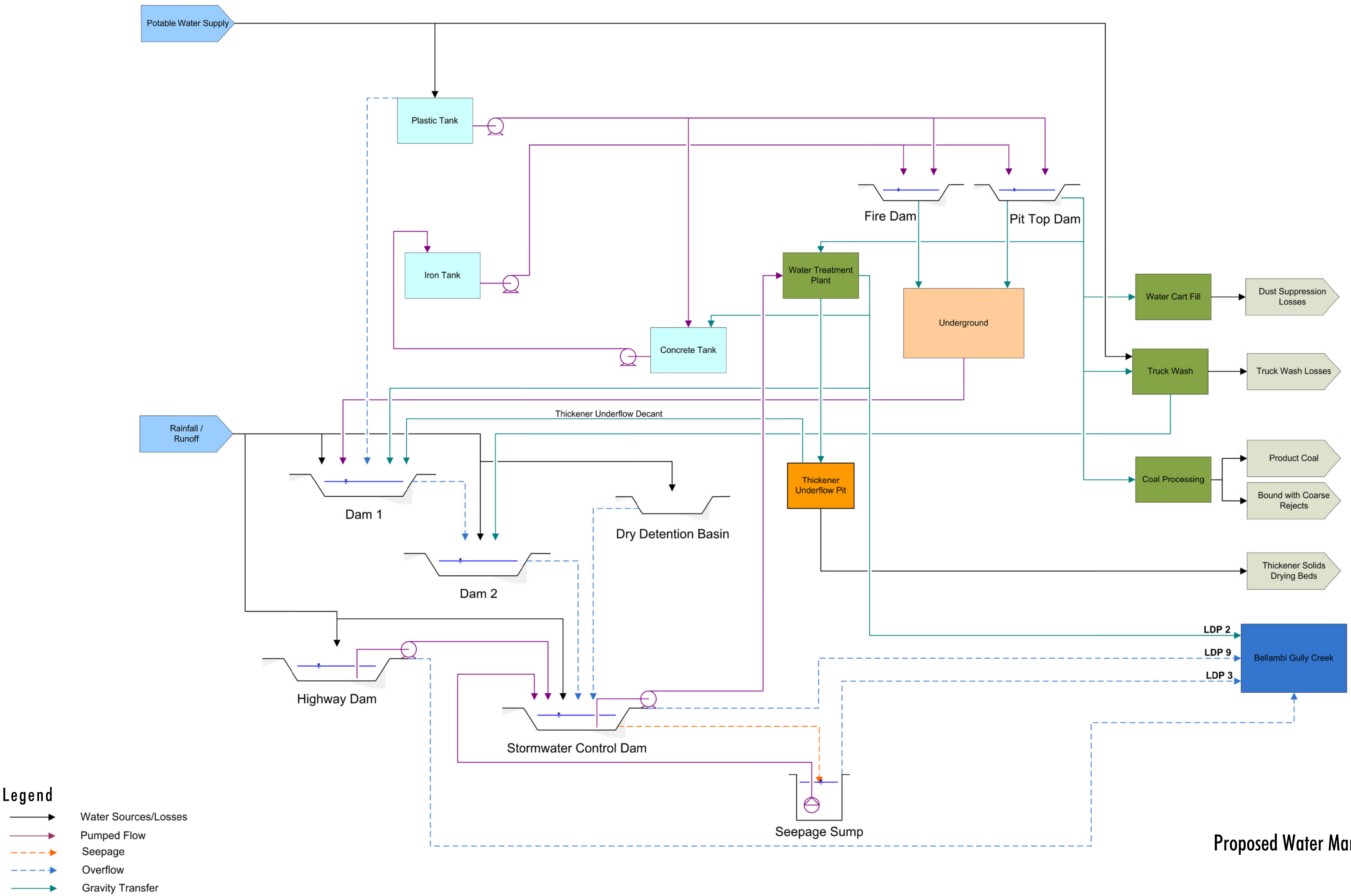

FIGURE 3.4

Proposed Water Management System Schematic

File Name (A4): R09/3687_059.dgn
20190716 17.19

4.0 Water Balance

4.1 Model Overview

The water balance model was developed for the Revised Project using the Goldsim modelling package. The model is a daily time step model and uses historical rainfall records from 1930 to 2017 from the BoM Woonona monitoring station (Station ID 68018), located approximately 2.2 km from site, with infill data from the Bellambi climate monitoring station (Station ID 68228) , located approximately 3.7 km from site, in periods with data gaps. Average daily evaporation data from the Sydney Airport AMO BoM (Station No. 66037), located approximately 53 km from site, was used as the evaporation data set in the model.

Inflows to the water balance include runoff and rainfall and groundwater influx to the underground mine workings.

4.2 Assumptions and Basis

The predictive water balance analysis was undertaken based on the proposed WMS (refer to **Figure 1.1**) and annual ROM production for the 2020 year of the Revised Project and the following assumptions and basis:

- a maximum groundwater inflow to the underground of 0.79 ML/day (Geoterra, 2019)
- catchment runoff from disturbed and natural catchments has been estimated using a soil store model with natural catchment runoff calibrated to the average regional runoff of 1.3 ML/year (NSW Farm Dams Calculator)
- the first 10 mm of runoff from the maintenance/administration catchment is captured in a first flush system and directed into the WMS
- all excess stormwater from dirty water catchments is directed to the Stormwater Control Dam.
- a maximum Seepage Sump pump discharge rate of 2.5 L/s to return seepage a Collection Sump catchment runoff to the SWCD (based on pump performance curve and estimated total discharge head)
- potable water is available for import to the WMS if required
- the underground loss and coal processing water demands are based on the following values:
    - 1.2 Mtpa ROM production
    - In-situ coal and coarse reject – 2.4% weight by weight (w/w)
    - Product coal moisture – 7.5% w/w
    - Coarse reject as percentage of ROM – 5%.
- operational demands based on previous water balances as follows:
    - water cart dust suppression losses of 0.39 ML/day (BECA, 2011)
    - truck wash demand of 0.3 ML/day (BECA, 2011) with an actual loss assumed to be 10% of the demand i.e. 0.03 ML/day).

- a maximum treated water discharge from LDP 2 to Bellambi Gully Creek of 2.5 ML/day in accordance with EPL 12040. While wet weather discharges are allowed above this rate (refer to **Table 2.4**), in practice WCL has not discharged above the dry weather discharge rate for several years. Modelling with a maximum controlled discharge rate of 2.5 ML/day provides conservative results for predicted uncontrolled discharges from the WMS

- the SWCD is operated to target a free storage capacity of at least 30 ML to accommodate high or prolonged rainfall events

- amenities potable water usage is estimated to be approximately 3.6 ML/year, however, potable water for amenities has not been included in the operational water balance as all incoming amenities water is lost directly through consumption or to sewer.

4.3 Results

The modelling predicts that the Revised Project will have a positive gross site water balance for all rainfall years modelled. The gross water balance does not account for controlled discharges (e.g. licensed discharges under EPL 12040) or water imports from external sources (e.g potable water imports) and provides an indication of whether the operation will have a surplus or deficit of water in the absence of discharges and imports. The water make associated with the Revised Project will either be used for operational demands or discharged off site in accordance will the EPL.

Gross water balance model results for the 10th percentile, 50th percentile and 90th percentile water balance years are presented in **Table 4.1**. Detailed net water balance results for the 50th percentile gross water balance year are presented in **Table 4.2**. The net water balance accounts for controlled discharges and water imports form external sources.

Table 4.1 Annual Gross Water Balance Results

Statistic	Result (ML/year)
10th Percentile	329
50th Percentile	390
90th Percentile	514

Table 4.2 50th Percentile Year Net Water Balance Result

Parameter	Result (ML/year)
Inflows	
Rainfall on dams and runoff	352
Groundwater	288
Potable Water Import to Supplement Operational Demands	0
ROM coal moisture	29
Total Inflows	***669***
Outflows	
Evaporation	31
Product Coal	83
Coarse Rejects	3
Water Cart Dust Suppression	142

Parameter	Result (ML/year)
Truck Wash	9
LDP 2 (from WTP)	391
LDP 3 (SWCD seepage)	0
LDP 9 (SWCD spillway)	0
Spills from Highway Dam	0
Total Outflows	***661***
Change in Site Water Inventory	9
Net Water Balance	**0**

The water balance results indicate that the Revised Project will have a surplus gross water balance in all years and be able to adequately meet site water demands with little to no import of water from off-site sources.

There is no predicted demand for import of Potable water with rainfall runoff and extracted groundwater more than adequate to meet the limited Revised Project water demands.

Table 4.3 presents the predicted licensed discharge volumes, **Table 4.4** presents the predicted licensed discharge frequencies and **Table 4.5** presents the predicted spill volumes and frequencies from the Highway Dam.

Table 4.3 Annual Predicted Licenced Discharge Volumes (ML/year)

Statistic	LDP 2	LDP 3	LDP 9
Minimum	0.0	0.0	0
10%	329.0	0.0	0
50%	383.3	0.0	2
90%	470.0	0.4	48
Maximum	592.9	0.9	136

Table 4.4 Predicted Licenced Discharge Frequencies (days/year)

Statistic	LDP 2	LDP 3	LDP 9
Minimum	359	0	0
10%	359	0	0
50%	361	2	0
90%	364	4	3
Maximum	365	10	7

Table 4.5 Annual Predicted Highway Dam Spills

Statistic	Volume (ML/year)	Frequency (days/year)
Minimum	0.00	0.0
10%	0.00	0.0
50%	0.28	2.0
90%	1.44	4.4
Maximum	43.45	8.0

The following observations are made with respect to the predicted licenced discharge results:

- LDP 2 discharges are likely to be required on most days of the year to manage water inventories as a result of the low water demands relative to rainfall runoff and groundwater inflows. Discharge from LDP 2 discharge flows directly into the Bellambi Gully Diversion Pipeline approximately 450 m upstream of the diversion pipeline outlet to Bellambi Creek (refer to **Figure 3.1**).

- Minimal off-site discharge volumes are predicted from LDP 3 as water is captured and returned to the SWCD. LDP 3 discharges are only likely during high rainfall events where the seepage sump overflows to Bellambi Gully Creek.

- LDP 9 discharges are predicted to be infrequent and only occur during high or prolonged rainfall events.

- Spill volumes from the Highway Dam are predicted to be relatively small except during high or prolonged rainfall events.

5.0 Mitigation and Management Measures

The key surface water management measures for the Revised Project involve the proposed Surface Facilities WMS (refer to **Section 3.2**). In addition, there will be a series of erosion and sediment control measures utilised during the construction and operational phases of the Revised Project (refer to **Section 5.1**). The proposed Surface Facilities WMS upgrades have also been addressed in the Modification 4 Preliminary Works Approval (Umwelt, 2019) and include:

- Installation of debris control structures upslope of the Bellambi Gully Creek diversion pipe inlets and regular maintenance of debris control structures and other stormwater controls to reduce the risk of blockages that could cause upslope catchment runoff to flow across the stockpile area.
- Re-grading of the eastern laydown area to allow the area to function as a dry detention basin with a capacity of 2.1 ML, and the construction of a channel to direct overflow from the dry sediment basin to the SWCD.
- Construction of a flood levee upstream of the stockpile area to direct upslope runoff (from laydown area, car parking and offices) to the Bellambi Gully Creek stormwater diversion pipe and provide stormwater attenuation during high rainfall events.
- Extension of existing noise bund to prevent run off from the catchment north of the Surface Facilities entering the stockpile area.
- Pre-treatment of water flowing to Dam 1 using flocculation blocks to enhance settling in Dam 1 and Dam 2 prior to overflow to the SWCD.
- Ongoing real time turbidity monitoring of LDP 2 discharge, Bellambi Gully Creek upstream and Bellambi Gully Creek downstream to allow rapid response to deviations above water quality trigger values (refer to **Section 3.1.2**).

The existing surface water monitoring programs at the Surface Facilities will be reviewed and updated as required as part of the implementation of the Revised Project. These programs will be documented in an updated Surface Facilities WMP. In addition, the WMP will also be updated to guide the overall management of water as part of the Revised Project and will include detailed Trigger Action Response Plans to ensure WCL personnel can respond accordingly to potential surface water management issues.

5.1 Erosion and Sediment Control Measures

Erosion and sediment control measures to be implemented as part of the Revised Project will be detailed in an Erosion and Sediment Control Plan (ESCP). These measures will be undertaken in accordance with:

- 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*.

5.1.1 Construction

An ESCP will be prepared for construction of works associated with the Revised Project. The ESCP will detail the specific soil and water controls and their inspection and maintenance requirements, along with revegetation requirements for each work area based on the construction program schedule.

5.1.2 Operations

Specific erosion and sediment control measures proposed to be implemented for the Revised Project will include those measures outlined in **Section 3.2** and the detailed Mine Closure and Rehabilitation Plan which will be prepared in advance of planned mine closure.

Periodic maintenance of the WMS will continue to be undertaken and includes:

- de-silting and maintenance of sediment dams and drainage lines
- operating the SWCD with a target free storage capacity of 30 ML to accommodate runoff from high or prolonged rainfall events
- cleaning and maintenance of upslope clean catchment stormwater debris control structures and drains to minimise excess stormwater entering the WMS
- ongoing water quality monitoring as detailed in **Section 7.1.3**.

6.0 Impact Assessment

The Revised Project and the associated WMS has the potential to impact on surface water systems including:

- Impacts to catchment areas and downstream watercourses.
- Impacts to flooding, including flow rates, velocities and depths.
- Impacts to water quality in downstream watercourses.

6.1 Catchment Areas and Annual Flow Volumes

The Surface Facilities WMS catchment area for the Revised Project will remain predominantly unchanged from the existing catchment area. However, improvements to the stormwater system (refer to **Section 3.2.1**) will reduce the frequency and volume of upslope clean catchment runoff entering the WMS during high rainfall events.

Flow volumes into Bellambi Gully Creek via the existing 1,800 mm stormwater diversion pipe are expected to be unchanged apart from higher rainfall events where the proposed flood mitigation management measures presented in **Section 3.2.1** will assist in directing additional upslope catchment runoff through the diversion pipe.

6.2 Flooding

Historical records and recent hydrological assessments of the Surface Facilities catchment demonstrates that the site is prone to flooding during high rainfall events (refer to **Sections 3.1.1** and **3.2.1**) resulting in potential wash out of coal from the stockpiles into Bellambi Lane. **Section 3.2.1** outlines the proposed measures to be implemented for the Revised Project to reduce flooding in Bellambi Lane. The mitigation measures are based on those proposed in a flood study prepared by Engeny (2018) which is being assessed as part of the proposed Modification 4 Preliminary Works Approval (Umwelt, 2019).

Flood modelling indicates that the proposed flood management measures are predicted to reduce flood impacts on downstream properties, Bellambi Lane and the Princes Highway during the 100 year ARI event (Engeny, 2018). The proposed improvements would reduce the frequency and volume of runoff from upslope clean catchments entering the WMS.

Further, the modelling indicates that:

- There will be a reduction in peak flood levels and flood extents as a result of the increased detention of overland flows in the eastern laydown area and the detention of water behind the upstream berm.
- There will be negligible impacts to downstream properties in the 5 year ARI event.
- There will be no impact on flood levels to the properties to the south of the SWCD (Engeny, 2018).

6.3 Downstream Water Quality

Water quality impacts associated with the Revised Project are expected to be reduced in comparison to the existing operation. Improvements to flood management will reduce the frequency and volume of uncontrolled discharges of dirty/mine water from the site during high rainfall events and the proposed water treatment measures (refer to **Section 3.2.2**) will result in lower concentrations of sediment in licensed off-site discharges.

6.4 Geomorphological and Hydrological Values

The Revised Project is not expected to result in impacts to the geomorphological or hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Revised Project are considered unlikely as flows through Bellambi Gully Creek are expected to be lower as a result of the proposed flood mitigation measures (refer to **Section 3.2.1**) when compared to the existing care and maintenance scenario.

The Revised Project will not change the contributing catchment of Bellambi Gully Creek over its life.

6.5 Riparian and Ecological Values of Watercourses

Stream flows in Bellambi Gully Creek are expected to remain comparable to the present flows, and further, it is expected that there will be an improvement in water quality downstream of the site as a result of the mitigation and management measures outlined in **Section 5.0**. Hence, no negative impacts on riparian and ecological values downstream of the Russell Vale Surface Facilities are considered likely as a result of the Revised Project when compared to the existing care and maintenance scenario.

6.6 Water Users

Water users downstream of the Russell Vale Surface Facilities require the protection of visual amenity and primary contact recreation. Historically, turbid water discharged from the Surface Facilities has impacted on the visual amenity of Bellambi Gully Creek in the nearby downstream reach.

As indicated in **Sections 0**, water quality downstream of the Surface Facilities is expected to improve as a result of the proposed mitigation and management measures for the Revised Project. As such, no negative impacts on water users downstream of the Surface Facilities are considered likely as a result of the Revised Project when compared to the existing care and maintenance scenario. It is considered more likely that the visual amenity in Bellambi Gully Creek will improve downstream of the Surface Facilities as a result of the proposed mitigation and management measures for the Revised Project.

6.7 Cumulative Impacts

The receiving waters downstream of the Surface Facilities have historically been impacted by the presence of the Russell Vale Colliery as well as urban development. As the Revised Project will not result in any change to the contributing receiving water catchment area, and will result in an improvement to the discharge water quality from the Surface Facilities, no negative cumulative impacts are considered likely as a result of the Revised Project when compared to the existing care and maintenance scenario.

7.0 Monitoring, Licensing and Reporting

Water systems at and surrounding the Surface Facilities are currently monitored in accordance with the WMP (WCL, 2019) and the site EPL (EPL 12040).

Water monitoring is undertaken to assess compliance against licence and consent conditions and for operational purposes. This includes monitoring of the site water balance and water quality.

A record of baseline data has been collected for Surface Facilities (refer to **Section 2.3.4**) and will be used to inform the ongoing review of monitoring data, allowing any potential impacts of the Revised Project to be identified and management measures implemented where appropriate.

As part of the implementation of the current Modification 4 Preliminary Works Approval (Umwelt, 2019) and again for the Revised Project, the WMP will be updated. The updated WMP will be used to guide the overall management of water as part of the Revised Project, and will include:

- A water balance including details of water supply, use, management and transfers.
- An ESCP that is consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and Volume 2E Mines and Quarries (DECC, 2008), or the latest versions.
- Relevant baseline data on the existing surface water environment.
- A detailed description of the WMS including design objectives and performance criteria.
- Detailed surface water quality and quantity monitoring requirements.;
- Trigger values for relevant water quality and quantity parameters.
- TARPs to guide an appropriate response to deviations from the specified trigger values.
- Reporting and notification requirements.

7.1 Monitoring

Erosion and sediment controls will be monitored during construction and operation in accordance with the *Blue Book* (Landcom, 2004 and DECC, 2008). Monitoring of the performance of the water management systems and associated erosion and sediment control measures will be set out in the revised WMP, with monitoring typically undertaken monthly and after major storm events.

7.1.1 Water Quantity Monitoring

As part of the water balance monitoring for the WMS, water imported to site, water used on site and water discharged from site will be monitored in accordance with *Water Reporting Requirements for Mines* (NSW Office of Water, undated).

SWCD seepage rate is also monitored on a monthly basis during dry weather using the rated collection sump pump flow rate and pump run time.

7.1.2 SWCD Embankment Monitoring

A general inspection is also undertaken of the SWCD embankment during seepage rate monitoring to identify any changes embankment condition that may be indicative of structural degradation. Any changes observed such as excessive water logging of the embankment, embankment deformities, changes to embankment vegetation coverage and embankment erosion are noted and further advice sought from appropriate specialists as required.

7.1.3 Water Quality Monitoring

Surface water quality monitoring will continue to be undertaken in accordance with the site EPL as detailed in **Table 2.4**.

7.1.4 Discharge Volume Monitoring

LDP2 discharge volume monitoring will continue to be undertaken in accordance with the site EPL as detailed in **Table 2.4**.

7.1.5 Stream Flow Monitoring

Flow monitoring in Bellambi Gully Creek will be undertaken by visual observation of the flows during water quality sampling (flow, no-flow). The flow observations will be used to inform the assessment of water quality data.

7.1.6 Water Conveyance Infrastructure

The following monitoring of water conveyance infrastructure will be implemented as part of the Revised Project:

- Event based inspections of major water conveyance infrastructure following heavy rainfall and high flow weather events. The infrastructure to be inspected will include the Bellambi Gully Diversion Pipeline, debris control structures, surface drains and dams.

- An annual audit of the condition of and maintenance works that have been undertaken on water conveyance infrastructure.

7.2 Decommissioning of the Water Management System

As part of decommissioning, water management dams will either remain in use for identified and approved future land uses or will be removed. If the dams are to be retained, the capacity of the dams will be reviewed and the size/volume modified as necessary to ensure total dam capacity remains within the landholding Maximum Harvestable Rights Dam Capacity (MHRDC). Areas disturbed by removal or modification of water management structures will be reshaped and revegetated. The measures required to effectively decommission the water management system and the water management controls required in the post mining landform will be considered in further detail as part of the detailed colliery closure planning process.

7.3 Licensing Requirements

7.3.1 Water Management Act 2000

As detailed in **Section 2.1.1** the Russell Vale Colliery Pit Top facilities are located within the area regulated by the WSP for the Greater Metropolitan Region Unregulated River Water Sources. Water use from surface and alluvial waters in and adjacent to the Russell Vale Colliery Pit Top facilities is therefore governed by the WM Act. Harvestable rights, which are a basic landholder right under the WM Act allow a landholder to capture and use up to 10% of the average regional runoff from a landholding. Basic landholder rights are exempt from volumetric licensing requirements, however, water extracted under basic landholder rights must be taken into consideration when assessing licensing requirements.

The WCL landholding associated with the Russell Vale Colliery totals approximately 1,410 ha, giving a MHRDC of 183 ML based on an average regional runoff 1.3 ML/ha/year (NSW Farm Dams Calculator). The Russell Vale Surface Facilities WMS catchment area is approximately 44.9 ha including approximately 16.7 ha of undisturbed catchment. Dams within the WMS catchment are primarily for pollution control purposes (Dam 1, Dam 2, the SWCD and the Highway Dam) and are considered to be exempt from surface water licensing requirements based on item 12 (Excluded Works) of Schedule 4 (Exemptions) and item 3 of Schedule 1 (Excluded Works) of the *Water Management (General) Regulation 2018*. Dam 5 and Dam 6 have an estimated combined capacity of less than 10 ML with minimal catchment area (<0.25 ha combined) and have therefore been excluded from the MHDRC assessment. The Pit Top Dam and Fire Dam also have negligible catchment areas with upslope runoff diverted around the dams and have not been considered in the MHRDC assessment. There are 2 dams within the WCL landholding outside of the Russell Vale Surface Facilities WMS catchment with a conservatively estimated capacity of up to 14 ML.

Given the conservatively estimated assessable dam capacity within the WCL landholding of 14 ML is below the MHRDC of 183 ML there is no requirement for WCL to obtain a surface water access licence.

7.3.2 Protection of the Environment Operations Act 1997

The Russell Vale Colliery operates under EPL 12040. **Sections 2.1.2** and **2.3.4.2** present details of the surface water conditions identified in EPL 12040 that are relevant to the Revised Project. No changes relating to EPL 12040 are anticipated as a result of the Revised Project.

7.3.3 Reporting

It is anticipated that the following reporting will be undertaken for the Revised Project:

- Monthly water quality reporting published on the WCL website.
- Real time water quality monitoring results for Bellambi Gully Creek upstream and downstream of the Russell Vale Surface Facilities, to be available on the WCL website in accordance with EPL 12040.
- Reporting of monitoring data and incidents in accordance with EPL 12040 requirements and conditions of consent.
- A summary of surface water monitoring results and WMS performance will be provided in the Annual Review. As a minimum, the following information will be reported in the Annual Review:
    - a summary of water quality monitoring results
    - an analysis of monitoring results against impact assessment criteria and historical monitoring results

- an annual site water balance and comparison against predictions in the EIS
- an assessment of any changes to the site water balance
- identification and assessment of any trends in the monitoring results
- any identified issues or exceedances of trigger values
- any non-compliances reported during the year and associated actions taken to address non-compliances
- the effectiveness of the erosion and sediment controls
- the performance of the WMS, and
- the condition of, and maintenance undertaken on, water conveyance infrastructure.

8.0 References

Wollongong Coal Limited, 2017. *Surface Facilities Water Management Plan*.

BECA, 2011. *Water Management Report Gujarat NRE No.1 Colliery Major Works Part 3*.

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Cardno, 2015. *Bellambi Gully Flood Study*.

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Douglas Partners, 2017. *Type 2 Dam Surveillance Report, Stormwater Control Dam WCL No 1 Colliery, Russell Vale.*

Douglas Partners, 2019. *Dam Safety Emergency Plan - Storm Water Control Dam WCL No. 1 Colliery Russell Vale Site.*

Engeny, 2017. *Bellambi Creek Diversion Pipeline Assessment*.

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Landcom, 2004. *Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.*

Geoterra, 2019, *Russell Vale Colliery Underground Expansion Project Russell Vale East First Worksings Groundwater Assessment.*

Umwelt, 2019, *Russell Vale Colliery Preliminary Works Project Modification 4 Further Response to Submissions.*

Department of Environment and Climate Change (DECC), 2008. *Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.*

Water NSW, 2018. *Maximum Harvestable Right Calculator* (https://www.waternsw.com.au/customer-service/water-licensing/basic-water-rights/harvestable-rights-dams/maximum-harvestable-right-calculator).

NSW Office of Water (NOW), undated. *Water Reporting Requirements for Mines*.

Umwelt, 2018. Response to Submissions, Russell Vale Colliery Preliminary Works Project Modification 4. December 2018. Prepared for Wollongong Coal.

Umwelt, 2019. Further Response to Submissions, Russell Vale Colliery Preliminary Works Project Modification 4. June 2019. Prepared for Wollongong Coal.

APPENDIX A

Relevant Existing Approval Consent Conditions

Table A1.1 Existing Surface Water Project Approval Conditions Relevant to the SWIA

Condition/ Schedule	Condition
32/3	The Proponent shall prepare and implement a Russell Vale Surface Facilities WMS for the surface facilities areas, to the satisfaction of the Director-General. This plan must: a) be prepared in consultation with EPA, NOW, DRE and WCC by suitably qualified and experienced persons whose appointment has been approved by the Director-General b) be submitted for approval to the Director-General within 6 months of this approval c) include: – a Site Water Balance – an Erosion and Sediment Control Plan.
33/3	The Site Water Balance must: (a) include details of: • sources and security of water supply • water use on site • water management on site • any off-site water transfers (b) investigate and implement all reasonable and feasible measures to minimise potable water use from Wollongong's reticulated water supply and to reuse and recycle water.
34/3	The ESCP must: (a) be consistent with the requirements of the Managing Urban Stormwater - Soils and Construction, Volume 2E: Mines and Quarries (DECC 2008), or its latest version (b) identify activities that may cause soil erosion and generate sediment, particularly in relation to Bellambi Gully Creek (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters (d) describe the location, function, and capacity of erosion and sediment control structures (e) describe what measures would be implemented to maintain the structures over time.
2/5	2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: (a) detailed baseline data

Condition/ Schedule	Condition
	(b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions) • any relevant limits or performance measures/criteria • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the Revised Project or any management measures. (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria (d) a program to monitor and report on the: • impacts and environmental performance of the Revised Project • effectiveness of any management measures (see c above) (e) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible (f) a program to investigate and implement ways to improve the environmental performance of the Revised Project over time (g) a protocol for managing and reporting any: • incidents • complaints • non-compliances with statutory requirements • exceedances of the impact assessment criteria and/or performance criteria. (h) a protocol for periodic review of the plan.
3/5	By the end of August 2012, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Director-General. This review must: (a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the next year (b) include a comprehensive review of the monitoring results and complaints records of the project over the past calendar year, which includes a comparison of these results against • the relevant statutory requirements, limits or performance measures/criteria • the monitoring results of previous years • the relevant predictions in the EA. (c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance

Condition/ Schedule	Condition
	(d) identify any trends in the monitoring data over the life of the project (e) identify any discrepancies between the predicted and actual impacts of the Revised Project, and analyse the potential cause of any significant discrepancies (f) describe what measures will be implemented over the next year to improve the environmental performance of the Revised Project.
4/5	Within 3 months of: (a) the submission of an annual review under Condition 3 above (b) the submission of an incident report under Condition 6 below (c) the submission of an audit under Condition 8 below (d) any modification to the conditions of this approval (unless the conditions require otherwise), the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Director-General.
6/5	The Proponent shall notify the Director-General and any other relevant agencies of any incident that has caused, or has the potential to cause, significant risk of material harm to the environment, at the earliest opportunity. For any other incident associated with the project, the Proponent shall notify the Director- General and any other relevant agencies as soon as practicable after the Proponent becomes aware of the incident. Within 7 days of the date of the incident, the Proponent shall provide the Director-General and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.
7/5	The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval, and to the satisfaction of the Director-General
8/5	Within 12 months of this approval, and every 3 years thereafter, unless the Director-General directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must: (a) be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (b) include consultation with the relevant agencies (c) assess the environmental performance of the project and assess whether it is complying with the requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals) (d) review the adequacy of strategies, plans or programs required under the abovementioned approvals (e) recommend appropriate measures or actions to improve the environmental performance of the project, and/or any assessment, plan or program required under the abovementioned approvals.
9/5	Within 6 weeks of the completion of this audit, or as otherwise agreed by the Director-General, the Proponent shall submit a copy of the audit report to the Director-General, together with its response to any recommendations contained in the audit report.

Condition/ Schedule	Condition
Appendix 3 Statement of Commitments	Dirty stormwater and mine water will be treated on site prior to discharge. Dirty stormwater from hard surfaces will be diverted into the Stormwater Control Dam (SWCD). Water will be held in the SWCD to reduce solids prior to treatment and then discharging via LDP2. The stormwater control dam (SWCD) will be kept at a level that allows 30ML of stormwater to be captured on site, reducing the flow and flood potential downstream. Chemicals will be properly stored and bunded. Dosing of flocculent will be metered and monitored on site. The underground pipe section of Bellambi Gully Creek will be replaced with a suitably designed and engineered open bypass channel constructed on the southern side of the coal stockpile area. This will include: • A dissipation pond to be constructed at the end of the bypass channel to reduce energy of flows back into Bellambi Gully Creek • Upgrades to the existing channel including Reno mattresses and Gabion drop structures to reduce the velocity of water flowing down the Gully • Regular maintenance to minimise scouring during major flow events. Preparation of a construction management plan that includes the following: • A dry and wet basin arrangement to minimise sediment transportation to the stormwater dam • Works will not take place during heavy rainfall that is likely to contribute to erosion • Undertake stripping of topsoil, if required, immediately before starting bulk earthworks to be used for rehabilitation or revegetation works on site • Suitable areas for any temporary stockpiling of excavated soil (on flat ground) will be clearly identified and delineated before the commencement of works • Ensure stockpiles are: o Constructed on the contour at least 2 (preferably 5) metres from hazard areas, particularly likely areas of concentrated water flows or slopes steeper than 10% o Stabilised if they are to be in place for more than 10 days. The stockpile of VENM excavated from the construction of the bypass channel will be grassed o Protected from run-on water by installing water diversions upslope o Installed with sediment filters immediately downslope to protect other lands and waterways from pollution.
Appendix 3 Statement of Commitments (continued)	Construction of Bellambi Gully Creek will be undertaken in accordance with engineering plans prepared in general to meet the design parameters outlined in Coffey (2010). All erosion, sediment control and runoff diversion measures will be established before any excavation begins. These will be left in place throughout works execution and beyond works completion until all surfaces have been fully restored and stabilised.

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APPENDIX 4

Biodiversity Assessment

Russell Vale Colliery – Underground Expansion Project: Updated Ecological Impact Assessment

FINAL REPORT

Prepared for Umwelt Pty Ltd

11 July 2019

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Summary

Wollongong Coal has previously submitted an application to expand their mining operations at the Russell Vale Colliery. This project is referred to as the Underground Expansion Project (UEP).

Following a second review by the Planning Assessment Commission (PAC) Wollongong Coal has revised their mine plan for the UEP and now proposes to undertake first workings only, to minimise subsidence and associated surface impacts.

This report provides a revised biodiversity impact assessment based on the revised mine plan, associated subsidence predictions and biodiversity values previously identified.

The subsidence assessment undertaken for the revised UEP assessment (SCT 2019) indicates that the first workings method and construction of development mains are not expected to cause perceptible surface subsidence or significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. The proposed first workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

As a result, impacts to previously identified biodiversity values are predicted to be negligible.

A monitoring program focussed on monitoring of subsidence impacts and primary impacts is recommended.

1 Introduction

1.1 Project background

The Russell Vale Colliery, is located approximately 8 kilometres north of Wollongong Central Business District (CBD), is owned and operated by Wollongong Coal Ltd (Figure 1). Wollongong Coal purchased the Colliery in December 2004, but extensive underground mining has been undertaken at the facility, dating from the late nineteenth century. However, a substantial volume of high quality coking coal resources remain, along with some potential thermal coal resources.

Wollongong Coal have previously submitted an application to expand their mining operations at the colliery; referred to as the Underground Expansion Project (UEP). The proposed works involved the extraction of coal from eight longwalls in the Wongawilli seam, in three blocks (Longwalls 1-3, 6-7 and 9-11) and the continued operation of the mine's surface facilities over a project life of 5 years. The project was deemed a major project, and as such is undergoing assessment under the now repealed Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A project application history is provided below.

The Planning Assessment Commission's (PAC) second review of the UEP preferred project application in 2016 raised concerns regarding potential impacts to surface water and groundwater reserves in the Cataract Catchment domain as well as potential impacts to Matters of National Significane (MNES) including the Endangered Ecological Community (EEC) *Coastal Upland Swamps in the Sydney Basin Bioregion*, listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (PAC 2016).

Following the PAC's review, Wollongong Coal revised the mine plan for the UEP to address the concerns raised by PAC. The revised mine plan proposed to not pursue secondary extraction processes (longwall mining) within the expansion areas, and only undertake first workings extractions. The engineering of the approved development mains will require an increased width to height ratio for the pillars, for the purpose of long-term geotechnical stability and reduced risk of further subsidence and associated surface impacts (Figure 2). It is expected that impacts to ecological values arising from the revised mine plan will be negligible.

1.2 Project application History

Originally, Wollongong Coal intended to expand its operations in two stages. Stage 1 plans were included in the Preliminary Works Part 3A project application that was approved on 13 October 2011, allowing some first workings coal extraction and surface facility upgrades. On 24 December 2012, the Preliminary Works Part 3A project was modified to allow the extraction of Longwalls 4 and 5 and the establishment of the main gate for Longwall 6. This step was undertaken to allow a continuation of operations at the Russell Vale Colliery while the Stage 2 application was being assessed.

The original Stage 2 application, known as the Underground Expansion Project Part 3A, was lodged with the NSW Department of Planning and Environment (DPE) on 12 August 2009 and contained an application to extract 11 longwalls in the Wonga East area and seven longwalls in the Wonga West area. This also included surface facility upgrades to allow production up to 3 million tonnes per annum (MTPA) for up to 20 years. Since that time, the project has been progressing through the Major Project approvals process and was placed on Public Exhibition on 18 February 2013. As a result of the submissions received on the application, Wollongong Coal made the decision to substantially revise the application to facilitate the approval process and allow continuity in operations. Due to the scope of the changes, the DPE requested Wollongong Coal prepare a Preferred Project Report (PPR) for the revised Underground Expansion Project Part 3A.

The Preferred Project Report and a response to submissions (NRE 2013) was provided to DPE in 2013. The PPR outlined the revised UEP mine plan, which was reduced to a five year interim, staged project, with extraction of eight longwalls in the Wonga East area and upgrading of surface facilities to manage an extraction rate of up to 3 MTPA run of mine (ROM) coal. The original Wonga West longwall extraction was removed from the UEP application. A number of additional submissions were received on the PPR from government agencies and the public. In response, a Residual Matters Report was prepared (Hansen Bailey 2014) and submitted to DPE in July 2014.

In December 2014 the UEP was referred to the PAC by DPE, with a recommendation for the project to be approved subject to stringent conditions (DPE 2014). The first PAC review, undertaken in February 2015, concluded that while the probability of a significant impact arising from the project was low, the consequence if an impact to Sydney's drinking water catchment occurred would be *"substantial and irreversible"* (PAC 2015, p. 3). The PAC concluded that they did not have sufficient information to determine the UEP project, and recommended the establishment of an independent risk assessment panel (IRAP) to oversee an integrated risk assessment, with a focus on subsidence and associated impacts.

The IRAP was established in consultation with DPE and an integrated risk assessment undertaken. The Integrated Risk Assessment focused on providing risk rankings to the potential impacts of the Project associated with subsidence, surface water and groundwater impacts, with a direct focus on water resources. The integrated risk assessment process is detailed in Hansen Bailey (2015). The IRAP concluded that the integrated risk assessment has been adequately undertaken and that the "*risks associated with underground mining on the quantity and quality of groundwater and surface water as well as upland swamps have been assessed and appropriate controls are identified"* (Hansen Bailey 2015, p. 8). DPE prepared an addendum report for the PAC (DPE 2015), stating following consideration of Wollongong Coal's response to the first PAC review the UEP be approved, subject to a number of recommended conditions of approval.

A second PAC review was conducted in December 2015 (PAC 2016). In this review the PAC remained concerned about potential impacts to sensitive environmental features; stating "*on the basis of all the information provided, the Commission is of the view that the social and economic benefits of the project as currently proposed are likely outweighed by the magnitude of impacts to the environmen*t". The PAC recommended that any further consideration have regard to the issues raised in their report.

The main potential impact mechanism from longwall mining is surface subsidence (Hansen Bailey 2015). Ultimately, Wollongong Coal have further refined the UEP application, proposing a long-term stable mining method of first workings only (Figure 2), as opposed to the previously proposed method of longwall mining. Subsidence impacts, as a result of the revised mining methodology, are predicted to be negligible.

Changes as a result of the Preferred Project significantly reduced predicted impacts to terrestrial and aquatic biodiversity and upland swamps. A summary of the reduced impact predictions were outlined in the PPR (Biosis 2014a) and are summarized below:

- Removal of Wonga West from the program resulted in reduced impacts to cliffs, providing habitat for threatened bats, rocky outcrops, providing habitat for threatened flora species and the Broad-headed Snake, and habitat for threatened frogs. The risk assessment for each of these groups of species indicated a low risk of potential impact.
- The revision of the mine plan to avoid undermining of Cataract Creek resulted in a reduced risk of impact to Macquarie Perch, Murray Cod and Silver Perch, as well as habitat for the threatened Adam's Emerald Dragonfly.
- The revision of the mine plan resulted in a reduction in risk for several upland swamps, including CRUS2, CRUS3 and CCUS5, and resulted in a low risk of impacts for all upland swamps except BCUS4 and CCUS4.

- The revised mine plan and revised subsidence predictions resulted in an increase in risk to one upland swamp, CCUS4.

As mentioned in section 1.2 of this report; despite these modifications to the mine plan, in their second review the PAC remained concerned about potential subsidence-related impacts on the environment. Following the second PAC review, and consideration of the findings of this review, Wollongong Coal have further revised the mine plan for the UEP to address the concerns raised by the PAC (Figure 2).

1.3 Scope of assessment

Wollongong Coal is preparing a revised Environmental Assessment as part of the Response to the Second PAC Review Report based on the revised mine plan. This report provides a revised biodiversity impact assessment based on impacts arising from this revised mine plan.

The objectives of this report are to:

- Provide a brief background to the history of the project (Sections 1.1 and 1.2).
- Detail the proposed changes to the UEP mine plan on which this impact assessment are based (Section 2).
- Provide a review of potential subsidence impacts and primary impacts arising from the revised mine plan (Section 3.2).
- Prepare revised impact assessments for species reliant on features at risk of impact due to subisdence, as previously assessed, including:
  - Threatened ecological communities reliant on perched aquifers (Section 3.3.1).
  - Threatened species occupying upland swamps (Section 3.3.2).
  - Threatened species occupying rock environments (Section 3.3.3).
  - Threatened species occupying aquatic environments (Section 3.3.4).
- Provide revised management and mitigation measures based on these changes (Section 4).
- Summarize the overall impact of the project on ecological values in the study area (Section 5).

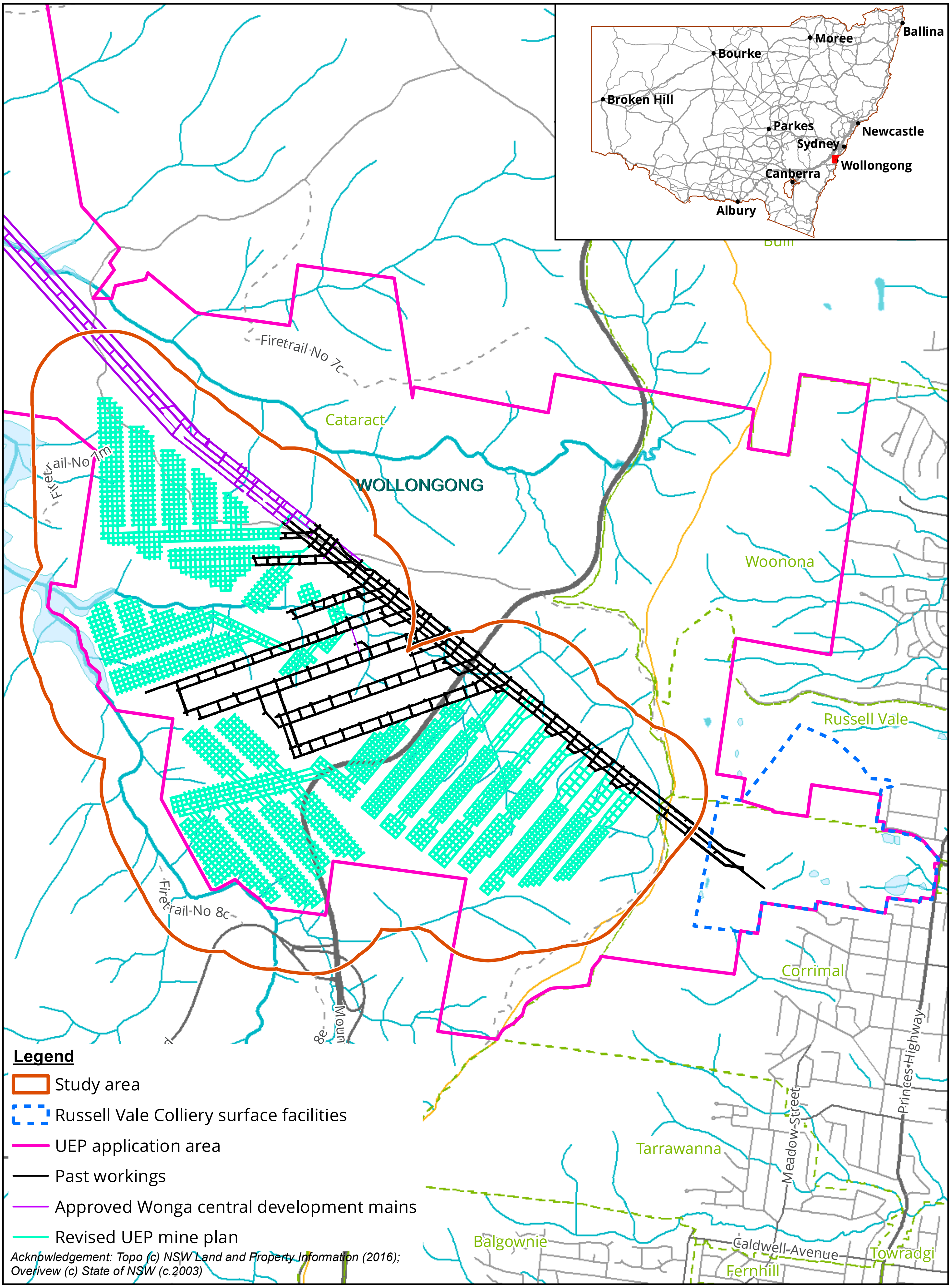

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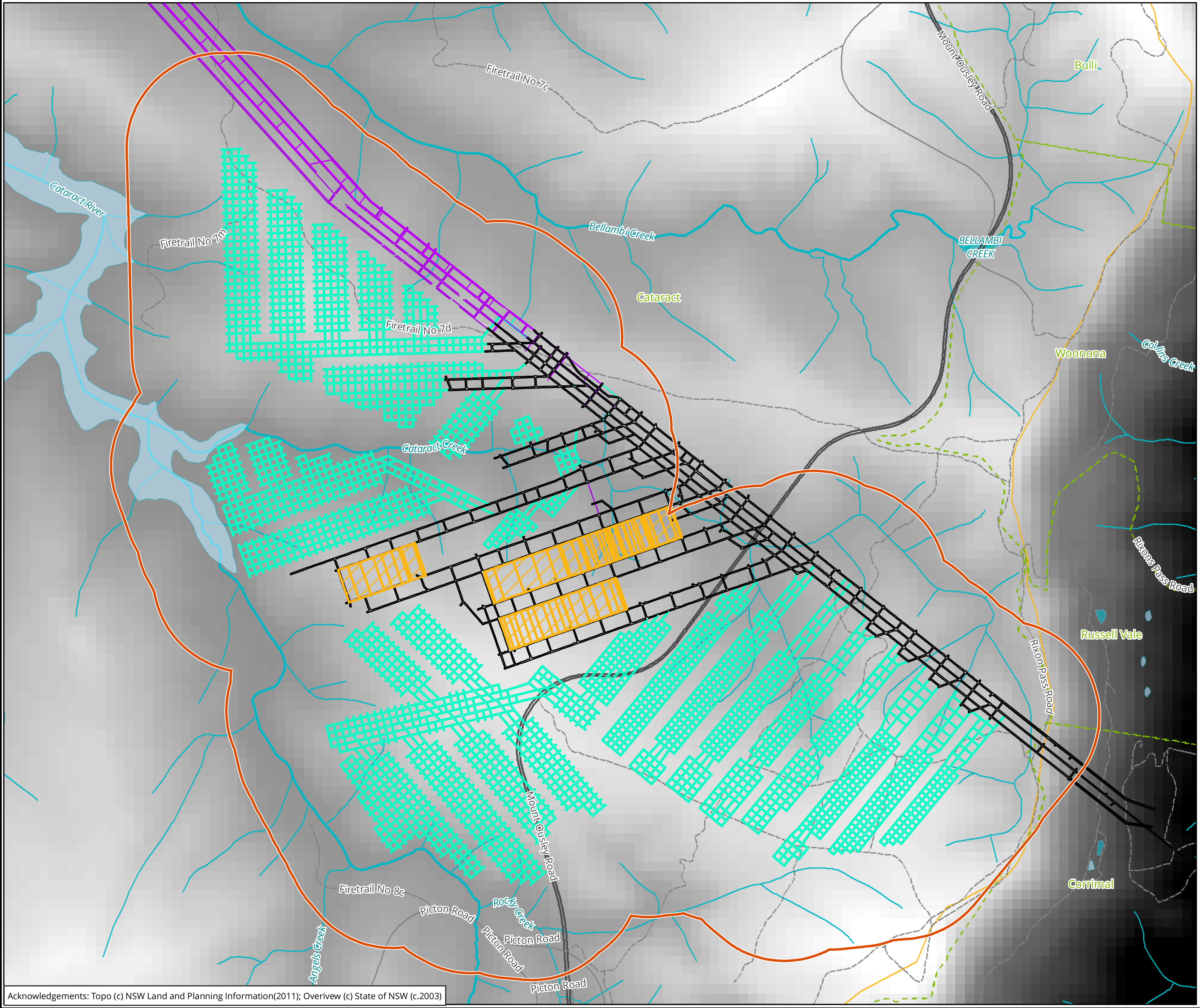
Figure 1 Location of the Russell Vale Colliery, New South Wales

Matter: 24737
Date: 10 July 2019,
Checked by: NMG, Drawn by: LH, Last edited by: amurray
Location:P:\24700s\24737\Mapping\

0 250 500 750 1,000
Metres
N
Scale 1:30,000 @ A4, GDA 1994 MGA Zone 56



Acknowledgements: Topo (c) NSW Land and Planning Information(2011); Overview (c) State of NSW (c.2003)

Legend

- Study area
- RV East Old Longwall Workings
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan

Figure 2 Revised UEP mine plan

0 200 400 600 800

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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24737_F2_MinePlan

2 Project changes

Substantial modifications to Wollongong Coal's original UEP have been undertaken to avoid and minimise impacts to surface features, as described in the Preferred Project UEP. These changes involved the removal of Wonga West from the application as well as the change in mining method, away from longwall extraction, in Wonga East.

Wollongong Coal's revised mine plan proposes to undertake first workings only to minise subsidence and associated surface impacts. The revised UEP mine plan proposes extraction of coal using the 'first workings' method rather than longwalls. Long-term research indicates that vertical subsidence as a result of the extraction method is typically less than 20 millemetres; consistent with variations in surface levels observed in natural or seasonal patterns (Commonwealth of Australia 2014). Wollongong Coal will use existing road headings for Longwalls 6 and 7 to access some areas and there will be further first working cut throughs in the areas previously proposed for longwall mining.

No direct impacts to surface features will result from the revised UEP mine plan. The project will not result in the direct removal of vegetation as the infrastructure upgrades at the Russell Vale Colliery will be undertaken within cleared areas. No clearing of upland swamp vegetation will occur and threatened flora species will be retained.

3 Revised Impact Assessment

This section provides an impact assessment for ecological values within the Wonga East study area. The study area is defined as the area located within 400 m of proposed first workings included in the revised mining plan Figure 2.

The sensitive habitat in the study area includes (Biosis 2014a):

- Rocky environments;
- Coastal upland swamps (listed as an endangered ecological community); and
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

Descriptions and locations of these sensitive habitats within the study area are further detailed in the Preferred Project EIS (Hansen Bailey 2015).

3.1 Candidate species requiring assessment

An updated desktop review of relevant databases for species listed under the EPBC Act, BC Act and/or the NSW *Fisheries Management Act 1994* (FM Act) determined that one listed ecological community, nine listed flora species and 17 listed fauna species have the potential to occur or are known to occur in the study area.

Not all of the threatened species and communities that have the potential to occur within the study area are considered to be susceptible to subsidence related impacts. This impact assessment focuses on the species and communities, and their habitats, which have potential to occur in the study area and are considered at risk of impact from subsidence due to mining in the Preferred Project plan (Biosis 2014a). As a result some species have been excluded from requiring further assessment, being species reliant on terrestrial environments that are at negligible risk of impact. For details outlining the risk assessment methodology applied to exclude some species from assessment, refer to Section 3 of Biosis (2014a) and Table 12 of the EIS (Hansen Bailey 2015). Refer to Biosis' ecological assessment (2014a) for further details on the habitat requirements for the species assessed in this report.

This previous assessment identified one listed ecological community, one listed flora species and 12 listed fauna species (nine terrestrial and three aquatic) that have the potential to occur or are known to occur in the study area and are considered at risk of impact from subsidence. An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2014, and the risk of impact from current project based on revised mining method is provided in Table 1. Further details are provided in Section 3.2.

Table 1 Threatened species, populations and communities likely to occur in the study area and previously assessed as susceptible to indirect subsidence impacts.

CR- Critically endangered, E – Endangered, V - Vulnerable

Scientific name	Common name	EPBC Act status	BC Act status	FM Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from current project based on revised mining method
Threatened ecological community							
-	*Coastal upland swamps in the Sydney Basin Bioregion*	E	E	-	Coastal upland swamps	Recorded	Negligible
Terrestrial species							
Flora							
Pultenaea aristata	Prickly Bush-pea	V	V	-	Coastal upland swamps	Recorded	Negligible
Fauna							
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	-	Rocky environments	Low	Negligible
Myotis macropus	Large-footed Myotis	-	V	-	Rocky environments and aquatic environments	Moderate	Negligible
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	-	V	-	Rocky environments	High	Negligible
Hoplocephalus bungaroides	Broad-headed Snake	V	E	-	Rocky environments	Low	Negligible
Heleioporus australiacus	Giant Burrowing Frog	V	V	-	Coastal upland swamps/ aquatic environments	Low	Negligible

Scientific name	Common name	EPBC Act status	BC Act status	FM Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from current project based on revised mining method
Litoria littlejohni	Littlejohn's Tree Frog	V	V	-	Aquatic environments	Low	Not assessed – absent in the study area
Mixophyes balbus	Stuttering Frog	V	E	-	Aquatic environments	Negligible	Not assessed – absent in the study area
Pseudophryne australis	Red Crowned Toadlet	-	V	-	Aquatic environments	Recorded	Negligible
Invertebrates							
Petalura gigantea	Giant Dragonfly	-	E	-	Coastal upland swamps	Recorded	Negligible
Aquatic species							
Bidyanus bidyanus	Silver Perch	CR	-	V	Aquatic environments	Recorded	Negligible
Maccullochella macquariensis	Trout Cod	E	-	E	Aquatic environments	Recorded	Negligible
Macquaria australasica	Macquarie Perch	E	-	E	Aquatic environments	Recorded	Negligible
Maccullochella peelii	Murray Cod	V	-	-	Aquatic environments	Recorded	Not assessed – population not considered an important population.

The likelihood of occurrence for some species in this list has changed since Biosis (2014) and Hansen Bailey (2015). These changes include:

- The likelihood of occurrence for the Large-eared Pied Bat has been downgraded to a low likelihood of occurrence. Although targeted surveys detected a single possible record, the study area does not support suitable roosting habitat.
- The Broad-headed Snake is now considered a low likelihood of occurrence. Suitable rocky habitat is highly limited in the study area and additional monitoring has not detected the species, or even suitable prey species.
- Littlejohn's Tree Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Suitable habitat is limited in the study area and targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.
- Stuttering Frog is now considered a negligible likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.

3.2 Potential subsidence impacts and primary impacts

Subsidence associated with underground mining can result in the deformation of the surface, termed subsidence effects. Subsidence effects include the deformation of the surface including vertical and horizontal displacement and curvature arising from tilts and strains (DoP 2008).

Subsidence impacts are used by DoP (2008) to describe the physical changes to the surface resulting from subsidence effects. Subsidence impacts include shear cracking of the rock mass, as well as buckling of strata from valley closure and upsidence.

Subsidence impacts can in turn result in environmental consequences (DoP 2008). In previous assessments, for the UEP, environmental consequences have been separated into primary (environmental) impacts and secondary (environmental) impacts. Primary impacts are those that occur over short timeframes, and include changes in groundwater regimes (including for perched aquifers), loss of or change in surface flows, loss of standing water in pools, changes in water quality, cliffs falls or fracturing of rocky outcrops.

Secondary impact can only occur following primary impacts and manifest over longer timeframes. Secondary impacts relevant to this assessment include changes in the extent and composition of upland swamps arising from changes in groundwater regimes, loss of or changes in habitat along creeks and resultant changes in frog populations or modification of habitat for species inhabiting rock environments and changes in populations.

The subsidence assessment undertaken for the revised UEP assessment (SCT 2019) indicates that the first workings are expected to cause very low levels of surface subsidence or significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. The proposed first workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

The pillars for approved development mains have been designed with an increased width to height ratio (8:10) for long-term stability. Some minor deformations of the development main pillars may be witnessed due to elastic depression (natural phenomena) of the strata above and below the pillars. The strata compression has potential to result in minor subsidence movements with correspondingly low levels of tilt and strain. Some ongoing low-level ground movement (mainly horizontal) associated with previous mining activities (i.e. Wongawilli Seams longwalls) may be experienced, however no perceptible impacts are likely (SCT 2019).

As a result, impacts to previously identified biodiversity values are predicted to be negligible. Based on this, a revised impact assessment is provided below.

3.3 Revised impact assessment

A revised impact assessment is required for those species with a moderate or greater likelihood of occurrence in the study area and considered at risk due to subsidence. Species are considered below in Section 3.3.2.

3.3.1 Coastal upland swamps

Detailed mapping and characterisation was undertaken by Biosis (2012a) of *Coastal Upland Swamps in the Sydney Basin Bioregion* (listed as an EEC under the EPBC Act and BC Act) throughout the study area. A total of 39 upland headwater swamps (approximately 49 hectares in total) were recorded in Wonga East. The extent of this EEC in relation to the proposed mine plan is illustrated in Figure 3.

The upland swamps in the study area are markedly different to other upland swamps on the Woronora plateau in that they are predominantly drier, generally smaller with shallower soils, have less humic material, have more interspersed sandstone outcrops within their outlines and are less spatially continuous than a "typical" humic, saturated swamp (Biosis 2014b). Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of upland swamps, historic impacts of mining on upland swamps, including impacts to hydrogeological features.

In the past, impact assessment for upland swamps in the Southern Coalfield has focused on the use of the criteria outlined in PAC (2010), OEH (2012) and TSSC (2014) to determine the risk of negative environmental consequences. These documents outline six criteria to be used to determine whether an upland swamp is at risk of negative environmental consequences, including:

- All swamps subject to tensile strains greater than 0.5 mm/m.
- All swamps subject to systematic compressive strains greater than 2 mm/m.
- All swamps with depth of cover less than 1.5 times longwall panel width.
- All swamps subject to tilt (transient or final) greater than 4 mm/m.
- All swamps subject to predicted valley closure of greater than 200 mm.
- All swamps subject to maximum observed closure strain of greater than 7 mm/m.

PAC (2010) states that the criteria above are a *"threshold for investigation – not a conclusion that the swamp will be impacted or suffer consequences"* (p. 120).

As outlined above, SCT (2018) have concluded that the revised mine plan will not result in any perceptible surface subsidence and are not considered to have any potential to perceptibly impact on natural surface features including upland swamps. No subsidence impacts will occur, meaning no primary or secondary impacts will result.

As a result, impacts to upland swamps from the revised UEP mine plan are predicted to be negligible.

3.3.2 Threatened species occupying coastal upland swamps

Upland swamps provide habitat for three threatened species in the study area that have previously been assessed as being vulnerable to impacts from mining (Table 1). These species are discussed below.

Prickly Bush-pea is restricted to the Woronora Plateau, and has been recorded within the study area in open habitats, including upland swamps and adjacent woodland (Biosis 2014a). Despite this species' restricted distribution, it is known to be common and widely distributed in the study area (Biosis 2014a; Figure 3). Amendments to the mining methodology in the current UEP proposal have addressed the issue of subsidence-related impacts. The first-workings mining method will not result in perceptible levels of subsidence and upland swamp habitat is considered at negligible risk of impact; subsequently, Prickly Bush-pea is considered at negligible risk of impact.

The Giant Burrowing Frog has been recorded as adults, metamorphs and tadpoles in a tributary of upland swamp CRUS2 between 2012 and 2016 (Figure 3). Although often associated with upland swamps, this association is not direct, rather that upland swamps are associated with minor drainage lines that provide suitable breeding pools and burrowing habitat for this species (DECC 2007). SCT (2018) predicts that the imperceptible levels of subsidence resulting from the revised UEP mine plan will not result in perceptible impacts to creeks. As such, the Giant Burrowing Frog is considered at negligible risk of impact.

The Giant Dragonfly is a ground water dependant species preferring uplands swamps with open vegetation and free water as habitat (OEH 2013). Previous targeted surveys undertaken by Biosis have identified individuals across CCUS4, CCUS5, CCUS10 and BCUS4 (Figure 3; Biosis 2014, Biosis 2015, Biosis 2017). Due to key life stages of the Giant Dragonfly being dependant on the accumulation of ground water and organic soils, the species is at risk from subsidence-related impacts in the form of habitat reduction. The first-workings mining method will not result in perceptible levels of subsidence and upland swamp habitat is considered at negligible risk of impact; subsequently, Giant Dragonfly populations are considered at negligible risk of impact as a result of the revised UEP Mine plan.

3.3.3 Threatened species occupying rocky environments

Rocky environments in the study area include cliffs and rocky outcrops (Figure 3). Rocky environments are considered sensitive ecological features in the study area as they provide potential habitat for the Large-footed Myotis and Eastern Bentwing-bat (Table 1) (Biosis 2014a). Cliffs provide potential roosting habitat for species are at risk of collapse from subsidence.

Changes to the mining methodology for the current project has removed the risk of subsidence-related damage to sensitive rocky environmental features in the study area. Consequently, the revised UEP is predicted to result in negligible risk of impact to roosting habitat for these species.

3.3.4 Threatened species occupying aquatic environments

Sensitive aquatic habitat includes major streams and their tributaries. These include Cataract River, Cataract Creek and Bellambi Creek in the study area. The study area also includes a number of first, second and third order tributaries of Cataract River, Cataract Creek and Bellambi Creek (Figure 3).

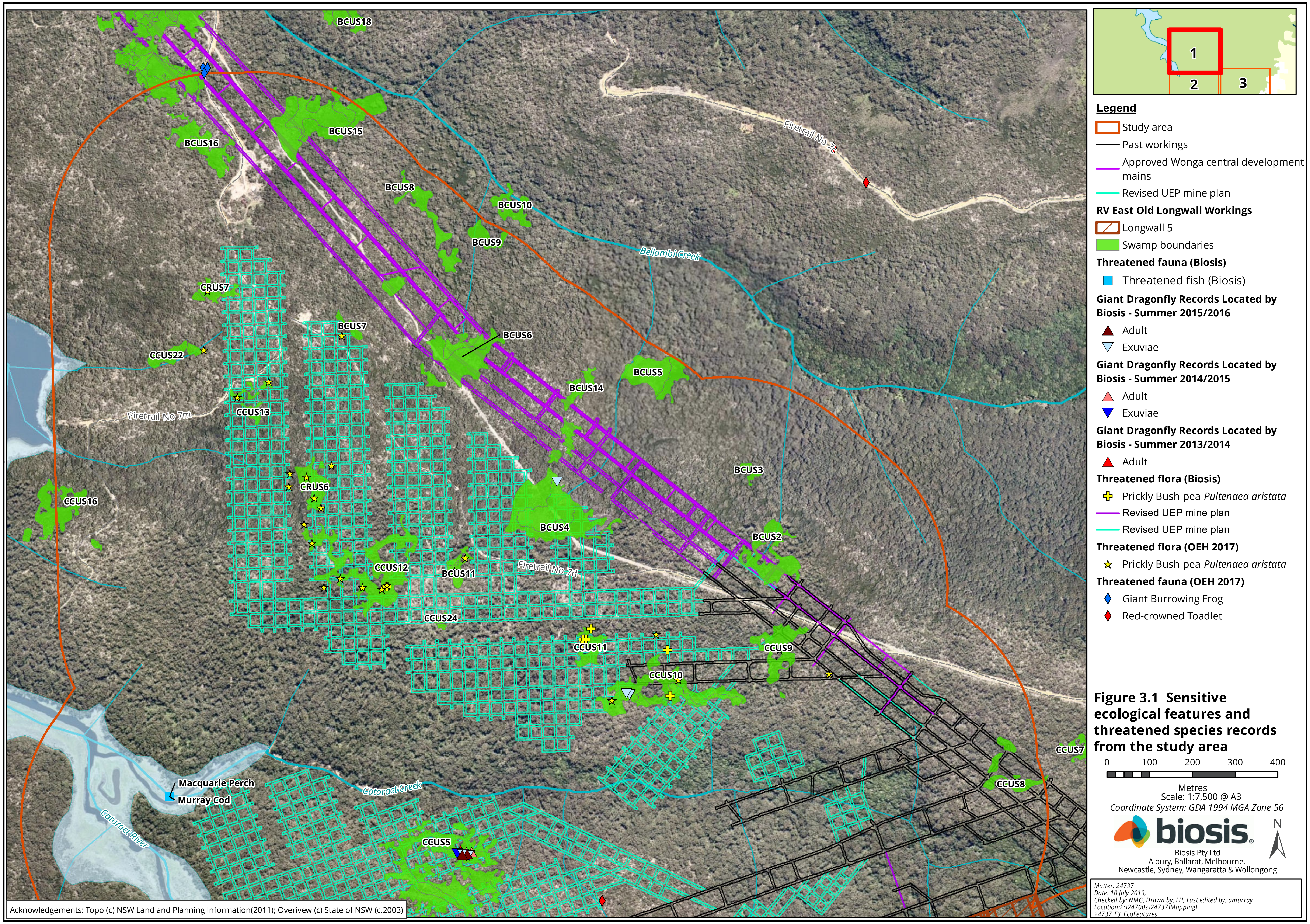
Threatened fish

Although these tributaries are ephemeral, they influence habitat, in the larger waterways, for three threatened fish species previously assessed as being vulnerable to impacts associated with subsidence (Table 1). Targeted fish surveys have been undertaken along Cataract River and Cataract Creek since 2009 by Cardno Ecology Lab and Biosis, and both waterways are known to support populations of Silver Perch, Macquarie Perch and Trout Cod in the lower reaches near Cataract Reservoir (Figure 3; Biosis 2016). However, within the study area these species occur in relatively low abundances and are part of larger populations within the Cataract Reservoir (Hansen Bailey 2015).

SCT (2018) has predicted that the imperceptible levels of subsidence resulting from the revised UEP mine plan will result in imperceptible impacts to surface water flows or water quality. In turn, negligible impacts are predicted to occur to the habitat of these threatened fish species.

Threatened frogs

The Red Crowned Toadlet have previously been recorded at two locations within the study area (Figure 3; Biosis 2013a, Biosis 2017). These two locations are associated with wet depressions situated below rocky outcrops. These environments are at negligible risk of impact as a result of the revised UEP mine plan.



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan

RV East Old Longwall Workings

- Longwall 5
- Swamp boundaries

Threatened fauna (Biosis)

- Threatened fish (Biosis)

Giant Dragonfly Records Located by Biosis - Summer 2015/2016

- Adult
- Exuviae

Giant Dragonfly Records Located by Biosis - Summer 2014/2015

- Adult
- Exuviae

Giant Dragonfly Records Located by Biosis - Summer 2013/2014

- Adult

Threatened flora (Biosis)

- Prickly Bush-pea-*Pultenaea aristata*
- Revised UEP mine plan
- Revised UEP mine plan

Threatened flora (OEH 2017)

- Prickly Bush-pea-*Pultenaea aristata*

Threatened fauna (OEH 2017)

- Giant Burrowing Frog
- Red-crowned Toadlet

Figure 3.1 Sensitive ecological features and threatened species records from the study area

0 100 200 300 400

Metres

Scale: 1:7,500 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis.

Biosis Pty Ltd
Albury, Ballarat, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

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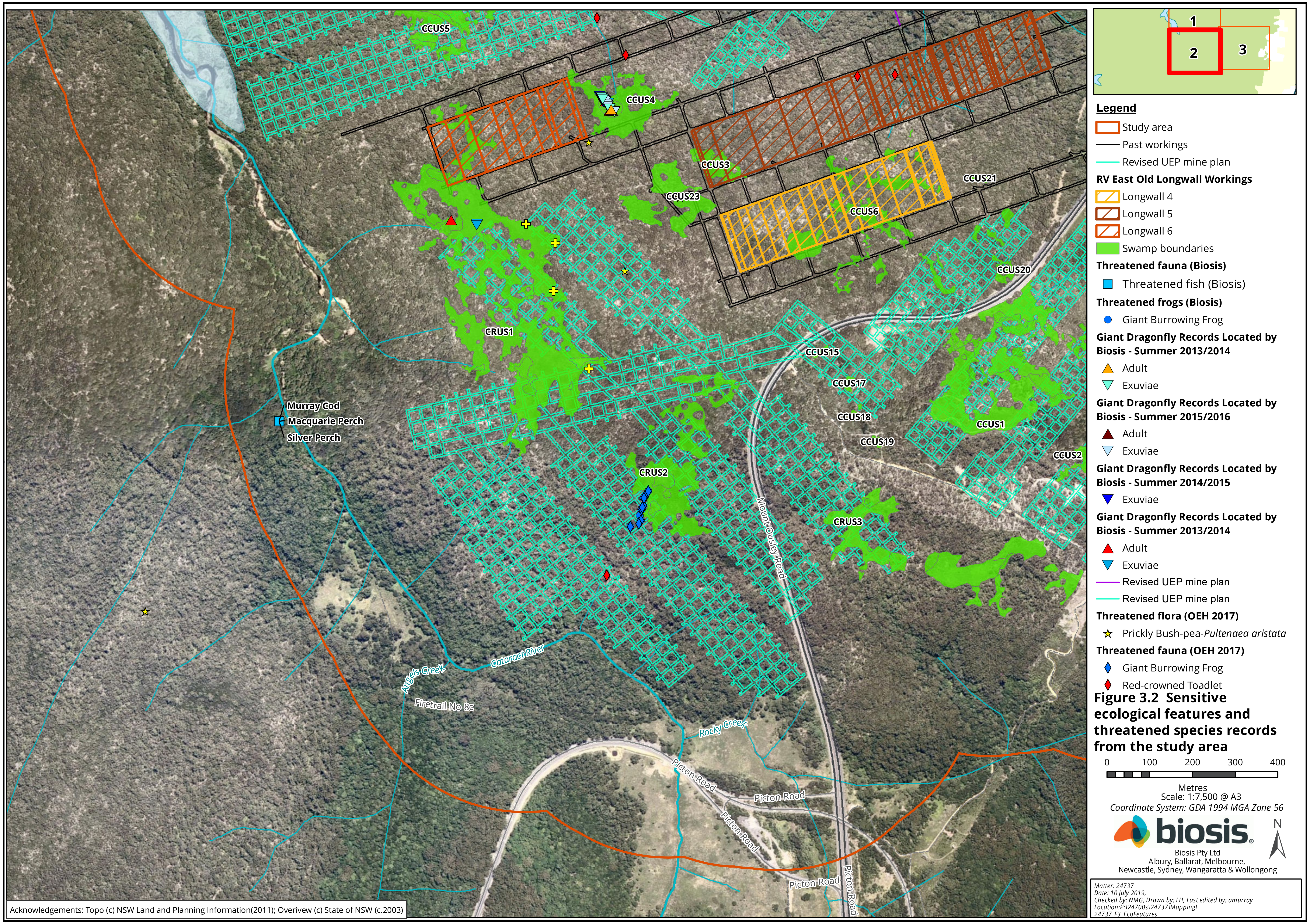

Figure 3.2 Sensitive ecological features and threatened species records from the study area

Acknowledgements: Topo (c) NSW Land and Planning Information(2011); Overview (c) State of NSW (c.2003)

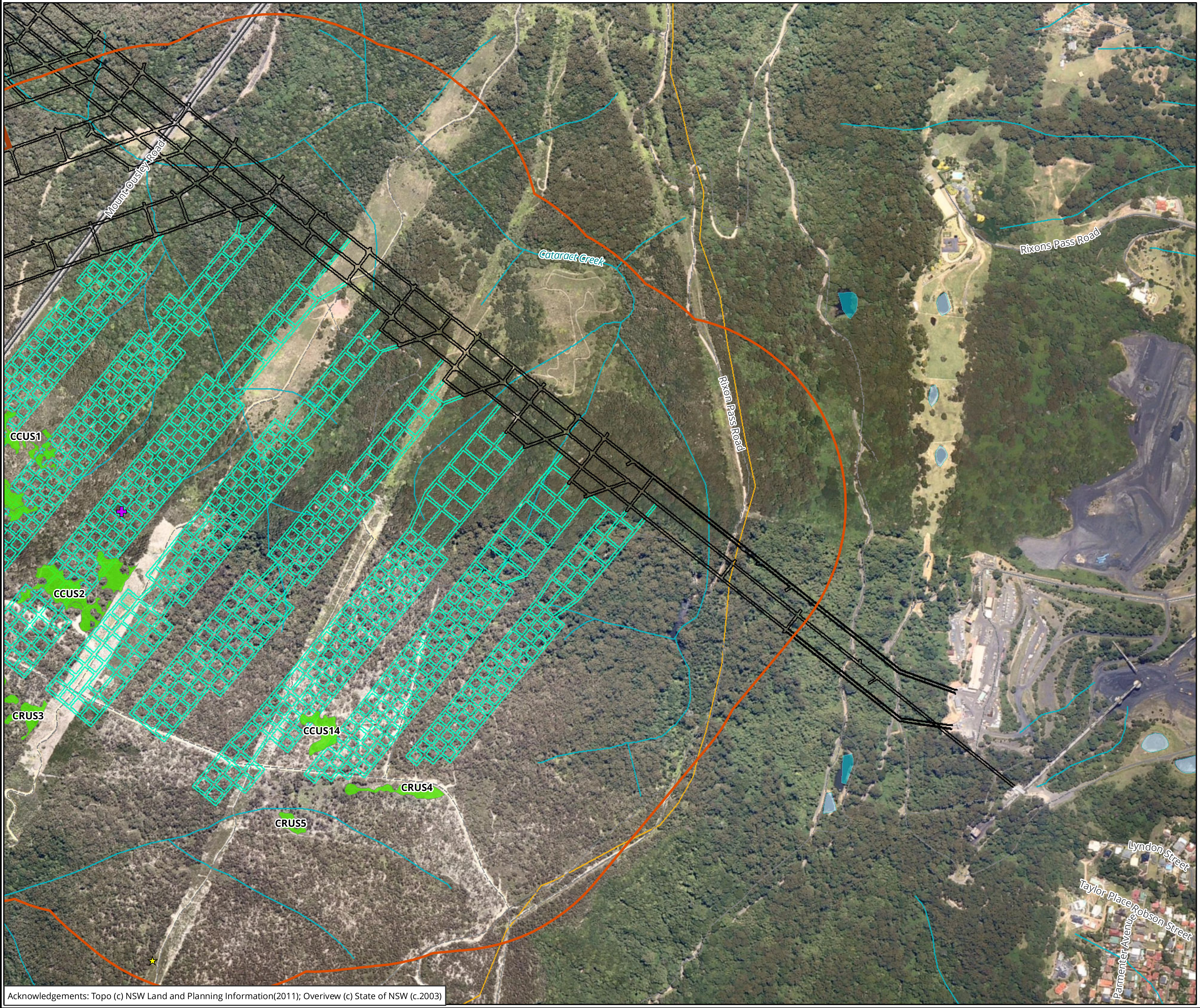

Figure 3.3 Sensitive ecological features and threatened species records from the study area

0 100 200 300 400

Metres

Scale: 1:7,500 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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4 Impact management and monitoring

Previous approvals for the Russell Vale Colliery have outline performance measures required by any management plan, as outlined in Table 2.

Table 2 Performance criteria for past approvals

Features	Performance Measure
Upland swamps	Negligible environmental consequences including: • negligible change in the size of swamps; • negligible change in the functioning of swamps; • negligible change to the composition or • distribution of species within swamps; and, • negligible drainage of water from swamps, or redistribution of water within swamps.
Threatened species, populations or their habitats and endangered ecological communities (except upland swamps)	Negligible environmental consequences

Impacts to biodiversity values are currently managed and monitored in accordance with the Biodiversity Management Plan (WCL 2015a) and Upland Swamp Management Plan (WCL 2015b). These management plans were developed to manage and monitor impacts arising from longwall mining of Longwalls 4, 5 and 6. Wollongong Coal have prepared an updated Biodiversity Management Plan (WCL 2018) pillar extraction of the V-mains, 309 Panel and the first workings on the H Panel, and associated surface and access infrastructure.

In line with the impacts mechanisms outlined in Section 3.2, monitoring should focus on subsidence impacts as well as primary impacts to groundwater systems associated with upland swamps, and surface water flows in creeks. On this basis the following monitoring is recommended:

- 3D subsidence monitoring along existing subsidence monitoring lines, and that the subsidence monitoring be extended.
- Visual inspection of the rock formation that forms the base of upland swamps CCUS4, CCUS5, CCUS10, BCUS4 and BCUS6 also be undertaken during routine monitoring.
- Monitoring of groundwater levels and water quality in upland swamps using the existing network of shallow groundwater piezometers.
- Continued monitoring of surface outflow monitoring in upland swamp CCUS4 using the existing box weir (site CT3a).
- Monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites.

Given no perceptible subsidence impacts are predicted to result from the revised UEP mine plan (SCT 2019) we recommend that monitoring is restricted to subsidence impacts and primary impacts only at this stage. If subsidence impacts and / or primary impacts are detected we recommend that the monitoring program is reassessed in accordance with the requirements of WCL (2015a and b).

5 Conclusion

In response to the second PAC Review Wollongong Coal has revised their mine plan for the UEP, and proposes to undertake first workings only, to minise subsidence and associated surface impacts. The revised UEP mine plan proposes extraction of coal using the first workings method rather than longwalls.

The subsidence assessment undertaken for the revised UEP indicates that the these first workings are not expected to cause perceptible surface subsidence or significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. As a result, the revised UEP is predicted to result in negligible impacts to natural surface features including upland swamps, rocky environments and aquatic environments, as well as species occupying these environments.

Given these negligible impacts, we recommend monitoring is restricted to subsidence monitoring and monitoring required to detect primary impacts to groundwater systems associated with upland swamps, and surface water flows and quality in creeks. If subsidence impacts and / or primary impacts are detected we recommend that the monitoring program is reassessed.

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APPENDIX 5

Noise Assessment

A C O U S T I C S   A N D   A I R

RUSSELL VALE COLLIERY

UNDERGROUND EXPANSION PROJECT
REVISED PROJECT NOISE ASSESSMENT

REPORT NO. 14141-C
VERSION A

JULY 2019

PREPARED FOR

WOLLONGONG COAL LIMITED
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DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Draft	13 June 2019	Roman Haverkamp	John Wassermann
A	Final	17 July 2019	Roman Haverkamp	John Wassermann

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

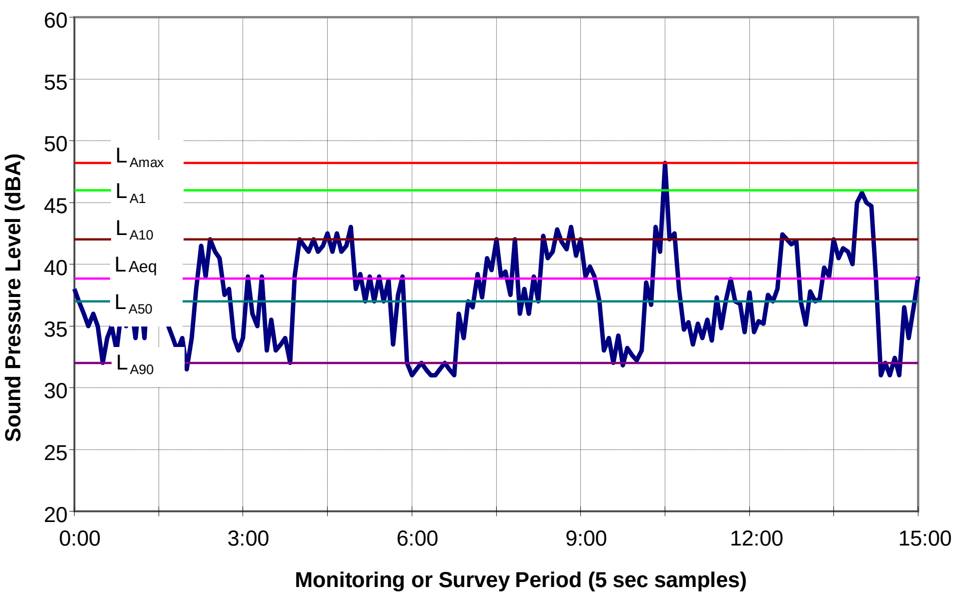
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Russell Vale Colliery is located within the Southern Coalfields Region of New South Wales, approximately 8 kilometres north of Wollongong and 70 kilometres south of Sydney. The Colliery is owned and operated by Wollongong Coal Limited (WCL) and is currently in care and maintenance, since the cessation of mining operations in 2015.

On behalf of WCL, Umwelt Australia Pty Limited (Umwelt) is coordinating the environmental assessment of a revised plan for the Russell Vale Colliery Underground Extension Project (UEP) – hereafter referred to as the Revised Project. The Revised Project will continue to be assessed under the current UEP application process under Part 3A of the EP&A Act.

The Revised Project proposes an updated mine plan design which addresses the concerns raised by the Planning Assessment Commission (PAC) in its First and Second Assessment Reports on the Russell Vale UEP. The Revised Project constitutes the principal response to the latest PAC report (PAC Second Review Report, dated March 2016).

This Noise Impact Assessment has been prepared by Wilkinson Murray Pty Ltd (WM) on behalf of Umwelt as part of the environmental assessment for the Revised Project. It provides a re-evaluation of operational and traffic noise impacts with respect to the Revised Project, with reference to the newly published *Noise Policy for Industry (NPfI)*.

This report has been prepared with consideration to the following New South Wales Government policies:

- *Noise Policy for Industry (NPfI)* (EPA, 2017);
- *Road Noise Policy (RNP)* (Environment Protection Agency [EPA], 2011)*;*
- *Interim Construction Noise Guideline (ICNG)* (Department of Environment and Climate Change [DECC], 2009);
- *Noise Guide for Local Government (NGLG)* (Environment Protection Agency [EPA], 2013);
- *Voluntary Land Acquisition and Mitigation Policy* (*VLAMP*) (NSW State Government, 2018); and
- *Construction Noise & Vibration Strategy (CN&VS)* (Transport for NSW Infrastructure and Services Division, 2018).

This report has been prepared to support the environmental assessment and assess the noise impacts associated with the Revised Project.

The remaining sections of this report address the following:

Section 2	Provides a description of the Revised Project focusing on matters relating to noise.
Section 3	Identifies the sensitive receivers located around the site and the rationale behind their consideration.
Section 4	Discusses the existing noise environment with consideration to the results from previous surveys conducted in the areas surrounding the site and additionally on long-term noise monitoring data collected by two on-site monitoring stations operated by WCL.
Section 5	Establishes the project-specific noise criteria considered relevant to the Revised Project, with consideration to the evaluation of the existing noise environment, as discussed in Section 4.
Section 6	Sets out the noise assessment methodology and assumptions, inclusive of considerations relating to the modelling process, meteorological conditions, noise source sound power levels and mitigation measures adopted by the Revised Project.
Section 7	Presents the Revised Project operational noise predictions and provides discussion on the predicted residual exceedances of criteria. A low-frequency noise assessment is also included in this section.
Section 8	Addresses the potential for night time noise impacts and sleep disturbance effects.
Section 9	Addresses the potential for construction noise impacts.
Section 10	Addresses the potential for road traffic noise impacts.
Section 11	Discusses implications with regards to the *VLAMP*.
Section 12	Presents conclusions with respect to the potential Revised Project noise effects.

2 PROJECT DESCRIPTION

In response to concern raised by government agencies, the PAC and the community, WCL proposes to revise operations on the Russell Vale Underground Expansion Project (UEP). The site changes are proposed principally to address potential subsidence, biodiversity and water impacts within the Cataract Reservoir catchment and noise and traffic impacts associated with surface operations (Revised Project).

The key elements of the Revised Project are:

- Mining using first working mining techniques only with the workings designed to be long term stable with minimal subsidence impacts.
- Extraction of approximately 3.7 million tonnes of ROM coal over 5 years at a production rate that would not exceed 1 million tonnes of product coal per year.
- Construction and use of a coal processing plant to improve the quality of product coal.
- Redesign of the Pit Top layout to strategically relocate infrastructure to more shielded locations;
- Reduced product trucking rates relative to the Preferred Project mine plan.
- Additional noise mitigation works at the Russell Vale Pit Top including relocation of infrastructure, a new noise barrier and extension to the height of existing bunds and acoustic treatment of coal processing infrastructure.

A summary of the key components of the Revised Project is provided in Table 2-1.

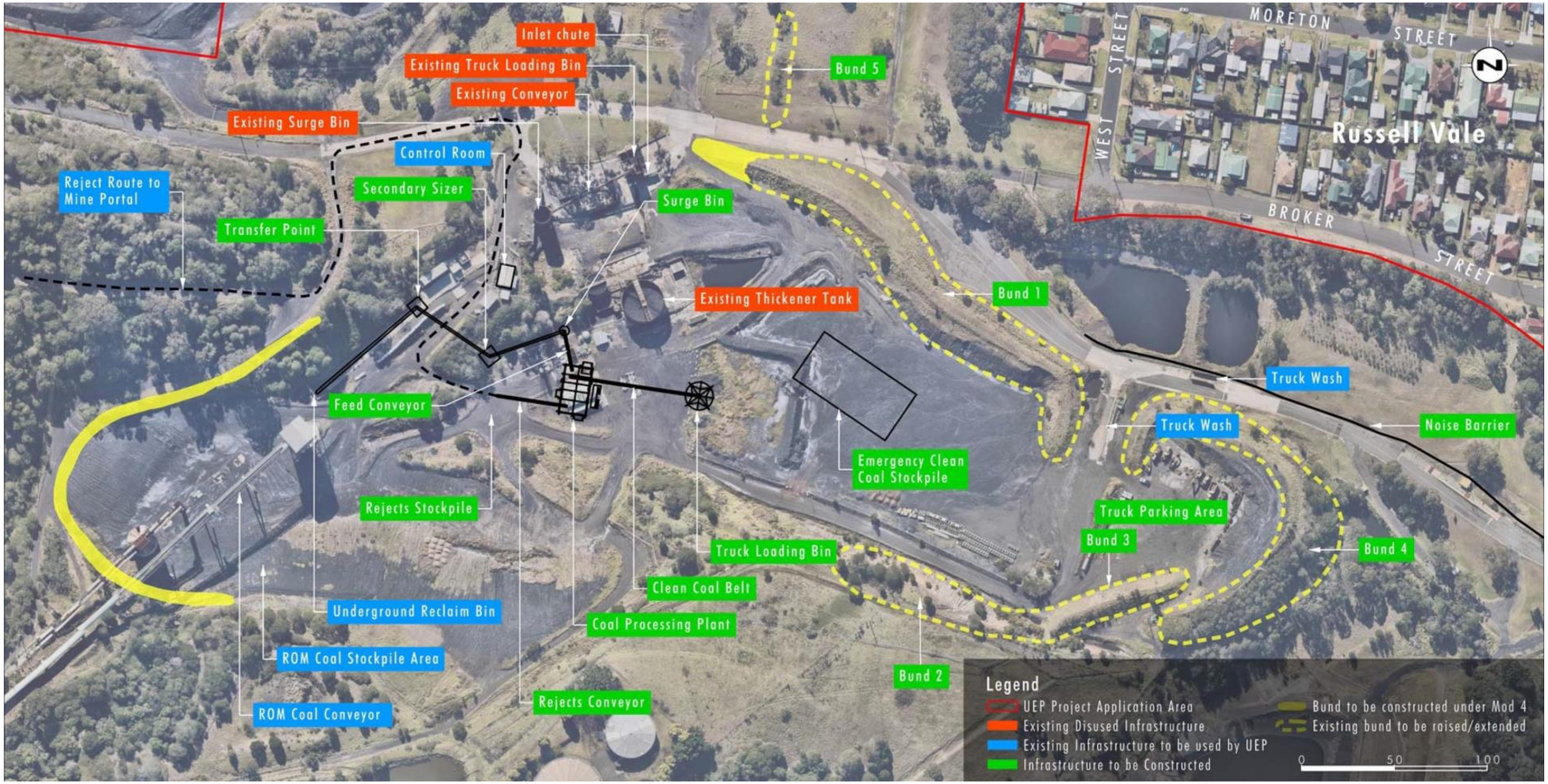
Figure 2-1 shows a locality map of the Russell Vale Colliery and identifies the proposed reconfigured site layout, including the principal noise sources and noise berms considered by this assessment. The noise sources are detailed further in Section 6.

Details of the Revised Project operations are provided in Sections 2.1 to 2.5.

Table 2-1 Revised Project Components

Project Component	Summary of the Revised Project
Mining Method	Non-caving first workings board and pillar panels using continuous miners.
Resource	Wongawilli Seam
Annual ROM Production	Up to 1.2 Mtpa
Product Coal	Up to 1 Mtpa
Mine Life	5 years
Total Resource Recovered	Approximately 3.7Mt ROM
Coal Processing	Construction and use of coal processing plant to improve product coal.
Hours of Operation	Underground Mining – 24 hours per day, 7 days per week Surface Facilities and Product Transport: 7.00am to 6.00pm, Monday to Friday, 8.00am to 6.00pm Saturday. No Sundays and Public Holidays. Provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions. This operation during the evening has been considered in this assessment.
Management of Mining Waste	Reject from the coal processing plant will be stockpiled for emplacement underground or trucked off-site as inert fill.
General Infrastructure	• Construction and use of new coal processing plant, secondary sizer, surge bin and truck loading facility • Construction and use of enclosed conveyors for transfer of ROM coal to new secondary sizer, coal processing plant and truck loading facility. • Ongoing use of ROM stockpile and establish new product and temporary reject stockpiles within Pit Top disturbance area • Minor changes to water management infrastructure • Construction of noise barriers and extension to height of existing bunds around Pit Top • Ongoing maintenance and refurbishment of existing ventilation shafts, water and electrical facilities.
Product Transport	Product coal will be transported by truck to Port Kembla via Bellambi Lane and Memorial Drive.
Transport Hours and Rates	An average rate of 16 laden trucks per hour leaving the site between 7.00am and 6.00pm. Monday to Friday and 8.00am and 6.00pm Saturday. No coal transport Sundays and Public Holidays. If coal transport is required during the evening to cater for unexpected Port closures or interruptions, these movements would be limited to an average of 12 trucks per hour leaving the site between 6.00pm and 10.00pm Mondays to Fridays only. Trucks arriving at the site prior to 7.00am Monday to Friday or 8.00am Saturday will be required to proceed to the truck parking area on site and turn off engine until loading commences at 7.00am Monday to Friday or 8.00am Saturday.
Operational Workforce	Approximately 205
Construction Workforce	Approximately 22

Figure 2-1 Russell Vale Colliery Revised Pit Top Layout



2.1 Coal Handling & Processing

ROM coal will be transported from the underground workings via the existing underground conveyor system. Coal is transported from the underground workings to the surface via a decline conveyor which transports coal from the portal to the stockpile area. There are two declines, one servicing mining in the Bulli seam and one servicing mining in the Wongawilli Seam. The Bulli Seam decline has been decommissioned and will not be used as part of the Revised Project.

The coal is transferred to a screening and sizing station at the top of the decline. From the screening and sizing station, coal is transferred to the ROM stockpile via a conveyor and tripper arrangement. From the ROM stockpile, the ROM coal is pushed into an underground reclaim bin by dozer where it will be transferred via a new conveyor through a secondary sizer and then to a new surge bin.

Coal will then be transferred to the new coal processing plant via a new conveyor. The processing plant is a coal sizing plant which removes rock material via a heavy media cyclone.

Product coal is then transferred to a new truck loading bin via a new clean coal conveyor. Coal will then be either loaded onto road trucks for transportation to Port or transferred to an Emergency Clean Coal Stockpile. Coal will be loaded onto road trucks from the Emergency Clean Coal Stockpile via front-end loader.

Rocky reject material that is separated by the coal processing plant will be transferred to a rejects stockpile by conveyor and will then be either loaded onto road trucks to be sold as inert fill material or will be transferred from a rejects stockpile by front-end loader and haul truck to the mine portal, and emplaced underground.

ROM coal may also be transferred from the site as a ROM coal product. This would occur during the first 12-24 months of operation while the site infrastructure is being constructed. Where this occurs, road trucks will be loaded using a front-end loader from the ROM stockpile area.

ROM coal will be delivered to the ROM stockpile 24 hours a day. The coal beneficiation operations would typically be limited to daytime hours only, 7.00am to 6.00pm Monday to Friday and 8.00am to 6.00pm Saturday. Provision is required for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions. This operation during the evening has been considered in this assessment.

Production rates will not exceed one million tonnes per annum (Mtpa) product coal.

2.2 Coal Transport

Product coal will be transported to Port Kembla by road registered semi-trailer trucks and B-double trucks. Consistent with previously approved operations, the transport route would be via Bellambi Lane and Memorial Drive which is the route that has historically been used for the transport of coal from the Russell Vale site.

Truck loading operations will be limited to 7.00am and 6.00pm, Monday to Friday, and 8.00am to 6.00pm on Saturdays. No loading or coal transport will occur on Sundays and Public Holidays. Provision is required for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions. This operation during the evening has been considered in this assessment.

The proponent recognises the risk of noise generated by early morning trucks parking and waiting outside the site until they are allowed to drive onto the site to load at 7.00am (Monday to Friday)_or 8.00am (Saturday). In order to avoid trucks parking in residential streets prior to the commencement of loading operations, a designated truck parking area will be established on site (refer to Figure 2-1). A noise barrier will be constructed along the site access road to mitigate the noise impacts of trucks accessing the truck parking area. Trucks entering the site prior to the commencement of loading operations will be required to turn off their engines while parked. Adequate parking areas will be available on site to avoid trucks queuing on the road outside of the Colliery.

Outbound laden (coal or reject) truck movements will be limited to an average of 16 per hour between the hours of 7.00am and 6.00pm Monday to Friday and 8.00am and 6.00pm Saturday. If trucking is required during the evening period to cater for unexpected Port closures or interruptions, outbound trucks will be further limited to an average of 12 trucks per hour between 6:00pm and 10:00pm Monday to Friday.

The sign posted speed limit for vehicles using Bellambi Lane is 60 km/hr. Under the Preliminary Works Approval, coal truck movements along Bellambi Lane were subject to a voluntary speed limit of 50 km/hr. This voluntary speed limit for trucks has been monitored through the use of Geographical Positioning Systems (GPS). While there has been an extremely high compliance with this limit (99.86% from 2,162 truck movements), three minor exceedances have occurred with all exceedances being below the signposted 60 km/hr limit. The voluntary speed limit for coal/reject trucks of 50 km/hr along Bellambi Lane will be maintained for the Revised Project with WCL aiming to achieve 95% compliance with the voluntary speed limit and 100% compliance with the sign posted 60 km/hr speed limit. All coal/reject trucks will be subject to GPS monitoring to monitor compliance with this speed limit.

2.3 Reject Material Handling

Reject material from the Coal Processing Plant and sizing and screening plant will be transferred to the reject stockpile. Reject material will consist of rock material.

Reject material will either be transferred off-site for use as inert fill material or hauled to the mine portal via an internal road where it will be temporarily stockpiled pending disposal in the underground Russell Vale workings. Reject material will be transferred to road truck via a front-end loader.

Haulage of reject material from the reject stockpile to the pit top will be limited to 7.00 am to 6.00pm Monday to Friday. Reject material transferred off-site will be managed within the overall coal transport limits for the Revised Project. The transport route and truck size for reject transferred off-site will depend on the destination of the material, but it will generally be transported via Bellambi Lane and Memorial Drive. It is anticipated that the majority of any reject material transported off-site would be transported to the south.

2.4 Construction Activities

Construction of the coal processing plant and associated infrastructure will be staged to meet production requirements and is planned to be undertaken within a 12-24-month timeframe (subject to delays such as weather and logistical issues), with an average construction workforce of 22 people.

The site will be operational during construction of the site infrastructure and coal processing plant with ROM coal being transported off site without processing. This is referred to as the 'phase-in' operation period.

In order to improve noise mitigation from site operations, bunds surrounding the Pit Top will be raised and/or extended and a new noise barrier installed along the site access road. The new access road noise barrier will be installed prior to the commencement of 'phase-in' operations. The extension of the main bund to the north of the Pit Top (Bund #1) will be commenced prior to 'phase-in' operations commencing. The construction of Bund #1 will be completed over as short a timeframe as possible, indicatively 6-8 weeks to achieve planned height. The remaining bunds will be progressively extended within the 'phase-in' operation period and completed prior to full operation commencing.

Construction works will be undertaken during standard construction hours 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm Saturday. No construction activities will be undertaken on Sunday and public holidays.

2.5 Mine Workforce

The operation of the mine will require a total of approximately 205 staff. Underground mining operations would work on a 3 shifts per day, 7 days per week basis.

3 NOISE-SENSITIVE RECEIVERS

The site is located on the lower slopes of the Illawarra Escarpment approximately 2 kilometres from the coast with residential areas generally to the north-northeast (Russell Vale) and south-southeast (Corrimal).

The potentially most exposed residential receivers are located in Russell Vale along Broker Street and West Street; and in Corrimal along Midgley Street, Wilford Street, Lyndon Street and Taylor Place.

Consistent with WM's 2014 assessment, the sensitive receivers considered by this assessment, which are deemed representative of the potentially most impacted receivers surrounding the site, are shown in Figure 3-1. Table 3-1 shows the addresses of these residential receivers.

The receivers identified in Table 3-1 are intended to broadly represent noise catchments around the site and intervening residential properties adjoining the site are subject to the same considerations as their closest neighbouring 'representative' receiver.

Review of the neighbourhood also identifies three schools in proximity of the site. These are also included in Table 3-1 and shown in Figure 3-1.

Table 3-1 Noise-Sensitive Receivers Considered

Receiver Type	Receiver ID	Address
Residence	R1	16 West St, Russell Vale
	R2	30 West St, Russell Vale
	R3	13 West St, Russell Vale
	R4	13 Broker St, Russell Vale
	R5	4 Broker St, Russell Vale
	R6	659 Princes Hwy, Russell Vale
	R7	34 Princes Hwy, Corrimal
	R8	95 Midgley St, Corrimal
	R9	109 Midgley St, Corrimal
	R10	6 Lyndon St, Corrimal
	R11	22 Lyndon St, Corrimal
	R12	46 Lyndon St, Corrimal
	R13	6 Taylor Pl, Corrimal
	R14	15 Taylor Pl, Corrimal
School	R15	Russell Vale Pre-school (652 Princes Highway, Russell Vale)
	R16	Autism Association NSW Aspect South Coast School (4 Wilford Street, Corrimal)
	R17	Early Learning Corrimal (67 Midgley Street, Corrimal)

Figure 3-1 Noise-Sensitive Receivers Considered

Noise Sensitive Receivers

4 EXISTING NOISE ENVIRONMENT

For the evaluation of noise impacts with respect to the Revised Project, this assessment considers long-term noise monitoring data collected by two on-site monitoring stations operated by WCL, and the result from a previous survey conducted by WM.

4.1 WCL 2016 Real-Time Background Noise Monitoring Results

For the purposes of this assessment long-term noise monitoring data collected by two on-site monitoring stations (NMT1 and NMT2) operated by WCL have been analysed.

RBLs determined from the long-term monitoring are shown in Table 4-1.

Table 4-1 Summary of Long-Term RBLs – Based on 2016 Full Year Measurements

Monitoring Location		Measured RBLs (dBA)		
ID	**Address**	**Day**	**Evening**	**Night**
NMT1	M2	39	38	37
NMT2	M3	39	38	34

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 7.00am.

It is considered that the NMT1 RBLs are representative of the long-term RBLs at the northern receivers set back from the Princes Highway and shielded from high traffic noise levels. Similarly, the NMT2 RBLs are representative of the long-term RBLs at the southern receivers shielded from the Princes Highway.

Figure 4-1 identifies the locations of the long-term monitoring sites (NMT1 and NMT2).

Continuous 15-minute interval data collected by each monitoring station over the entire 2016-year period has been processed in accordance with the *NPfI* methodology in conjunction with the coinciding 15-minute interval meteorological data collected by the WCL-operated on-site weather station. No changes in land use occurred in the area since 2016 and therefore the local acoustic environment is not believed to have changed since 2016.

The site went into care and maintenance in late 2015 and was not operational throughout 2016. As such, it is considered that use of this long-term data provides a good representation of the site's existing background noise environment. Short-term RBLs (e.g. RBLs based on one week) may vary slightly depending on the time of year and therefore, long-term RBLs (e.g. RBLs based on one year) are considered more accurate and should be used if available.

RBLs determined from the long-term monitoring are shown in Table 4-1.

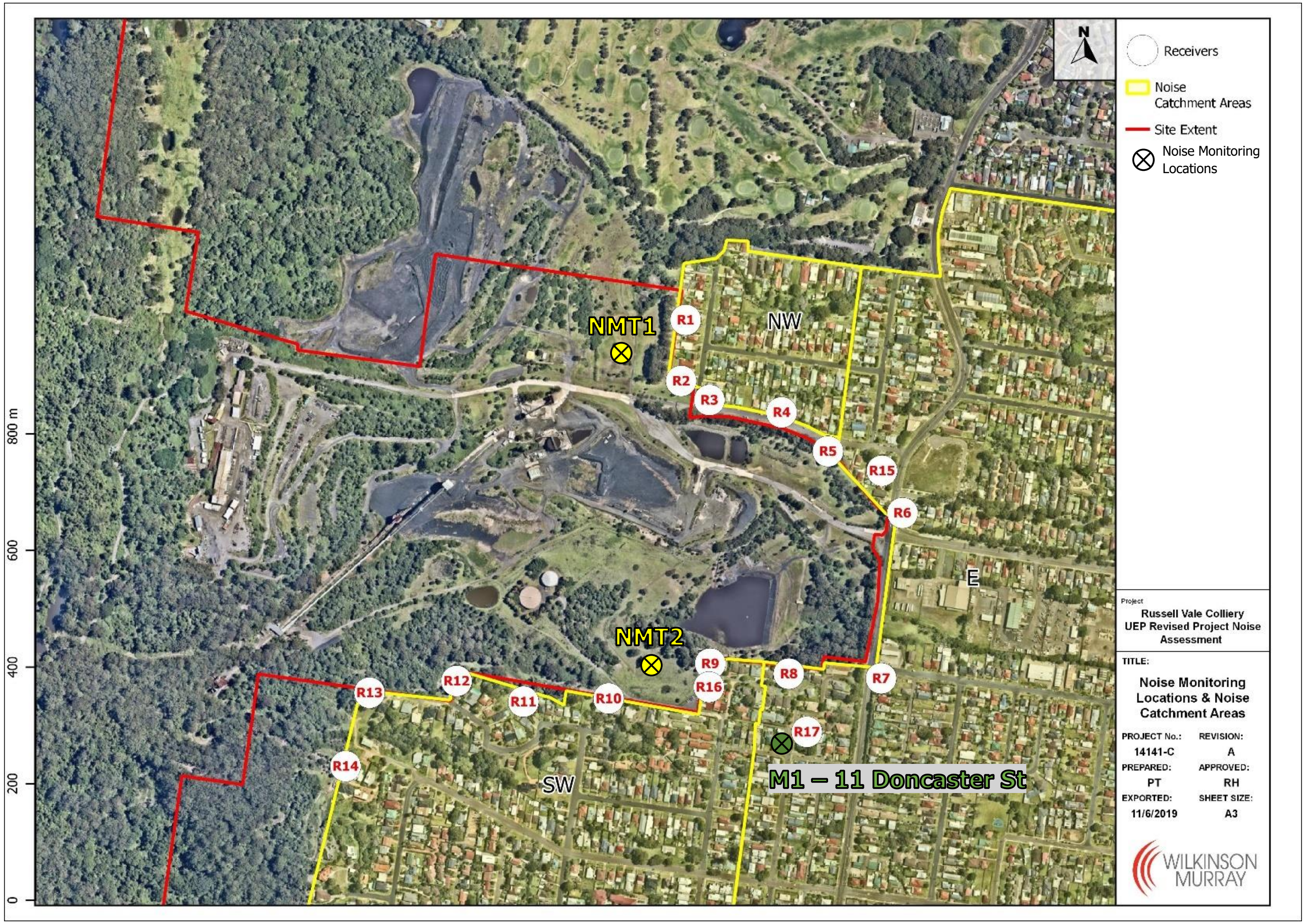
Table 4-1 Summary of Long-Term RBLs – Based on 2016 Full Year Measurements

Monitoring Location		Measured RBLs (dBA)		
ID	**Address**	**Day**	**Evening**	**Night**
NMT1	M2	39	38	37
NMT2	M3	39	38	34

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 7.00am.

It is considered that the NMT1 RBLs are representative of the long-term RBLs at the northern receivers set back from the Princes Highway and shielded from high traffic noise levels. Similarly, the NMT2 RBLs are representative of the long-term RBLs at the southern receivers shielded from the Princes Highway.

Figure 4-1 Noise Monitoring Locations and Noise Catchment Areas



4.2 WM 2014 Background Noise Survey

In order to identify an RBL for receiver areas with an acoustic environment dominated by traffic noise from the Princes Highway, reference is made to noise measurements undertaken by WM between 6-18 June 2014 as part of the noise assessment undertaken for the previously proposed site arrangement (WM report dated 9 October 2014). RBLs were established for the daytime, evening and night time assessment periods at three representative locations. See Glossary of Terms provided at the beginning of this report for definitions.

The survey was conducted in the absence of noise generated by mining operations during a period when the site did not operate.

Meteorological data for the relevant periods were obtained from the on-site weather station at the Russell Vale Colliery. Periods in which it was likely to be raining, or when wind speeds exceeded 5 m/s at microphone height, were excluded from analysis, in accordance with the *NPfI*.

The RBLs were established following the process recommended by the *NPfI*. Full details concerning the monitoring and analysis procedure are set out in Section 5 of the WM 2014 report.

The survey carried out by WM in 2014 included a monitoring location at 11 Doncaster Street, Corrimal (M1) (refer to Figure 4-1). The RBLs measured at M1 are considered to be representative of an acoustic environment dominated by Princes Highway traffic noise. As such, the RBLs measured at M1 have been selected as the relevant RBLs for R5, R6, R7 and R8.

RBLs measured at M1 are shown in Table 4-2.

Table 4-2 Summary of M1 RBLs

Monitoring Location		Measured RBLs (dBA)		
ID	**Address**	**Day**	**Evening**	**Night**
M1	11 Doncaster Street	43	40	37

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 7.00am.

4.3 RBLs Relevant to Assessment

RBLs have been established for the early morning shoulder period (5.00am-7.00am) in order to allow for accurate assessment of night time operations with early morning truck arrivals. Table 4-3 summarises the RBLs adopted by this assessment. The morning shoulder period RBLs were found to be 2 dB higher than the night time RBLs at all three locations. Note that RBLs for the revised night time period (10.00pm-5.00am) have been calculated and were found to be the same as for the previously defined night time period (10.00pm-7.00am).

Table 4-3 RBLs Relevant to Assessment

Monitoring Location	Representative Receiver ID	Measured RBLs (dBA)			
		Day	Evening	Night	Early Morning Shoulder
NMT1 (2016 Long-Term Survey)	R1, R2, R3, R4	39	38	37	39
M1 (2014 WM Survey)	R5, R6, R7, R8	43	40	37	39
NMT2 (2016 Long-Term Survey)	R9, R10, R11, R12, R13, R14	39	38	34	36

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

The three noise catchment areas (i.e. northern receivers, southern receivers, and eastern receivers) where the RBLs summarised in Table 4-3 are deemed representative are shown in Figure 4-1.

It should be noted that when a development has been operating for more than 10 years, the *NPfI* states that its noise emissions may be included in the background noise assessment. As such, excluding noise generated by the Colliery from the background noise environment may be considered conservative as it would result in more stringent noise criteria.

5 OPERATIONAL NOISE ASSESSMENT CRITERIA

This section discusses the various noise criteria and guidelines relevant to the Revised Project, with consideration to the RBLs discussed in Section 4.

5.1 Project Noise Trigger Levels – Residential Receivers

The *NPfI* sets out two forms of project noise trigger levels. In assessing noise levels at residences, the trigger levels should be assessed at the most-affected point on or within the residential property boundary or, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence. Project noise trigger levels apply to noise levels measured under certain specific wind and temperature inversion conditions, as outlined in the *NPfI*.

Project noise trigger levels are described below.

5.1.1 Project Intrusiveness Noise Levels

The *NPfI* specifies an intrusiveness noise level which requires that the $L_{Aeq,15min}$ from a specific industrial source should not exceed the background noise level by more than 5 dB.

Table 5-1 provides a summary of the Project intrusiveness noise levels at the identified receivers.

Table 5-1 Project Intrusiveness Noise Levels

Representative Receiver		Project Intrusiveness Noise Levels, $L_{Aeq,15min}$ (dBA)			
ID	Address	Day	Evening	Night	Early Morning Shoulder
R1	16 West St, Russell Vale	44	43	42	44
R2	30 West St, Russell Vale				
R3	13 West St, Russell Vale				
R4	13 Broker St, Russell Vale				
R5	4 Broker St, Russell Vale	48	45	42	44
R6	659 Princes Hwy, Russell Vale				
R7	34 Princes Hwy, Corrimal				
R8	95 Midgley St, Corrimal				
R9	109 Midgley St, Corrimal	44	43	39	41
R10	6 Lyndon St, Corrimal				
R11	22 Lyndon St, Corrimal				
R12	46 Lyndon St, Corrimal				
R13	6 Taylor Pl, Corrimal				
R14	15 Taylor Pl, Corrimal				

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

5.1.2 Project Amenity Noise Levels

The *NPfI* specifies an amenity noise level which aims to maintain noise amenity over the whole daytime, evening and night periods where it is subjected to cumulative noise from a number of industrial sources.

The amenity noise level is relevant in the context of controlling cumulative noise impacts resulting from the concurrent operation of the Project and the other potential sources of industrial noise. The amenity noise level sets upper limits to control the total $L_{Aeq,Period}$ noise levels at a given receiver from all industrial sources over day, evening and night periods.

The identified receivers are considered to be suburban residences in accordance with the *NPfI* because they are located in an area that has local traffic with characteristically intermittent traffic flows. For suburban residences, the recommended amenity noise levels are:

- Daytime (7.00am-6.00pm) $L_{Aeq,Period}$ 55 dBA
- Evening (6.00pm-10.00pm) $L_{Aeq,Period}$ 45 dBA
- Night Time (10.00pm-7.00am) $L_{Aeq,Period}$ 40 dBA

Note that the amenity noise level refers to the $L_{Aeq,Period}$ noise level, which represents noise over an entire day, evening or night time period, whereas the intrusiveness noise level refers to a noise level over 15 minutes.

Because no other industries are present in the area, or likely to be introduced in the area in the future, the values above represent the Project amenity noise levels. The policy also stipulates that Project trigger noise levels should be expressed as $L_{Aeq,15min}$ values and provides the following method to convert $L_{Aeq,Period}$ levels into $L_{Aeq,15min}$ levels:

- $L_{Aeq,15min} = L_{Aeq,Period} + 3$ dB

Therefore, the resultant Project amenity noise levels are:

- Daytime (7.00am-6.00pm) $L_{Aeq,15min}$ 58 dBA
- Evening (6.00pm-10.00pm) $L_{Aeq,15min}$ 48 dBA
- Night Time (10.00pm-7.00am) $L_{Aeq,15min}$ 43 dBA

5.1.3 Project Noise Trigger Levels

The *NPfI* describes the 'Project noise trigger levels' as being the lower (i.e. more stringent) of the Project intrusiveness noise level and Project amenity noise levels.

Table 5-2 summarises the Project noise trigger levels used for all identified receivers in this assessment. The Project intrusiveness noise levels are lower (i.e. more stringent) compared to the Project amenity noise levels and therefore become the Project trigger noise levels.

Table 5-2 Project Noise Trigger Levels – Residential Receivers

Representative Receiver		Project Noise Trigger Levels, $L_{Aeq,15min}$ (dBA)			
ID	**Address**	**Day**	**Evening**	**Night**	**Early Morning Shoulder**
R1	16 West St, Russell Vale	44	43	42	44
R2	30 West St, Russell Vale				
R3	13 West St, Russell Vale				
R4	13 Broker St, Russell Vale				
R5	4 Broker St, Russell Vale	48	45	42	44
R6	659 Princes Hwy, Russell Vale				
R7	34 Princes Hwy, Corrimal				
R8	95 Midgley St, Corrimal				
R9	109 Midgley St, Corrimal	44	43	39	41
R10	6 Lyndon St, Corrimal				
R11	22 Lyndon St, Corrimal				
R12	46 Lyndon St, Corrimal				
R13	6 Taylor Pl, Corrimal				
R14	15 Taylor Pl, Corrimal				

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

5.2 Project Noise Trigger Levels – Schools

The *NPfI* sets out an internal amenity noise level of 35 dBA for school classrooms. The level is expressed as an $L_{Aeq,1hr}$ and is applicable to the Revised Project's noisiest 1-hour period when the school is in use (day and evening only).

It is accepted in the industry that an internal noise level inside a space is generally equivalent to the outdoor noise level just outside the space minus 10 dB with windows open. Assuming natural ventilation is required in the identified schools, an internal amenity noise level of 35 dBA would correspond to an external amenity noise level of 45 dBA.

As explained in Section 5.1.3, the *NPfI* stipulates that Project trigger noise levels should be expressed as $L_{Aeq,15min}$ values. For the purpose of this assessment, the $L_{Aeq,1hr}$ levels are conservatively assumed to be the same as $L_{Aeq,15min}$ levels. Therefore, a Project trigger level of 45 dBA ($L_{Aeq,15min}$) was used for all three identified schools during the day and evening periods.

5.3 Modifying Factor Adjustments

Where a noise source contains certain annoying characteristics, such as low frequency noise, the *NPfI* states that a penalty should be applied to measured or predicted noise levels before comparing to the relevant Project noise trigger levels.

The *NPfI* provides a method of low frequency noise assessment based on:

- overall 'C' weighted and 'A' weighted predicted or measured levels; and
- one-third octave predicted or measured levels in the range 10–160 Hertz (Hz).

Two penalties are nominated in the *NPfI*:

2 dB (evening and night)	if the C- minus A-weighted noise level over the same period is 15 dB or more, and where any of the third octave noise levels in Table C2 of the *NPfI* are exceeded by up to and including 5 dB and cannot be mitigated.
2 dB (day) and 5 dB (evening and night)	if the C- minus A-weighted noise level over the same period is 15 dB or more, and where any of the third octave noise levels in Table C2 of the *NPfI* are exceeded by more than 5 dB and cannot be mitigated.

Table C2 of the *NPfI* is 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*

5.4 Residual Noise Impacts

The *NPfI* recognises that where all source and pathway feasible and reasonable noise mitigation measures have been applied a proposed development might give rise to residual noise impacts.

Table 4.1 of the *NPfI*, which interprets the significance of any potential noise exceedances, is reproduced below in Table 5-3. These significance categories (i.e. negligible, marginal, moderate and significant) are generally consistent with Table 1 of the *Voluntary Land Acquisition and Mitigation Policy* (*VLAMP*) (NSW State Government, 2018) which addresses noise and air quality impacts from State significant mining, petroleum and extractive industry developments.

Table 5-3 Significance of Residual Noise Impacts

If the predicted noise level minus the project noise trigger level is:	**And the total cumulative industrial noise level is:**	**Then the significance of residual noise level is:**
<=2 dBA	Not applicable	Negligible
>= 3 but <=5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
>= 3 but <=5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1dB	Moderate
>5 dBA	=< recommended amenity noise level	Moderate

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
>5 dBA	> recommended amenity noise level	Significant

The *NPfI* also gives examples of noise mitigation measures addressing residual noise impacts in Table 4.2 of the policy. Table 4.2 of the *NPfI* is reproduced in Table 5-4.

Table 5-4 Examples of Receiver-Based Treatment to Mitigate Residual Noise Impacts

Significance of residual noise level	Example of potential treatment
Negligible	The exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatment or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for 'marginal', but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Significant	May include suitable commercial agreement where considered feasible and reasonable.

5.5 Assessment Methodology

Table 5-5 presents the methodology for assessing noise levels which may exceed the *NPfI* Project noise trigger levels at all receivers surrounding the Colliery.

Table 5-5 Project Noise Impact Assessment Methodology

Noise Management Zone		Noise Affectation Zone
1-2 dB above Project noise trigger levels (refer Table 5-2)	3-5 dB above Project noise trigger levels (refer Table 5-2)	> 5 dB Project noise trigger levels (refer Table 5-2)
No treatment/controls required	• Voluntary mitigation rights applicable. • Architectural treatment required if requested (incl. ventilation & upgraded façade elements).	• Voluntary mitigation rights applicable. • Architectural treatment required if requested (incl. ventilation & upgraded façade elements). • Voluntary land acquisition rights applicable.

5.6 Maximum Noise Level Event Assessment

To help protect residents from sleep disturbance (awakening or disturbance to sleep stages), the *NPfI* states the following:

> *Where the subject development/premises night time noise levels at a residential location exceed:*
>
> - *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*
>
> *a detailed maximum noise level event assessment should be undertaken.*

Based on the measured night time RBLs, the Project's trigger levels for the maximum noise level event screening assessment have been established and are summarised in Table 5-6. Schools are not included in Table 5-6 as they are only deemed to be used during the day and evening periods.

The trigger levels for the maximum noise level event assessment are only applicable to night time and early morning shoulder operations.

Table 5-6 Maximum Noise Level Event Screening Assessment Trigger Levels

Representative Receiver		Maximum Noise Level Event Screening Assessment Trigger Levels (dBA)			
ID	Address	L_{AFmax}		$L_{Aeq,15min}$	
		Night	Early Morning Shoulder	Night	Early Morning Shoulder
R1	16 West St, Russell Vale	52	54	42	44
R2	30 West St, Russell Vale				
R3	13 West St, Russell Vale				
R4	13 Broker St, Russell Vale				
R5	4 Broker St, Russell Vale	52	54	42	44
R6	659 Princes Hwy, Russell Vale				
R7	34 Princes Hwy, Corrimal				
R8	95 Midgley St, Corrimal				
R9	109 Midgley St, Corrimal	52	52	40	41
R10	6 Lyndon St, Corrimal				
R11	22 Lyndon St, Corrimal				
R12	46 Lyndon St, Corrimal				
R13	6 Taylor Pl, Corrimal				
R14	15 Taylor Pl, Corrimal				

Notes:
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

6 NOISE ASSESSMENT METHODOLOGY & ASSUMPTIONS

6.1 Noise Modelling Methodology

With consideration to the Revised Project, operational noise levels for the day, evening, night and early morning shoulder operating scenarios have been calculated at the nearby receivers using the Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd. This modelling software is recommended by the *NPfI* and has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project. Total predicted operational noise levels are then compared with the Project trigger noise levels presented in Table 5-2.

Construction of site infrastructure and coal processing plant is expected to take between 12 and 24 months. The site would be operational during the construction period with ROM coal being transported off-site without processing. Site operation during the first 12-24 month-period is referred to as the 'phase-in' operation and is included in the assessment for completeness. It is important to note that daytime predictions for the 'phase-in' operation also include construction activities and are assessed against the Project trigger noise levels since the site would be operational at the same time and construction noise would be indiscernible from operational noise by the community.

Two operational scenarios have therefore been modelled:

- Phase-in Operation, representing the initial 12-24 months of operation where ROM coal is transported off site without processing and construction of site infrastructure is ongoing.
- Full Operation, representative of when the coal processing plant is operational, and the site is operating at full production capacity.

6.2 Revised Project Operations – Phase-in Operation

During construction of site infrastructure and coal processing plant, the Revised Project would involve the following operational processes:

- Coal from the underground workings would be taken through the primary sizer building near the conveyor portal, transported downhill via the decline conveyor, and distributed throughout the ROM stockpile area using the tripper system. The site is expected to operate at a reduced production capacity during the phase-in operation period.
- A dozer (CAT D8) would manage the stockpile.
- A front-end loader would load ROM coal into road trucks for transportation off-site.

The ROM stockpile dozer would be restricted to daytime only use (between 7.00am and 6.00pm Monday to Friday and 8.00am to 6.00pm Saturday). The front-end loader and road trucks would also typically only operate during daytime hours, however provision is required to operate into the evening period (between 6.00pm and 10.00pm Monday to Friday) in the event of unexpected Port closures or interruptions, therefore for the purpose of this assessment have been assumed to operate during the day and evening periods. The existing infrastructure (primary sizer building, decline conveyor and tripper system) would operate on a 24-hour basis.

Construction activities undertaken during this period include construction of the coal processing plant, conveyors and associated infrastructure and ongoing extension to noise berms surrounding the pit top facilities.

6.3 Revised Project Operations – Full Operation

Once all proposed upgrades are completed, the Revised Project would involve the following operational processes:

- Coal from the underground workings would be taken through the primary sizer building near the conveyor portal, transported downhill via the decline conveyor, and distributed throughout the ROM stockpile area using the tripper system.
- A dozer (CAT D8) would manage the stockpile and push coal into an underground conveyor system which would transport coal through the proposed secondary sizer building and into the surge bin.
- From the surge bin, the sized coal would then be transported via conveyor to the proposed coal processing plant for processing.
- From the coal processing plant the clean coal would be transported via conveyor to truck loading bin for transportation off-site via road trucks. Rejects would be transported from the coal processing plant via a further conveyor to form a rejects stockpile.
- A front-end loader would load the rejects from the stockpile to a truck for transportation off-site or to the mine portal area for underground emplacement via Eimco underground loader.

The ROM stockpile dozer, rejects front-end loader, rejects truck and underground loader would be restricted to daytime only use (between 7.00am and 6.00pm). Road trucks and the reclaim circuit (including the secondary sizer, surge bin, coal processing plant and truck loading bin) would also typically only operate during daytime hours, however provision is required to operate into the evening period (between 6.00pm and 10.00pm Monday to Friday) in the event of unexpected Port closures or interruptions, therefore for the purpose of this assessment have been assumed to operate during the day and evening periods. The rest of the infrastructure would operate on a 24-hour basis.

As mentioned in Section 2.3, reject material may either be transferred off-site and sold for use as fill material (if meeting VENM specifications) or transferred back into the underground Russell Vale workings. Both scenarios have been addressed in the assessment and the worst-case daytime noise emissions have been reported.

6.4 Meteorological Environment for Noise Assessment Purposes

Fact Sheet D of the *NPfI* defines standard meteorological conditions and noise-enhancing meteorological conditions to be considered for the assessment. The definition of those conditions is provided in Table D1 of Fact Sheet D which is reproduced below.

Table D1: Standard and noise-enhancing meteorological conditions.

Meteorological conditions	***Meteorological parameters***
Standard meteorological conditions	*Day/evening/night: stability categories A-D with wind speed up to 0.5m/s at 10m AGL*
Noise-enhancing meteorological conditions	*Day/evening: stability categories A-D with light winds (up to 3m/s at 10m AGL)* *Night: stability categories A-D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10m AGL*

Notes: *m/s = metres per second; m = metres; AGL = above ground level; where a range of conditions is nominated, the meteorological condition delivering the highest predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10m AGL. Stability categories are based on the Pasquill-Gifford stability classification scheme.*

Fact Sheet D provides two options when considering meteorological effects:

- Conservatively adopt noise-enhancing meteorological conditions without processing meteorological data local to the site; or

- Determine the significance of noise-enhancing meteorological conditions based on meteorological data local to the site and adopt significant noise-enhancing conditions for the assessment. Where noise-enhancing meteorological conditions are deemed non-significant, standard meteorological conditions may be adopted.

The second option was adopted for the noise assessment as it would provide a more realistic estimate of noise impacts.

The significance of noise-enhancing meteorological conditions is based on the 2016 meteorological data collected by the WCL-operated on-site weather station. It includes wind speed, wind direction and observations of sigma-theta used to determine Pasquill stability categories (in accordance with Fact Sheet D).

Percentages of occurrence of moderate-to-strong temperature inversions were found to be above the threshold of occurrence of 30% in Winter (i.e. 33.1 %). As such, moderate-to-strong temperature inversions are considered significant to the Project. Those are applicable to the night and early morning shoulder periods.

Fact Sheet D of the *NPfI* does not provide guidance regarding the use of drainage flow winds during temperature inversions. A pragmatic risk management approach may be adopted, whereby temperature inversions with drainage flow winds are only considered in the assessment when the frequency of occurrence is greater than 10 % in any season. Based on recent discussions with a senior NSW EPA officer, this approach is considered reasonable and acceptable.

Analysis of the on-site meteorological data establishes a frequency of occurrence of night time (including the early morning shoulder period) meteorological conditions involving temperature inversions with drainage flow winds at more than 10 % in the following directions: SSE, S, SSW, SW, WSW, W, WNW, NW and NNW. Drainage flow winds in those directions are consistent with the topography of the site which is located on the slope of the Illawarra escarpment. Drainage flow winds from the SSE, S, SSW and NNW directions are believed to result from the effect of gradients within the site. The above drainage flow winds have been considered as part of the noise assessment. Drainage flow winds are considered too infrequent for all other directions and may be managed by WCL.

Drainage flow winds were found to be significant at up to 1.5 m/s in the nominated directions except for the SSE, WNW and NW directions where winds were only found to be significant at up to 1 m/s and the NNW direction where significant winds were only established at up to 0.5 m/s.

With regards to meteorological conditions involving winds but no inversions, analysis of the on-site meteorological data according to Fact Sheet D of the *NPfI* established no wind-related noise-enhancing meteorological conditions during the day, evening or night time periods.

All meteorological conditions presented in Table 6-1 have been considered for the assessment. Those include both standard and noise-enhancing conditions since noise-enhancing meteorological conditions do not necessarily result in higher noise levels when compared with standard meteorological conditions at a particular receiver location.

Table 6-1 Relevant *NPfI* (Fact Sheet D) Meteorological Conditions

Assessment Period	*NPfI* Meteorological Condition	Description of Meteorological Parameters
Day	Standard meteorological conditions	0.5m/s wind in source-to-receiver direction; stability categories A-D
Evening	Standard meteorological conditions	0.5m/s wind in source-to-receiver direction; stability categories A-D
Night	Noise-enhancing meteorological conditions	Stability category F; no drainage flow wind
		Stability category F with 1.5 m/s drainage flow wind in S, SSW, SW, WSW & W directions
		Stability category F with 1 m/s drainage flow wind in SSE, WNW & NW directions
		Stability category F with 0.5 m/s drainage flow wind in NNW direction
	Standard meteorological conditions	0.5m/s wind in source-to-receiver direction; stability categories A-D
Early Morning Shoulder	Noise-enhancing meteorological conditions	Stability category F; no drainage flow wind
		Stability category F with 1.5 m/s drainage flow wind in S, SSW, SW, WSW & W directions
		Stability category F with 1 m/s drainage flow wind in SSE, WNW & NW directions
		Stability category F with 0.5 m/s drainage flow wind in NNW direction
	Standard meteorological conditions	0.5m/s wind in source-to-receiver direction; stability categories A-D

Notes:

- m/s = metre per second
- SSE = South South East
- S = South
- SSW = South South West
- SW = South West
- WSW = West South West
- W = West
- WNW = West North West
- NW = North West
- NNW = North North West
- Wind in source-to-receiver direction was considered using the closest direction in a 16-direction compass to the source-to-receiver direction.

For each assessment period, only the highest noise predictions under the relevant *NPfI* meteorological conditions presented in Table 6-1 (including both standard and noise-enhancing meteorological conditions as described in Fact Sheet D) are reported.

Appendix A provides wind roses for the 2016 meteorological data collected by the WCL-operated on-site weather station.

6.5 Reasonable & Feasible Noise Mitigation Measures

Reasonable and feasible noise mitigation measures have been implemented on site or included as commitments going forward and as such have been included in modelling assumptions for this Revised Project noise impact assessment. These include recommendations provided to WCL by independent noise and vibration consultants Hatch, in a number of reports [1,2,3], and additional recommendations arising from this assessment.

Reasonable and feasible noise mitigation measures include constructing a noise barrier along the access road and new berms as well as raising/extending several of the existing berms with the intent to reduce potential noise impacts on the community. Some of these mitigation measures would be implemented prior to commencement of the phase-in operation to ensure noise generated by the phase-in operation is mitigated appropriately.

Table 6-2 and Table 6-3 provide a summary of the mitigation measures which have been included in the Revised Project noise modelling.

Table 6-2 Summary of Physical Mitigation Measures Incorporated in Modelling

Physical Noise Mitigation Measures	
Existing Noise bunds [1]	• Four existing noise bunds (Bunds #1, #2, #3 & #4 as shown in Figure 2-1) have been installed to minimise site noise at the nearby receivers located directly to the north, north-east, south-east and east of the colliery. • Additionally, an existing 2.5 m high bund has been built near the Rubber Tyred Vehicle (RTV) and track portal area.
Extension and raise of bunds [1]	• Bund #1 to be raised by additional 5 m throughout whole length and extended to the west until turn-off in access road. WCL has committed to raising and extending Bund #1 over as short a timeframe as possible (indicatively 6-8 weeks to achieve planned height), therefore it has been assumed for modelling purposes that this work is completed prior to the phase-in operation starting. • Bund #2 to be raised and extended to reach RL of 56 m throughout whole length. • Bund #3 to be raised and extended to reach RL of 47 m throughout whole length. • Bund #4 to be raised by 4-5 m to reach RL of 44 m throughout whole length. • Bund #5 to be raised by additional 3 m throughout whole length and extended to the south until access road. • Bunds #2-5 will be raised progressively throughout the 'phase-in' operation using material available on site or imported clean fill. Bund construction will be complete prior to full operation commencing.

[1] *Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014
[2] *Russell Vale Coal Reclaim, Screening, Sizing and Separation Plant*, Hatch, February 2015
[3] *Russell Vale Coal Deshaling Plant*, Hatch, November 2015

<table>
<tr><th colspan="2">Physical Noise Mitigation Measures</th></tr>
<tr><td>Temporary stockpile of ROM coal (during phase-in operations)</td><td>A 9 m high temporary stockpile of ROM coal to be constructed directly to the east and north-east of the dozer location to provide shielding to the northern receivers from dozer noise. Once constructed, the temporary stockpile would remain untempered with until completion of the phase-in operation. WCL has committed to building the temporary stockpile of ROM coal as early as possible during the 'phase-in' operation.</td></tr>
<tr><td>Access road noise barrier</td><td>Construction of a 4 m high noise barrier along the northern side of the access road starting from the Princes Highway entrance to the turn off to the truck parking area. WCL has committed to building the noise barrier prior to the phase-in operation commencing.</td></tr>
<tr><td>New infrastructure layout maximising shielding from site topography</td><td>Positioning of secondary sizer near bottom of nearby batter and surge bin at toe of nearby batter to maximise shielding to northern receivers.</td></tr>
<tr><td>Acoustic treatment of Primary Sizer Building</td><td>Side sheeting lined with absorption material installed around all facades of the building (except for the northern façade where an opening had to be left for ventilation purposes).</td></tr>
<tr><td>Acoustic treatment of Existing Tripper System</td><td>Internal lining and vibration isolation of tripper impact plates and hangers as well as internal lining and top covering of trouser leg chutes completed.</td></tr>
<tr><td colspan="2">Decline conveyor semi-enclosed.</td></tr>
<tr><td colspan="2">Poly rollers provided to all conveyors.</td></tr>
<tr><td colspan="2">Vulcanised Joints applied to all conveyors.</td></tr>
<tr><td colspan="2">Coal processing plant to be enclosed in acoustically treated building according to recommendations made by Hatch.</td></tr>
<tr><td colspan="2">Secondary sizer plant to be enclosed in acoustically treated building according to recommendations made by Hatch.</td></tr>
<tr><td colspan="2">Surge bin to be acoustically treated building according to recommendations made by Hatch.</td></tr>
<tr><td colspan="2">D8 dozer provided with attenuation pack and grouser treatment.</td></tr>
</table>

Note: Bund identification numbers are shown in Figure 2-1.

Table 6-3 Summary of Operational Mitigation Measures Incorporated in Modelling

Operational Noise Mitigation Measures
Coal loading and laden truck movements typically restricted to daytime period only, with provision for occasional operation in the evening period to cater for unexpected Port closures or interruptions. 40 km/hr on-site speed limit and 50 km/hr speed limit along Bellambi Lane with driver code of conduct enforced.
The D8 dozer, rejects front-end loader, rejects truck and underground loader would be restricted to daytime only use.
Reclaim conveyor system, secondary sizer, surge bin, coal processing plant and truck loading bins typically restricted to daytime period only, with provision for occasional operation in the and evening period to cater for unexpected Port closures or interruptions.
Dozer movements restricted to near ground level (directly above underground reclaim system) during phase-in operation to maximise shielding provided by temporary ROM coal stockpile.
Early morning truck movements to designated truck parking area prior to 7.00am would be restricted to a maximum of 6 arrivals per 15-minute period.

6.6 Revised Project Equipment Inventory, Sound Power Levels & Periods of Operation

Table 6-4 sets out the principal noise sources and associated sound power levels (SWLs) considered in the Revised Project noise model. The table also specifies where plant items have already been mitigated and provides a source reference for each SWL used.

Figure 6-1 shows the location of all the identified noise sources.

Table 6-4 Russell Vale Revised Project – Equipment Inventory, Including Sound Power Levels & Period of Operation

Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
Coal Transport Infrastructure	RV2 decline conveyor	S1	Day, Evening, Night, Shoulder	1	70/m	Yes – Semi-Enclosure Constructed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport coal from portal area to primary sizer building
	Primary sizer building	S2	Day, Evening, Night, Shoulder	1	104	Yes – Enclosure Constructed	Russell Vale Tripper Conveyor and Surface Noise Source Management, Hatch, July 2014 (SWL of 104 dBA after partial mitigation).	Crush coal to smaller size
	RV1 conveyor (enclosed)	S3	Day, Evening, Night, Shoulder	1	70/m	Yes – Semi-Enclosure Constructed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport coal from portal area to ROM stockpile area
	RV1 stackout conveyor	S4	Day, Evening, Night, Shoulder	1	70/m	Yes – Poly Rollers Installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport coal from decline conveyor to ROM stockpile area
	RV1 tripper system	S5	Day, Evening, Night, Shoulder	1	100 103 (Stockpile)	Yes – Tripper treated according to Hatch advice	Wilkinson Murray site measurements (11 June 2015)	Distribute coal within ROM stockpile area
	Drive tower	S6	Day, Evening, Night, Shoulder	1	94	Yes – Enclosure Constructed	Russell Vale Tripper Conveyor and Surface Noise Source Management, Hatch, July 2014	Drive conveyor and tripper system

Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
ROM Coal Reclaim	D8 dozer	S7	Day (up to 2hr per day)	1	112	Yes – Hushpack engine and grouser attenuation proposed to be applied prior to commencement of Revised Project	Wilkinson Murray site measurements (8 July 2014), Hushpack Engineering advice, Umwelt Mt Owen Assessment	Manage ROM stockpile
	Reclaim tunnel fans	S8	Day, Evening	1	108	No Change	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Provide ventilation for reclaim tunnels
	Reclaim tunnel to transfer station conveyor	S9	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport coal from reclaim tunnel to transfer station
	New transfer station	S10	Day, Evening	1	100	Yes – Enclosure Constructed	Wilkinson Murray database	Transfer coal from one conveyor to the next
	Transfer station to secondary sizer conveyor	S11	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport coal from transfer station to secondary sizer
	New secondary sizer building	S12	Day, Evening	1	105	Yes – Equipment to be enclosed in building according to design advice from Hatch. With the proposed acoustic building claddings (speed panel) the effective sound power level reduces to 72 dBA	Russell Vale – Coal reclaim, screening sizing and separation plant, Hatch, February 2015	Crush coal to smaller size
	Secondary sizer to surge bin conveyor	S13	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport sized coal to surge bin

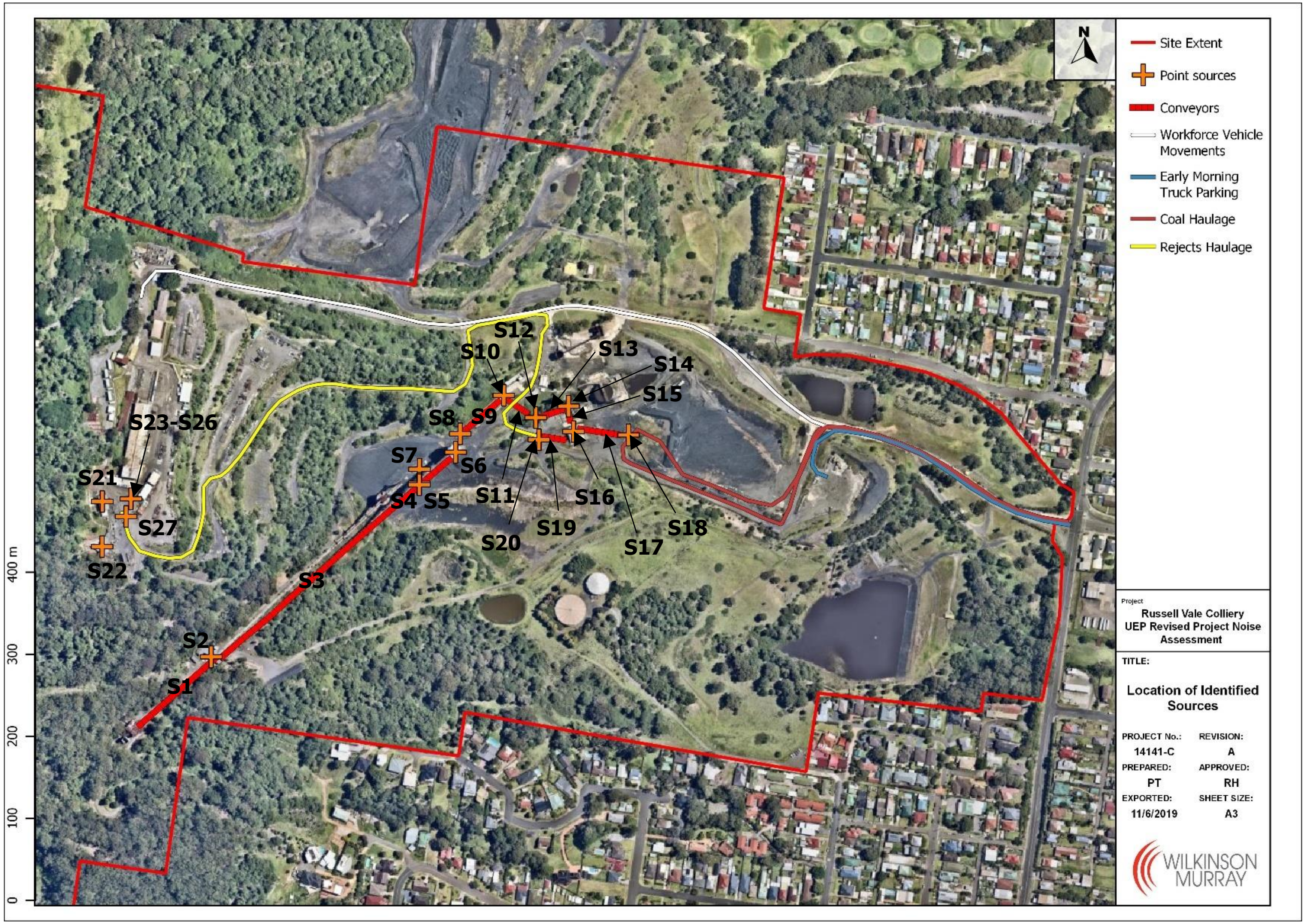
Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
	600t surge bin	S14	Day, Evening	1	105	Yes – Surge bin to be clad according to design advice from Hatch. With the proposed acoustic cladding, the effective sound power level reduces to 100 dBA	Wilkinson Murray database	Regulate coal being transferred to existing truck loading bins
	Surge bin to coal processing plant conveyor	S15	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport sized coal to coal processing plant
	Coal processing plant	S16	Day, Evening	1	103 (Ground Flr) 109 (Screen Flr)	Yes – Equipment to be enclosed in building according to design advice from Hatch. With the proposed acoustic building claddings (Concrete/R32) the effective sound power level reduces to 49 dBA (Ground Flr) and 86 dBA (Screen Flr)	Russell Vale Coal Deshaling Plant, Hatch, November 2015	Coal processing plant
	Coal processing plant to truck loading bin conveyor	S17	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery – Noise Assessment Major Works Project, ERM, Nov 2012	Transport clean coal to truck loading bin
	Truck loading bin	S18	Day, Evening	1	105	-	Wilkinson Murray database	Load coal into road trucks to transport off-site
	Rejects conveyor	S19	Day, Evening	1	70/m	Yes – Poly Rollers to be installed	NRE No.1 Colliery - Noise Assessment Major Works Project, ERM, Nov 2012	Transport reject material to rejects stockpile

Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
	Front-End Loader	S20	Day	1	113	FEL would only operate for up to approx. 2 min within a 15-minute assessment period (due to operational limitation on the number of trips possible within 15 minutes). This limited operation reduces the effective sound power level to 104.2 dBA	Wilkinson Murray site measurements of CAT988B front-end loader (8 July 2014)	Load reject into trucks
Coal Haulage	Truck and dog	-	Day, Evening	Up to 32/Hr (Day) Up to 24/Hr (Eve)	102 (40 km/hr)	On site speed limit of 40 km/hr enforced and driver code of conduct applied. Coal Haulage restricted to day and evening only. No night movements.	Wilkinson Murray database	Transport off-site
Rejects Haulage	Truck	-	Day	Up to 2/Hr (Day)	102 (40 km/hr)	On site speed limit of 40 km/hr enforced and driver code of conduct applied. Rejects Haulage restricted to day only. No evening or night movements.	Wilkinson Murray database	Transport rejects to underground emplacement area
RTV Portal Area	Compressor House	S21	Day, Evening, Night, Shoulder	1	105	Yes – Enclosure Constructed	Russell Vale Tripper Conveyor and Surface Noise Source Management, Hatch, July 2014	Generate power for underground facilities

Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
	Main Ventilation Fans	S22	Day, Evening, Night, Shoulder	2	104	No Change	Russell Vale Tripper Conveyor and Surface Noise Source Management, Hatch, July 2014	Provide underground ventilation
	Hyster116 forklift	S23	Day, Evening, Night, Shoulder	1	84	No Change	Wilkinson Murray site measurements (8 July 2014)	General maintenance work
	Hyster117 forklift	S24	Day, Evening, Night, Shoulder	1	95	No Change	Wilkinson Murray site measurements (8 July 2014)	General maintenance work
	Juggonaut	S25	Day, Night, Shoulder	1	104	No Change	Noise Levels of Mobile Equipment, BGMA, July 2010	Transport men and material down portal. Assumed to be operating for 5mins at shift change during the day and at night (i.e. not evening period)
	Men transporter	S26	Day, Night, Shoulder	3	104	No Change	Derived from Juggonaut SWL (Noise Levels of Mobile Equipment, BGMA, July 2010)	Transport men down portal. Assumed 3 to be operating for 3mins at shift change during the day and at night (i.e. not evening period)
	Eimco underground loader	S27	Day	1	110	Loader use limited to day use only	Wilkinson Murray site measurements of CAT970 front-end loader (8 July 2014)	Transport rejects to underground emplacement

Area	Fleet/ Infrastructure Item	Source ID (Fig. 6-1)	Period	Number of Items	Sound Power Level (dBA)	Mitigation Applied?	Reference	Function
Early morning truck parking	Truck	-	Shoulder	Up to 14/30mins	102 (40 km/hr)	On site speed limit of 40 km/hr enforced and driver code of conduct applied. Once at the truck parking area, trucks would turn off their engine immediately until 7.00am.	Wilkinson Murray database	Remove potential noise generated by early morning trucks parking and waiting outside the site
Workforce	Light vehicles	-	Day, Evening, Night, Shoulder	Up to 56/30mins (Day) Up to 26/30mins (Eve, Night, Shoulder)	67 (40 km/hr)	-	Wilkinson Murray database	Staff movements at shift change

Figure 6-1 Russell Vale Revised Project – Location of Identified Sources



6.7 Construction Fleet Inventory & Sound Power Levels (Phase-in Operation)

Table 6-5 sets out the principal noise sources and associated sound power levels (SWLs) assumed for construction of the site infrastructure and coal processing plant. Two scenarios were addressed, and the worst-case scenario was included in the daytime noise model for the phase-in operation.

Table 6-5 Construction Fleet Inventory & Sound Power Levels (Phase-in Operation)

Construction Scenario	Plant Item	Number of Items	SWL/Item	Total SWL
Site establishment & Earthworks	Scraper	1	113	116
	Water Cart	1	107	
	Compactor	1	106	
	Franna Crane	1	105	
	3-tonne Excavator	1	90	
	23-tonne Excavator	1	105	
	Bobcat	1	104	
	40-tonne Dump Truck	1	102	
Service Installation	Franna Crane	1	105	116.8
	20-tonne Crane	1	113	
	Water Cart	1	107	
	Front-End Loader	1	113	

As shown in Table 6-5, service installation represents the construction scenario with the higher total SWL. As such, it was assumed when predicting daytime noise levels from the phase-in operation.

It should be noted that a correction of -5 dB was applied to the total SWL for each construction scenario to account for time correction, as the entire construction fleet would not always operate concurrently (i.e. not all plant items are expected to be operating all the time).

7 INDUSTRIAL NOISE PREDICTIONS & DISCUSSION

7.1 Revised Project Predicted Noise Levels – Full Operation

The predicted $L_{Aeq,15min}$ operational noise levels representative of the full operation (once all infrastructure items and upgrades have been built) under the Revised Project are presented in this section.

Results are presented as $L_{Aeq,15min}$ noise levels under Fact Sheet D meteorological conditions (Section 6.4). The maximum result of applicable Fact Sheet D meteorological conditions (i.e. standard conditions and noise-enhancing conditions) is presented.

Project noise trigger levels, as discussed in Section 5.0, are shown in yellow shading. Predicted levels exceeding criteria are shown in bold.

Table 7-1 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Full Operation

Representative Receiver ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day		Evening		Night		Early Morning Shoulder	
	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL
R1	41	44	39	43	**43**	42	44	44
R2	42	44	40	43	**43**	42	43	44
R3	42	44	40	43	42	42	43	44
R4	41	44	38	43	**43**	42	43	44
R5	44	48	43	45	41	42	43	44
R6	44	48	42	45	42	42	44	44
R7	40	48	39	45	41	42	42	44
R8	40	48	39	45	42	42	43	44
R9	38	44	36	43	**41**	39	41	41
R10	37	44	35	43	**41**	39	41	41
R11	36	44	34	43	38	39	38	41
R12	37	44	35	43	37	39	37	41
R13	39	44	37	43	38	39	38	41
R14	38	44	36	43	39	39	39	41
R15[1]	40	45	-	n/a	-	n/a	-	n/a
R16[1]	37	45	-	n/a	-	n/a	-	n/a
R17[1]	31	45	-	n/a	-	n/a	-	n/a

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.
Note 1: Receivers relate to the school therefore only daytime predictions presented.

As shown in Table 7-1, night time noise levels are predicted to exceed the Project noise trigger levels by 1 dB at R1, R2 and R4, and by up to 2 dB at R9 and R10. At all other locations, compliant night time noise levels are predicted. Table 7-1 shows that no exceedances are to be expected during the day, evening and early morning shoulder periods at any of the identified representative receivers. As discussed in Section 7.4, these night time noise exceedances are only predicted to occur between 2 and 5% of the night time period in Winter.

It is important to note that a 1 to 2 dB exceedance represents a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*.

Predicted $L_{Aeq,15min}$ operational noise levels for the full operation under the Revised Project comply with the Project amenity noise levels of 58 dBA, 48 dBA and 43 dBA for the day, evening and night time periods, respectively.

7.2 Revised Project Predicted Noise Levels – Phase-in Operation

The predicted $L_{Aeq,15min}$ operational noise levels representative of the phase-in operation under the Revised Project are presented in this section.

Results are reported as $L_{Aeq,15min}$ noise levels under Fact Sheet D meteorological conditions (Section 6.4) with the maximum result of applicable Fact Sheet D meteorological conditions (i.e. standard conditions and noise-enhancing conditions) being presented.

Project noise trigger levels, as discussed in Section 5.0, are shown in yellow shading. Predicted levels exceeding criteria are shown in bold.

Daytime predictions conservatively include construction activities associated with the site infrastructure and coal processing plant (Section 6.7).

Table 7-2 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Phase-in Operation

Representative Receiver ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day		Evening		Night		Early Morning Shoulder	
	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL
R1	41	44	37	43	**43**	42	44	44
R2	42	44	39	43	**43**	42	43	44
R3	41	44	39	43	42	42	42	44
R4	40	44	37	43	**43**	42	43	44
R5	43	48	42	45	41	42	43	44
R6	45	48	43	45	42	42	44	44
R7	40	48	38	45	41	42	42	44
R8	40	48	38	45	42	42	43	44
R9	37	44	36	43	**41**	39	41	41
R10	37	44	34	43	**41**	39	41	41
R11	36	44	33	43	38	39	38	41
R12	37	44	34	43	37	39	37	41
R13	38	44	36	43	38	39	38	41
R14	37	44	35	43	39	39	39	41

Representative Receiver ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	Day		Evening		Night		Early Morning Shoulder	
	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL	Prediction	PNTL
R15[1]	39	45	-	n/a	-	n/a	-	n/a
R16[1]	35	45	-	n/a	-	n/a	-	n/a
R17[1]	30	45	-	n/a	-	n/a	-	n/a

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.
Note 1: Receivers relate to the school therefore only daytime predictions presented.

Table 7-2 shows that night time noise levels during the phase-in operation are predicted to exceed the Project noise trigger levels by 1 dB at R1, R2 and R4, and by up to 2 dB at R9 and R10. Compliance of night time noise levels is anticipated at all other representative locations. Table 7-2 indicates that no exceedances are to be expected during the day, evening and early morning shoulder periods at any of the identified representative receivers.

Again, 1 to 2 dB exceedances represent a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*.

Predicted $L_{Aeq,15min}$ operational noise levels for the phase-in operation would comply with the Project amenity noise levels of 58 dBA, 48 dBA and 43 dBA for the day, evening and night time periods, respectively.

7.3 Discussion on Extent of Noise Exceedances

Assessment of noise at the 17 identified receivers, which represent the potentially most impacted noise-sensitive receivers, has enabled the appropriate design of revised site operations and extensive noise mitigation measures, as detailed in Table 6-2 of this report.

Because of the presence of residual noise exceedances anticipated at some of the identified receivers, it is necessary to determine the extent of the residual noise impacts surrounding the site. Noise contours of Project noise trigger levels in combination with additional point-source noise predictions have been generated for the full operation to identify all receivers expected to be subject to residual noise exceedances and determine the level of exceedance for each of those receivers.

Figures showing indicative day, evening, night and early morning shoulder period noise contours of the Project noise trigger levels under Fact Sheet D meteorological conditions for the full operation scenario are presented in Appendix B. It is important to note that receivers partly or totally 'inside' noise contours can be subject to rounded noise levels in compliance with criteria. Project noise trigger level applicability areas shown in the noise contour figures do not apply to the schools (R15-R17).

Table 7-3 presents a summary of all noise-sensitive receivers where exceedances are expected during full operation. Exceedance are only expected at night and no exceedances are expected during the other assessment periods. As discussed in Section 7.4, these night time noise exceedances are only predicted to occur between 2 and 5% of the night time period in Winter.

Table 7-3 Predicted Noise Exceedances from Project – Full Operation

Receiver Address	$L_{Aeq,15min}$ Noise Level (dBA) – Night	
	Prediction	PNTL
16 West St, Russell Vale	**43**	42
18 West St, Russell Vale	**43**	42
20 West St, Russell Vale	**43**	42
22 West St, Russell Vale	**43**	42
24 West St, Russell Vale	**43**	42
26 West St, Russell Vale	**43**	42
28 West St, Russell Vale	**43**	42
30 West St, Russell Vale	**43**	42
11 Broker St, Russell Vale	**43**	42
13 Broker St, Russell Vale	**43**	42
15 Broker St, Russell Vale	**43**	42
17 Broker St, Russell Vale	**43**	42
19 Broker St, Russell Vale	**43**	42
23 Broker St, Russell Vale	**43**	42
25 Broker St, Russell Vale	**43**	42
4 Lyndon St, Corrimal	**40**	39
6 Lyndon St, Corrimal	**41**	39
8 Lyndon St, Corrimal	**41**	39
8 Wilford St, Corrimal	**41**	39
10 Wilford St, Corrimal	**40**	39
101 Midgley St, Corrimal	**41**	39
103 Midgley St, Corrimal	**41**	39
105 Midgley St, Corrimal	**41**	39
107 Midgley St, Corrimal	**41**	39
109 Midgley St, Corrimal	**41**	39
76 Midgley St, Corrimal	**40**	39
78 Midgley St, Corrimal	**40**	39

Note:
Night: the period from 10.00pm to 5.00am.

Table 7-3 indicates that exceedances are anticipated at residences located at the above 27 addresses during the proposed full operation. All exceedances would range between 1 and 2 dB, representing a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*.

7.4 Frequency of Occurrence of Residual Noise Exceedances

Appendix C provides a selection of cumulative frequency of occurrence noise graphs showing the percentage of time for which the identified night time residual exceedances are expected to occur in winter. Because the noise exceedances relate to noise levels during temperature inversions, the percentage of time for which Project noise trigger levels are expected to be exceeded would be the greatest in winter.

The five graphs included in Appendix C show the cumulative frequency of occurrence of night time noise levels in winter for the five receivers expected to exceed the Project noise trigger levels, namely receivers R1, R2, R4, R9 and R10.

Review of the graphs indicates that the identified residual noise exceedances are only expected to occur between 2 and 5% of the night time period in Winter.

7.5 Low-Frequency Noise Assessment Results

A low-frequency noise assessment was conducted to ascertain whether any of the identified representative receivers should be subject to a modifying factor correction due to dominant low-frequency content. Such correction would be applied to the predicted noise levels before comparing to the relevant Project noise trigger levels.

As stated in Section 5.2, the *NPfI* provides a method for assessing low frequency noise based on:

- overall 'C' weighted and 'A' weighted predicted or measured levels; and
- one-third octave predicted or measured levels in the range 10–160 Hz.

The C-weighted noise level minus A-weighted noise level assessment focuses on the full operation scenario. It was conducted on four of the identified representative receivers (namely, receivers R2, R5, R8 and R11) for all four assessment periods. The assessment was based on the relevant *NPfI* meteorological conditions (Table 6-1) resulting in the highest noise levels.

Table 7-4 summarises the C-weighted noise level minus A-weighted noise level assessment results for the Full Operation scenario.

Table 7-4 C- Minus A-Weighted Noise Levels – Full Operation

Representative Receiver ID	$L_{Ceq,15min}$ Noise Level - $L_{Aeq,15min}$ Noise Level (dB)			
	Day	Evening	Night	Early Morning Shoulder
R2	13.3	14.8	9.3	9.6
R5	10.3	10.9	7.7	10.5
R8	11.3	11.8	9.2	9.5
R11	14.4	14.5	12.1	12.2

Results presented in Table 7-4 show that the difference between overall 'C' weighted and 'A' weighted predicted levels are less than 15 dB at all four receivers and across all assessment periods. It is expected similar results would occur at all receivers surrounding the Colliery.

As such, the low-frequency noise assessment indicates that it is unlikely that any of the receivers surrounding the Project would be subject to dominant low-frequency noise. Therefore, no modifying factor correction for low-frequency noise is warranted for the Project.

7.6 Contextualisation of Revised Project Noise Assessment

Appendix D provides a comparison of the predicted Revised Project noise levels for the full operation with those predicted by the previous UEP assessment, as detailed in the WM report dated 9 October 2014 (Report No 14141 Ver C). Under the same meteorological conditions, noise levels associated with the Revised Project are found to have reduced by 0-9 dB, 2-11 dB, and 1-11 dB for the day, evening and night periods, respectively, when compared with the levels predicted in the UEP assessment. These reductions are noted to be considerable.

Appendix E provides a discussion of historical noise levels at Russell Vale Colliery since 1980.

Appendix F summarises the responses to noise issues identified in PAC Second Review Report. Section 4.5 of the PAC Second Review Report discusses noise issues and the Commission's findings are summarised in Section 4.5.5, with concluding comments provided in Section 5 of the PAC Second Review Report. Specific responses to the matters raised by the PAC are provided in Appendix F of this report.

8 MAXIMUM NOISE LEVEL EVENT ASSESSMENT

Two noise sources have been identified as potentially triggering sleep arousal during the night time or early morning shoulder periods:

- Intermittent noise from coal pieces and rocks impacting the tripper trouser leg chutes, and
- Early morning truck arrivals.

A maximum noise level event screening assessment has been conducted for each of these sources. As described in Section 5.6, the screening assessment is based on two criteria:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater.

Intermittent noise from coal pieces and rocks impacting the tripper trouser leg chutes has the potential to trigger sleep arousal at night. Intermittent noise associated with this source has been considered in the assessment of sleep disturbance.

The mitigated tripper arrangement sound power level of $L_{A1,1min}$ 108 dBA as used in WM's 2014 assessment, has been applied in the Revised Project night time impact noise assessment.

L_{AFmax} noise predictions are based on the relevant meteorological conditions determined in accordance with Fact Sheet D of the *NPfI* (Table 6-1).

The Project's L_{AFmax} trigger levels for the maximum noise level event screening assessment are shown in yellow shading.

Table 8-1 L_{AFmax} Levels from Site Infrastructure

Representative Receiver		Predicted L_{AFmax} Noise Level (dBA)	Maximum Noise Level Event Screening Assessment L_{AFmax} Trigger Levels (dBA)	
ID	Address		Night	Early Morning Shoulder
R1	16 West St, Russell Vale	46	52	54
R2	30 West St, Russell Vale	43		
R3	13 West St, Russell Vale	42		
R4	13 Broker St, Russell Vale	45		
R5	4 Broker St, Russell Vale	40	52	54
R6	659 Princes Hwy, Russell Vale	43		
R7	34 Princes Hwy, Corrimal	42		
R8	95 Midgley St, Corrimal	44		
R9	109 Midgley St, Corrimal	39	52	52
R10	6 Lyndon St, Corrimal	38		
R11	22 Lyndon St, Corrimal	38		
R12	46 Lyndon St, Corrimal	40		
R13	6 Taylor Pl, Corrimal	39		

Representative Receiver		Predicted L_{AFmax} Noise Level (dBA)	Maximum Noise Level Event Screening Assessment L_{AFmax} Trigger Levels (dBA)	
ID	**Address**		**Night**	**Early Morning Shoulder**
R14	15 Taylor Pl, Corrimal	41		

Notes:
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

Table 8-1 indicates that L_{AFmax} noise levels associated with the Revised Project's infrastructure are predicted to be below the L_{AFmax} trigger levels at all the representative receivers.

Trucks allowed to access the truck parking area prior to 7.00am may potentially trigger sleep arousal during the early morning shoulder period. Based on the relevant meteorological conditions determined in accordance with Fact Sheet D of the *NPfI*, predicted L_{AFmax} noise levels generated by trucks on site are set out in Table 8-2. The noise predictions assume the access road noise barrier is in place.

Table 8-2 L_{AFmax} Levels from Early Morning Trucks Accessing Parking Area

Representative Receiver		Predicted L_{AFmax} Noise Level (dBA)	Maximum Noise Level Event Screening Assessment L_{AFmax} Trigger Levels (dBA)
ID	**Address**		**Early Morning Shoulder**
R1	16 West St, Russell Vale	45	54
R2	30 West St, Russell Vale	47	
R3	13 West St, Russell Vale	47	
R4	13 Broker St, Russell Vale	42	
R5	4 Broker St, Russell Vale	52	54
R6	659 Princes Hwy, Russell Vale	47	
R7	34 Princes Hwy, Corrimal	46	
R8	95 Midgley St, Corrimal	43	
R9	109 Midgley St, Corrimal	42	52
R10	6 Lyndon St, Corrimal	38	
R11	22 Lyndon St, Corrimal	30	
R12	46 Lyndon St, Corrimal	30	
R13	6 Taylor Pl, Corrimal	26	
R14	15 Taylor Pl, Corrimal	33	

Note:
Early Morning Shoulder: the period from 5.00am to 7.00am.

Review of Table 8-2 indicates that $L_{A1,1min}$ noise levels due to trucks allowed to access the truck parking area prior to 7.00am are within the L_{AFmax} trigger levels at all the representative receivers. Note that R5 is subject to higher L_{AFmax} noise levels due to a gap in the existing berm running along the northern boundary of the site.

Table 8-3 assesses night time and early morning shoulder $L_{Aeq,15min}$ noise levels associated with the full operation against the Project's $L_{Aeq,15min}$ trigger levels for the maximum noise level event screening assessment shown in yellow shading.

Table 8-3 $L_{Aeq,15min}$ Levels - Night & Early Morning Shoulder (Full Operation)

<table>
<tr><th colspan="2">Representative Receiver</th><th colspan="2">$L_{Aeq,15min}$ Noise Level (dBA)</th><th colspan="2">Maximum Noise Level Event Screening Assessment $L_{Aeq,15min}$ Trigger Levels (dBA)</th></tr>
<tr><th>ID</th><th>Address</th><th>Night</th><th>Early Morning Shoulder</th><th>Night</th><th>Early Morning Shoulder</th></tr>
<tr><td>R1</td><td>16 West St, Russell Vale</td><td>43</td><td>44</td><td rowspan="4">42</td><td rowspan="4">44</td></tr>
<tr><td>R2</td><td>30 West St, Russell Vale</td><td>43</td><td>43</td></tr>
<tr><td>R3</td><td>13 West St, Russell Vale</td><td>42</td><td>43</td></tr>
<tr><td>R4</td><td>13 Broker St, Russell Vale</td><td>43</td><td>43</td></tr>
<tr><td>R5</td><td>4 Broker St, Russell Vale</td><td>41</td><td>43</td><td rowspan="4">42</td><td rowspan="4">44</td></tr>
<tr><td>R6</td><td>659 Princes Hwy, Russell Vale</td><td>42</td><td>44</td></tr>
<tr><td>R7</td><td>34 Princes Hwy, Corrimal</td><td>41</td><td>42</td></tr>
<tr><td>R8</td><td>95 Midgley St, Corrimal</td><td>42</td><td>43</td></tr>
<tr><td>R9</td><td>109 Midgley St, Corrimal</td><td>41</td><td>41</td><td rowspan="6">40</td><td rowspan="6">41</td></tr>
<tr><td>R10</td><td>6 Lyndon St, Corrimal</td><td>41</td><td>41</td></tr>
<tr><td>R11</td><td>22 Lyndon St, Corrimal</td><td>38</td><td>38</td></tr>
<tr><td>R12</td><td>46 Lyndon St, Corrimal</td><td>37</td><td>37</td></tr>
<tr><td>R13</td><td>6 Taylor Pl, Corrimal</td><td>38</td><td>38</td></tr>
<tr><td>R14</td><td>15 Taylor Pl, Corrimal</td><td>39</td><td>39</td></tr>
</table>

Notes:
Night: the period from 10.00pm to 5.00am.
Early Morning Shoulder: the period from 5.00am to 7.00am.

Table 8-3 shows that night time noise levels during the full operation are predicted to exceed the Project's $L_{Aeq,15min}$ trigger levels for the maximum noise level event screening assessment by 1 dB at R1, R2, R4, R9 and R10. Compliance of night time noise levels is anticipated at all other representative residential receivers. Table 8-3 indicates that no exceedances are to be expected during the early morning shoulder periods at any of the identified representative receivers.

It should be noted that the same negligible 1 dB exceedances are anticipated during the phase-in operation.

A 1 dB exceedance represents a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*. However, it warrants a detailed assessment for the night time period in accordance with the *NPfI*.

The detailed assessment considers aspects like the extent to which maximum noise levels exceed the RBL and the number of times maximum noise level events occur across the night time period. Since maximum noise levels are below the relevant RBLs plus 15 dB, it is considered that no noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.

9 CONSTRUCTION NOISE

As mentioned in Section 6.5, reasonable and feasible noise mitigation measures for the operation of the Revised Project would include building new berms and raising as well as extending several of the existing berms around the Pit Top with the intent to reduce potential noise impacts on the community.

Based on past experience for similar projects, it is understood regulators consider construction of noise berms an activity to be assessed against the *Interim Construction Noise Guideline (ICNG)* even if occurring within the context of an operational site. This is generally justified for the following two reasons:

- Potential noise impacts associated with the construction of noise berms is expected to be relatively high by nature (i.e. mobile fleet associated with the construction of noise berms would be in relatively close proximity and exposed [i.e. working on top of the berms] to surrounding receivers) but unavoidable in order to mitigate long-term noise generated by the site in general; and
- Construction of noise berms is relatively short in duration.

9.1 Construction Noise Criteria

The recommended noise management levels described in the *ICNG* for residences are provided in Table 9-1.

Table 9-1 Construction Noise Guideline Noise Management Levels - Residences

<table>
<tr><th>Time of Day</th><th>Management Level $L_{Aeq,15min}$</th><th>How to Apply</th></tr>
<tr><td rowspan="2">Recommended standard hours:
Monday to Friday
7.00 am to 6.00 pm
Saturday
8.00 am to 1.00 pm
No work on Sundays
or public holidays</td><td>Noise affected
RBL + 10 dBA</td><td>The noise affected level represents the point above which there may be some community reaction to noise:
• Where the predicted or measured $L_{Aeq,15\ min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.
• The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</td></tr>
<tr><td>Highly noise affected
75 dBA</td><td>The highly noise affected level represents the point above which there may be strong community reaction to noise:
• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences).
2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</td></tr>
<tr><td>Outside recommended standard hours:</td><td>Noise affected
RBL + 5 dBA</td><td>• A strong justification would typically be required for works outside the recommended standard hours.
• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</td></tr>
</table>

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
		• Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

The recommended noise management level described in the *ICNG* for schools when in use is an external $L_{Aeq,15min}$ noise level of 55 dBA.

9.2 Description of Construction Activities

In order to improve noise mitigation from site operations, bunds surrounding the Pit Top will also be raised and/or extended using material won onsite or imported clean fill material. Bunds shown on Figure 2-1 will be modified as follows:

- Bund #1 will be raised by an additional 5 m throughout its length and extended to the west to the edge of the access road turn-off.
- Bund #2 will be raised and extended to reach Reduced Level (RL) of 56 m throughout its length.
- Bund #3 will be raised and extended to reach an RL of 47 m throughout its length.
- Bund #4 will be raised by 4-5 m to reach an RL of 44 m throughout its length.
- Bund #5 will be raised by additional 3 m throughout its length, and extended to the south to the access road.

Table 9-2 sets out the principal noise sources and associated sound power levels (SWLs) assumed for construction of the noise berms.

Table 9-2 Construction Fleet Inventory & Sound Power Levels (Construction of Noise Berms)

Plant Item	Location	Number of Items	SWL/Item
Front-End Loader	At Berm	1	113
7-tonne Compactor	At berm	1	106
Grader	At berm	1	113
Road-registered Dump Truck	Travelling between Rejects Stockpile and Noise Berm	1	102 (40 km/hr)

As mentioned in Section 2.4, construction works would be undertaken during standard construction hours 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm Saturday. No construction activities will be undertaken on Sunday and public holidays.

9.3 Construction Noise Predictions

The predicted $L_{Aeq,15min}$ construction noise levels are presented in this section. Construction noise levels were predicted for all identified berms (as shown in Figure 2-1) and the worst-case noise predictions were reported in Table 9-3. Therefore, the predictions represent noise levels generated when constructing the berm closest to a receiver in question.

Although not required by the *ICNG*, construction noise predictions are conservatively provided under relevant meteorological conditions determined in accordance with Fact Sheet D of the *NPfI* (Table 6-1).

Recommended noise management levels described in the *ICNG* are shown in yellow shading and predicted levels exceeding relevant noise affected levels are shown in bold.

Table 9-3 $L_{Aeq,15min}$ Levels from Berm Construction

ID	$L_{Aeq,15min}$ Noise Level (dBA)	'Noise Affected' Level (dBA)	'Highly Noise Affected' Level (dBA)
R1	**61**	49	75
R2	**65**	49	75
R3	**63**	49	75
R4	**56**	49	75
R5	**57**	53	75
R6	**57**	53	75
R7	**54**	53	75
R8	**57**	53	75
R9	**59**	49	75
R10	**52**	49	75
R11	41	49	75
R12	36	49	75
R13	39	49	75
R14	44	49	75
R15	53	55	-
R16	**57**	55	-
R17	45	55	-

The results of Table 9-3 indicate that construction noise levels would comply with the *ICNG* 'highly noise affected' management level at all representative residential receivers.

At some point in time, the *ICNG* 'noise affected' management level is likely to be exceeded at 11 of the representative receivers. These exceedances would only occur for a very short duration (i.e. during the construction of the closest berm[s] and under adverse weather conditions) and it is expected that noise levels associated with the construction of noise berms would generally comply with the 'noise affected' management level.

These exceedances trigger the need to implement all feasible and reasonable work practices to meet the 'noise affected' levels and are expected given the nature of the works (i.e. involving relatively close and exposed mobile plant). The following section describes all feasible and reasonable work practices that should be implemented to address construction noise impacts.

9.4 Work Practices Implemented to Address Construction Noise Impacts

Because of the expected brief exceedances of the 'noise affected' management levels, the proponent should implement the following feasible and reasonable work practices in accordance with the *ICNG*.

9.4.1 Schedule activities to minimise noise impacts

- Commitment to undertake all berm construction works during the recommended standard hours;
- Schedule construction of berms as early as possible within the phase-in period so that they can be used as early as possible as noise barriers;
- Commitment to complete all identified noise berms within the phase-in period;
- Where feasible and reasonable, reduce duration of berm construction works; and
- Consult with affected neighbours about scheduling berm construction works to minimise noise impacts.

9.4.2 Use Quieter Equipment and Methods

- Provide dump truck access to the berms on the side further away from the closest receivers to maximise distance to receivers and shielding from berm;
- Where feasible and reasonable, use dump truck, front-end loader, compactor and grader with less annoying alternatives to the typical 'beeper' alarms (e.g. smart alarms and broadband alarms); and
- Regularly inspect and maintain equipment to ensure it is in good working order.

9.4.3 Notification Before and During Construction of Berms

- Provide, reasonably ahead of time, information such as nature of works to be carried out, the intention behind the works (i.e. to reduce long-term operational noise levels emanated from the site), total berm construction duration, what berm(s) are expected to be noisy, their duration, and when respite periods would occur;
- Provide information to neighbours before and during construction through letterbox drops, postal or email mailing lists, meetings or individual contact; and
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, construction hours and regular information updates - this signage should be clearly visible from the outside and include a contact phone number for enquiries during the works.

9.4.4 Complaint Handling

- Give complaints a fair hearing;
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow;
- Call back as soon as possible to keep people informed of action to be taken to address noise problems;
- Implement all feasible and reasonable measures to address the source of complaint; and

- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, time of verbal response and timeframe for written response where appropriate.

9.4.5 Application of *CN&VS* Additional Management Measures

The *Construction Noise & Vibration Strategy (CN&VS)* (Transport for NSW Infrastructure and Services Division) sets out 'additional mitigation measure matrices' used to determine the additional measures to be implemented once all feasible and reasonable work practices have been put in place.

The matrices recommend that during standard construction hours, periodic notification and attended noise monitoring should be implemented when construction noise levels are expected to exceed RBLs plus 20 dB and be less than the *ICNG* 'highly noise affected' management level of 75 dBA. Noise associated with the construction of noise berms would generally be likely to exceed RBLs plus 20 dB when construction occurs within 200 m of a receiver.

Therefore, in line with the CN&VS, we recommend that notifications providing an overview of upcoming works be distributed to all noise-sensitive receivers located within 200 m of upcoming berm construction works. Refer to Section 9.4.3 for content and means of notifications.

Also in line with the *CN&VS*, we recommend that attended noise monitoring be conducted at the nearest and potentially most impact residence(s) when construction of noise berms is occurring within 200 m of noise-sensitive receivers. The purpose of monitoring would be to confirm construction noise levels are consistent with the predictions presented in Table 9-3.

10 ROAD TRAFFIC NOISE

Product coal will be transported by truck to Port Kembla using road registered semi-trailer trucks and B-double trucks. Consistent with previously approved operations, the transport route would be via Bellambi Lane and Memorial Drive which is the route that has historically been used for the transport of coal from the Russell Vale site. Bellambi Lane and Memorial Drive is an approved 25/26 metre B-double route, as is the remainder of the transport route to Port Kembla.

Truck loading operations will typically be limited to 7.00am and 6.00pm, Monday to Friday, and 8.00am to 6.00pm on Saturdays. Provision is required for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions. This operation during the evening has been considered in this assessment. These loading hours remain the same as previously approved under the Preliminary Works Approval.

Outbound laden (coal or reject) trucks will be limited to an average of 16 return trips (32 movements) per hour between the hours of 7.00am and 6.00pm. If coal transport is required during the evening to cater for unexpected Port closures or interruptions, these movements would be further limited to an average of 12 return trips (24 movements) per hour between 6.00pm and 10.00pm Mondays to Fridays only.

The sign posted speed limit for vehicles using Bellambi Lane is 60 km/hr. Under the Preliminary Works Approval, coal truck movements along Bellambi Lane were subject to a voluntary speed limit of 50 km/hr. This voluntary speed limit will be maintained for the Revised Project with WCL aiming to achieve 95% compliance with the voluntary speed limit and 100% compliance with the sign posted 60 km/hr speed limit. All coal/reject trucks will be subject to GPS monitoring to monitor compliance with this speed limit.

The noise impact to residences associated with traffic along Bellambi Lane would likely be most sensitive to movements associated with coal trucks from the Colliery.

10.1 Identification of Receivers

Residential receivers are located on both sides of Bellambi Lane. Those to the north have their rear yards facing Bellambi Lane. These receivers are accessed via Keerong Avenue. Under the Wollongong Local Environmental Plan (LEP) 2009, this area is zoned R2 Low Density Residential. On the southern side of Bellambi Lane, residences as well as light industrial sites face the road. With reference to the LEP this area is zoned IN2 Light Industrial Zone.

10.2 Suitable Noise Criteria

Bellambi Lane has been identified as a 'principal haulage route' as per the *Road Noise Policy*. The following is extracted from Section 2.2.2 of the *RNP* in support of this classification.

> *"Some industries such as mines and extractive industries are, by necessity, in locations that are often not served by arterial roads. Heavy vehicles must be able to access these often more remote sites, and this may mean travelling on local public roads. Good planning practice acknowledges this type of road use and develop ways of managing any associated adverse noise impacts. Where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for arterial/sub arterial roads, recognising that they carry a different level and mix of traffic to local roads."*

This assessment considers the increase in noise levels from the existing traffic volumes. As per the *RNP*, an increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

10.3 Methodology & Assessment

Table 10-1 sets out the existing Bellambi Lane vehicle volumes considered by this assessment, based on the vehicle volumes, as set out in Tables 3.1 and 3.3 of the traffic and transport impact assessment report for the Revised Project (Transport and Urban Planning Pty Ltd Report No. 17066r, dated December 2018) and applying an average 1.5% per year background traffic growth (linear) for Bellambi Lane as estimated in the traffic and transport impact assessment. The existing traffic volumes are based on traffic counts undertaken between 2-8 May 2017, during a period when Russell Vale Colliery was in care and maintenance, and as such do not include vehicle movements associated with the site.

Table 10-1 2019 Existing Bellambi Lane Traffic (excl. Project Traffic)

Timeframe	Vehicle Type	5 Day Average			7 Day Average		
		WB*	EB*	Total	WB*	EB*	Total
Daytime 15-hr (7am-10pm)	LV [1]	2288	2664	4952	2109	2491	4600
	HV [2]	128	149	277	118	139	257
	Total	2415	2813	5228	2228	2630	4858
Night Time 9-hr (7am-10pm)	LV [1]	177	263	440	167	233	400
	HV [2]	10	14	24	9	13	22
	Total	187	277	464	176	246	422

Notes: Based on Traffic Counts undertaken between 2-8 May 2017 and applying an average 1.5% per year background traffic growth (linear)
1 - Light Vehicles – Austroads 1 and 2 vehicle classifications
2 - Heavy Vehicles – Austroads 3-12 vehicle classifications
* EB = Eastbound; WB = Westbound

With consideration to the project's traffic generation, Table 10-2 shows the anticipated total vehicle volumes on Bellambi Lane i.e. existing plus project traffic.

Table 10-2 Project plus Existing 2019 Bellambi Lane Traffic

Timeframe	Vehicle Type	5 Day Average		
		*WB	*EB	Total
Daytime 15-hr (7am-10pm)	LV [1]	2314	2740	5054
	HV [2]	352	373	725
	Total	2665	3114	5779
Night Time 9-hr (7am-10pm)	LV [1]	254	289	543
	HV [2]	10	14	24
	Total	264	303	567

Notes: 1 - Light Vehicles – Austroads 1 and 2 vehicle classifications
2 - Heavy Vehicles – Austroads 3-12 vehicle classifications
* EB = Eastbound; WB = Westbound

In order to assess the impact along Bellambi Lane, the existing and projected traffic volumes have been evaluated using the *CoRTN (Calculation of Road Traffic Noise)* algorithm. The analysis indicates that with the Revised Project traffic may be expected to result in relative traffic noise level increases of:

- 2.0 dB during the day; and
- 0.6 dB at night.

These increases are noted to be within the 2 dB increase margin recognised by the *RNP* as acceptable and considered to be barely perceptible to the average person. These relative traffic noise level increases are expected to reduce during the project life as background traffic volumes are expected to grow at a rate of 1.5% per year while project traffic volumes will remain the same.

It is important to note that irrespective of the modelling, traffic noise impacts are also being managed as follows:

- Haulage is restricted (as per Condition 6 of Major Project Approval 08_0009 for PKCT) such that no movements are to occur during the night time period.
- The above truck numbers are based on the use of 19 metre articulated vehicles (i.e. semi-trailers, truck and dog trailers). WCL may, in the future, use B-double vehicles which will reduce the average number of outbound trucks per hour.

11 VOLUNTARY LAND ACQUISITION & MITIGATION POLICY

The NSW State Government has issued the *Voluntary Land Acquisition and Mitigation Policy (VLAMP)* which addresses noise and air quality impacts from State significant mining, petroleum and extractive industry developments.

Table 1 of the *VLAMP*, which interprets the significance of any potential noise exceedances and identifies potential treatment for these exceedances, is reproduced below in Table 11-1. As mentioned in Section 5.3, the characterisation of impacts according to the *VLAMP* is generally consistent with Table 4.1 of the *NPfI* addressing the significance of residual noise impacts.

Table 11-1 Characterisation of Noise Impacts & Potential Treatments

If the predicted noise level minus the project noise trigger level 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 discernible 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 <=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*, but the increase in total cumulative industrial noise level resulting from the development >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 level 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 level 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.

The provisions for voluntary mitigation and land acquisition rights under the *VLAMP* have been reproduced below.

Voluntary Mitigation Rights

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 1dB(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 3dB(A) at any residence on privately owned land.*

All noise levels must be calculated in accordance with the NPfI or RING (as applicable).

The selection of mitigation measures should be guided by the potential treatments identified in Table 1 (see following page).

Voluntary Land Acquisition Rights

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; 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).

Predicted noise levels indicate that no residence or privately-owned land would be subject to voluntary mitigation or land acquisition rights in accordance with the *VLAMP*.

12 CONCLUSION

This report provides a re-evaluation of operational and traffic noise impacts with respect to the Revised Project, with reference to the newly published *Noise Policy for Industry*.

The principal findings of the Revised Project noise assessment are as follows:

- The proposed Revised Project, which has been developed by WCL to address those issues raised in the PAC Second Review Report, involves the implementation of revised site operations and extensive noise mitigation measures, as detailed in Table 6-2 of this report, including relocation of secondary sizer and surge bin, raising and extension of noise berms, construction of noise barrier, restrictions on coal haulage, acoustic treatment of the D8 dozer, and acoustic treatment of new processing plantrooms.
- A full year of noise monitoring data, captured by on-site monitoring stations during 2016 whilst the site was not operational, and additional data obtained over a 12-day period in June 2014 has been reviewed. Project noise trigger levels have been re-evaluated based on the long-term background noise level data.
- Despite the implementation of feasible and reasonable mitigation, some infrequently residual exceedances of the operational criteria are predicted to remain: night time noise levels during phase-in and full operations are predicted to exceed the Project noise trigger levels by up to 1 dB at representative receivers R1, R2 and R3 and by up to 2 dB at representative receivers R9 and R10. A 1 to 2 dB exceedance represents a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*.
- Noise contours of Project noise trigger levels and additional point-source noise predictions have identified exceedances at a total of 27 addresses during the proposed full operation. A summary of all receivers subject to residual exceedances is provided in Table 7-3 of the report. All exceedances would range between 1 and 2 dB, representing a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*.
- A low-frequency noise assessment was conducted in accordance with the *NPfI* and established that it is unlikely any of the receivers surrounding the Project would be subject to dominant low-frequency noise.
- L_{AFmax} noise levels due to night and early morning shoulder operations from the Revised Project are predicted to be within the L_{AFmax} trigger levels for the maximum noise level event screening assessment at all the identified receivers. However, night time $L_{Aeq,15min}$ noise levels during the full and phase-in operations are predicted to exceed the Project's $L_{Aeq,15min}$ trigger levels by 1 dB at R1, R2, R4, R9 and R10. These represent a negligible residual noise impact indiscernible by the average listener according to the *NPfI* and the *VLAMP*. Furthermore, since maximum noise levels are below the relevant RBLs plus 15 dB, it is considered that no noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.
- Operational noise predictions associated with the Revised Project comply with the Project amenity noise levels. Therefore, no consideration of cumulative industrial noise was required.

- Construction of the noise berms would trigger exceedances of the *ICNG* 'noise affected' management level at 11 of the identified representative receivers. These exceedances would only occur for a very short duration and it is expected that noise levels would generally comply with the 'noise affected' management level. Construction noise levels would comply with the *ICNG* 'highly noise affected' management level at all identified receivers. It is recommended that the proponent should inform all noise-sensitive receivers located within 200 m of upcoming berm construction works of the nature of works to be carried out, the expected noise levels and duration, as well as contact details. It is also recommended that attended noise monitoring be conducted at the nearest and potentially most impact residence(s) when construction of noise berms is occurring within 200 m of noise-sensitive receivers.

- The traffic generation of the Revised Project will be similar to the previous traffic generation of the Russell Vale Colliery, when it was operational. With respect to the background traffic volumes on Bellambi Lane, traffic generation from the Revised Project is expected to result in acceptable relative traffic noise increases of no more than 2 dB.

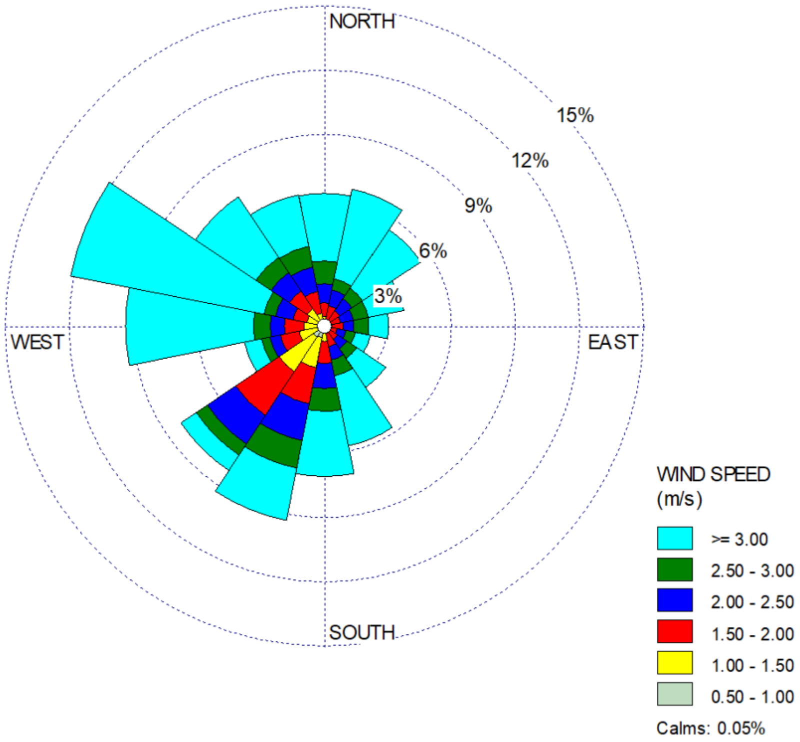
- As demonstrated in Appendices D and E, significantly reduced operational noise levels are predicted with the proposed mitigation measures and site reconfiguration, in comparison with the pre-existing operation of the site and when compared with the recently proposed site arrangement (as detailed in WM report dated 9 October 2014 – Report No 14141 Ver C).

- Appendix F documents the response to the noise issues raised in PAC Second Review report to the Underground Expansion Project at Russell Vale Colliery.

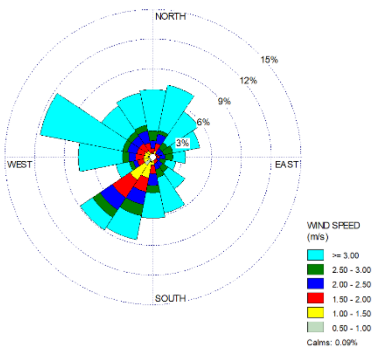
APPENDIX A

WIND ROSES

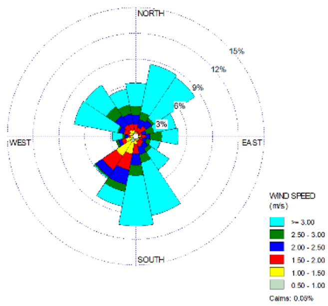
ANNUAL



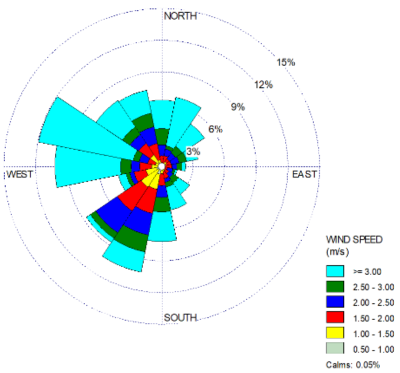
SPRING



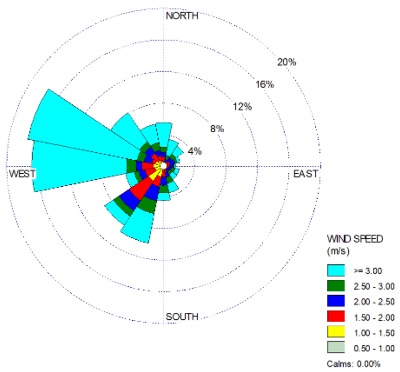
SUMMER



AUTUMN



WINTER



APPENDIX B

NOISE CONTOURS


N
Receivers
Project Noise Trigger Level Applicability Area
44dBA
800 m
600
400
200
0
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario - Day (1/2)
Noise Contour 44dBA of Project Noise Trigger Level
14141-C
A
PT
RH
12/6/2019
A3
WILKINSON MURRAY


N
Receivers
Project Noise Trigger Level Applicability Area
48dBA
800 m
600
400
200
0
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario - Day (2/2) Noise Contour 48dBA of Project Noise Trigger Level
PROJECT No.: 14141-C
REVISION: A
PREPARED: PT
APPROVED: RH
EXPORTED: 12/6/2019
SHEET SIZE: A3
WILKINSON MURRAY


N
Receivers
Project Noise Trigger Level Applicability Area
43dBA
0
200
400
600
800 m
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario - Eve (1/2) Noise Contour 43dBA of Project Noise Trigger Level
PROJECT No.:
14141-C
REVISION:
A
PREPARED:
PT
APPROVED:
RH
EXPORTED:
12/6/2019
SHEET SIZE:
A3
WILKINSON MURRAY


N
Receivers
Project Noise Trigger Level Applicability Area
45dBA
800 m
600
400
200
0
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
Project
Russell Vale Colliery UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario - Eve (2/2) Noise Contour 45dBA of Project Noise Trigger Level
PROJECT No.: 14141-C
REVISION: A
PREPARED: PT
APPROVED: RH
EXPORTED: 12/6/2019
SHEET SIZE: A3
WILKINSON MURRAY

Project
Russell Vale Colliery
UEP Revised Project Noise Assessment

TITLE:
Full Operation Scenario - Night (1/2) Noise Contour 39dBA of Project Noise Trigger Level

PROJECT No.:	REVISION:
14141-C	A
PREPARED:	APPROVED:
PT	RH
EXPORTED:	SHEET SIZE:
12/6/2019	A3

WILKINSON MURRAY

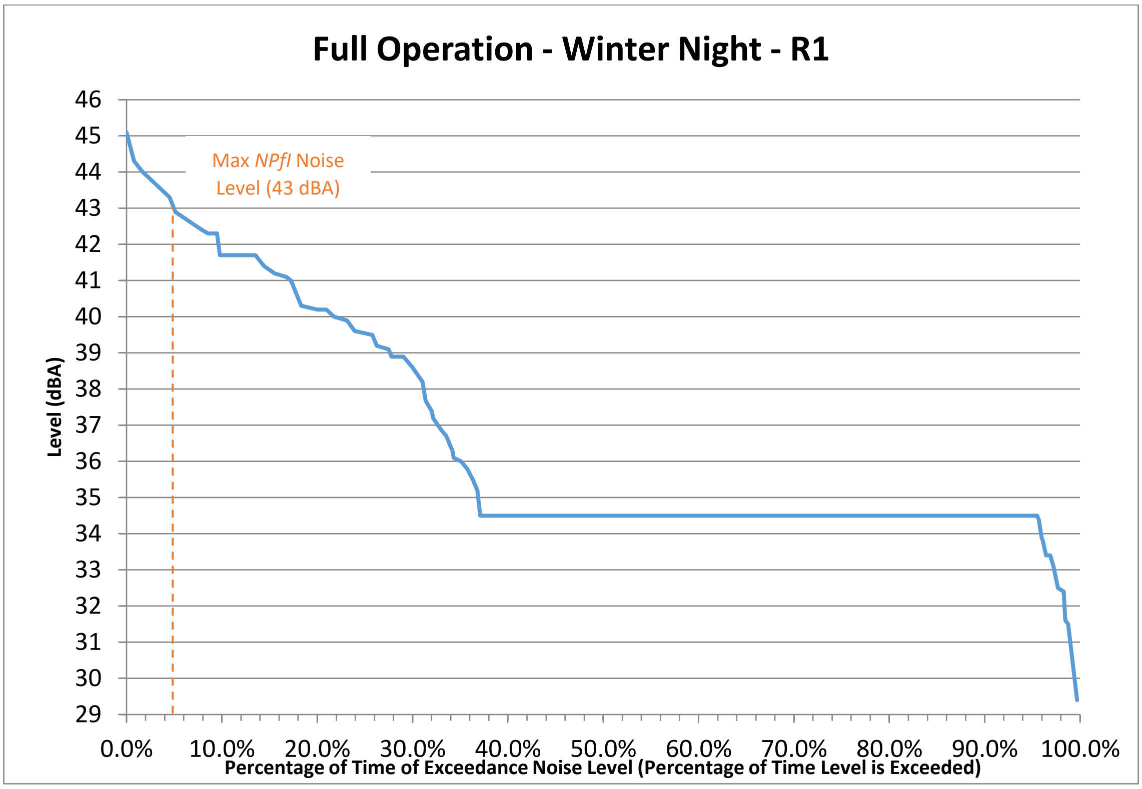

Receivers
Project Noise Trigger Level Applicability Area
42dBA
N
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
800 m
600
400
200
0
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario - Night (2/2)
Noise Contour 42dBA of Project Noise Trigger Level
PROJECT No.:
14141-C
REVISION:
A
PREPARED:
PT
APPROVED:
RH
EXPORTED:
12/6/2019
SHEET SIZE:
A3
WILKINSON MURRAY

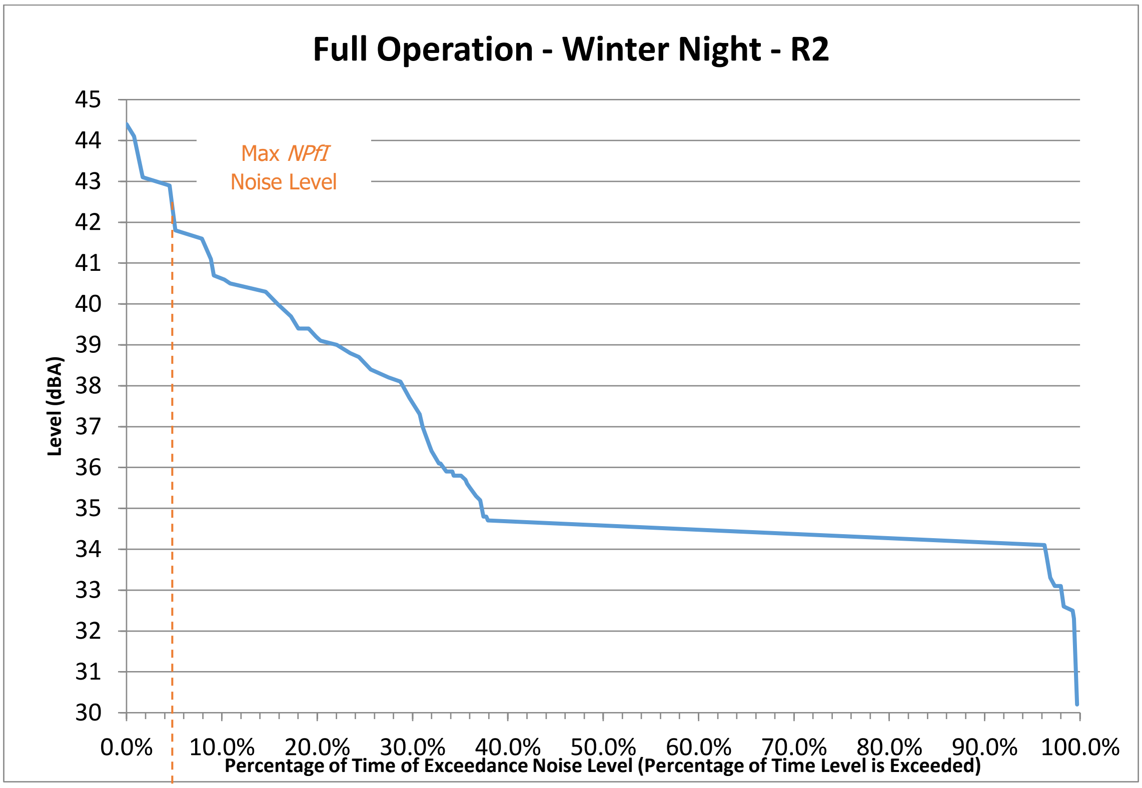

Receivers
Project Noise Trigger Level Applicability Area
41dBA
N
800 m
600
400
200
0
R1
R2
R3
R4
R5
R15
R6
R7
R8
R9
R16
R10
R11
R12
R13
R14
R17
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario
AM Shoulder (1/2)
Noise Contour 41dBA of Project Noise Trigger Level
14141-C
A
PT
RH
12/6/2019
A3
WILKINSON MURRAY

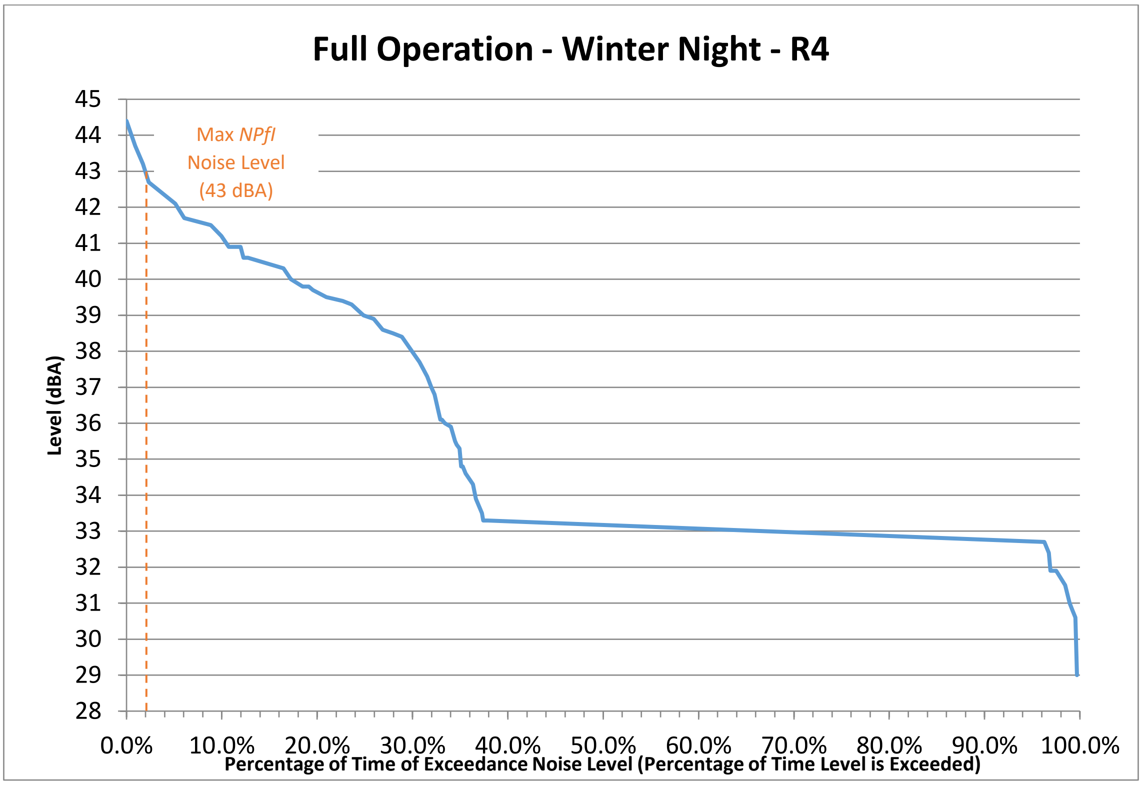

N
Receivers
Project Noise Trigger Level Applicability Area
44dBA
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
800 m
600
400
200
0
Project
Russell Vale Colliery
UEP Revised Project Noise Assessment
TITLE:
Full Operation Scenario
AM Shoulder (2/2)
Noise Contour 44dBA of Project Noise Trigger Level
14141-C
A
PT
RH
12/6/2019
A3
WILKINSON MURRAY

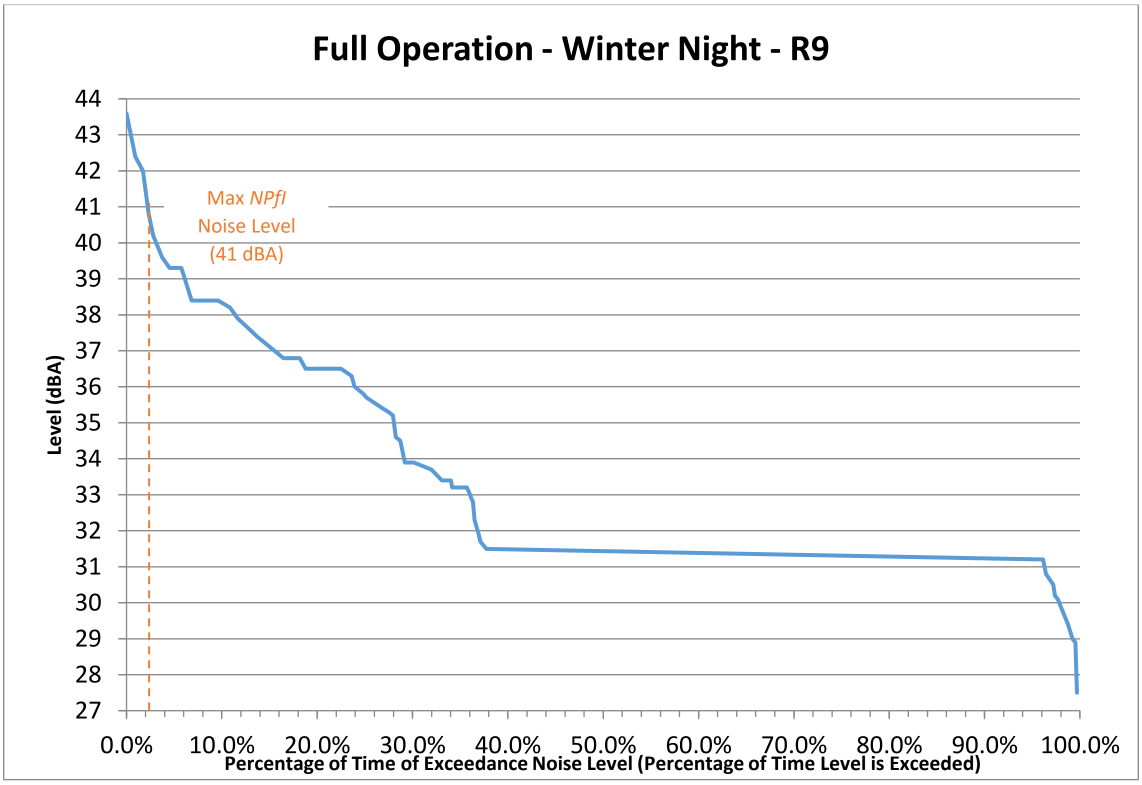
APPENDIX C

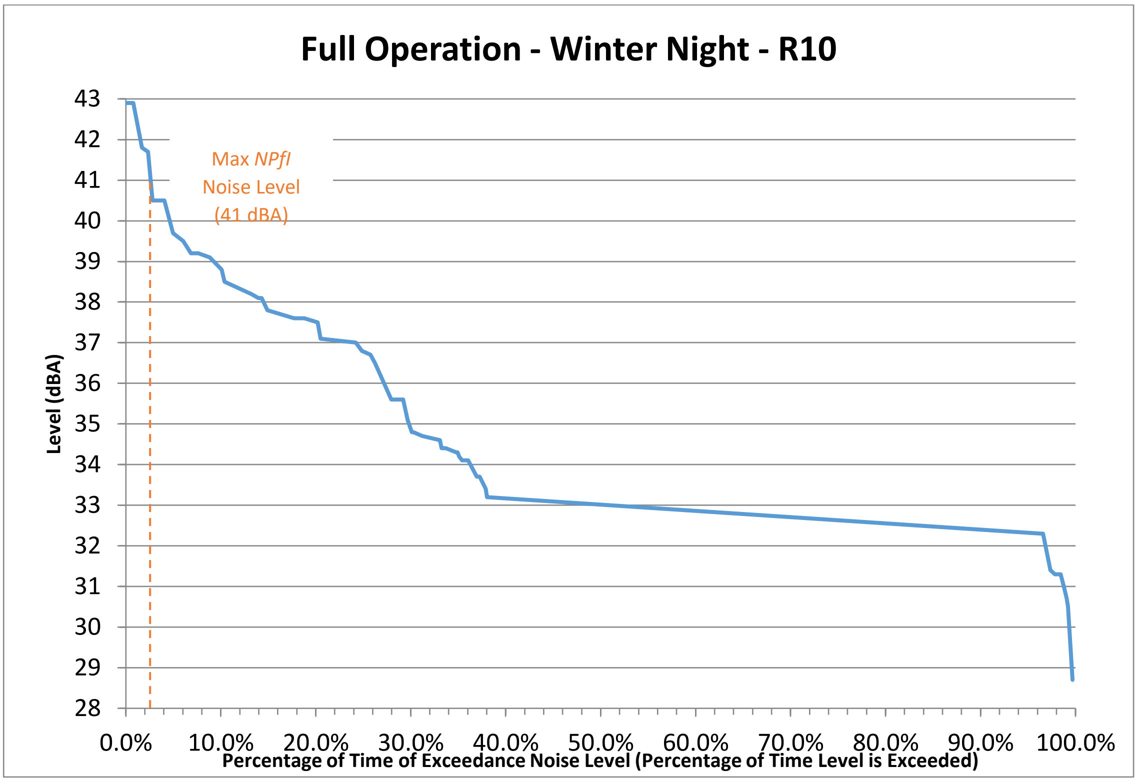
CUMULATIVE FREQUENCY OF OCCURRENCE NOISE GRAPHS


Full Operation - Winter Night - R1
Max NPfI Noise Level (43 dBA)
Level (dBA)
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage of Time of Exceedance Noise Level (Percentage of Time Level is Exceeded)


Full Operation - Winter Night - R2
Max NPfI Noise Level
Level (dBA)
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage of Time of Exceedance Noise Level (Percentage of Time Level is Exceeded)


Full Operation - Winter Night - R4
Max NPfI
Noise Level
(43 dBA)
Level (dBA)
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
0.0% 10.0% 20.0% 30.0% 40.0% 50.0% 60.0% 70.0% 80.0% 90.0% 100.0%
Percentage of Time of Exceedance Noise Level (Percentage of Time Level is Exceeded)


Full Operation - Winter Night - R9
Max NPfI
Noise Level
(41 dBA)
Level (dBA)
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
0.0% 10.0% 20.0% 30.0% 40.0% 50.0% 60.0% 70.0% 80.0% 90.0% 100.0%
Percentage of Time of Exceedance Noise Level (Percentage of Time Level is Exceeded)


Full Operation - Winter Night - R10
Max *NPfI* Noise Level (41 dBA)
Level (dBA)
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage of Time of Exceedance Noise Level (Percentage of Time Level is Exceeded)

APPENDIX D

COMPARISON WITH NOISE PREDICTIONS FROM PREVIOUS ASSESSMENTS

D.1 Comparison of Revised Project Noise Levels against Previous UEP Predicted Noise Levels

Tables D-1 and D-2 compare the predicted Revised Project noise levels for the full operation with those predicted by the previous UEP assessment (UEP Project Year 4 with all upgrades in place), as detailed in the WM report dated 9 October 2014 (Report No 14141 Ver C), for neutral and adverse conditions respectively.

The previous UEP assessment was prepared in accordance with the now superseded *Industrial Noise Policy* and presented predictions expressed as 10th percentile exceedance noise levels or P10 noise levels (i.e. the level that is exceeded 10% of the time), and levels under calm isothermal conditions. As such, noise predictions associated with the Revised Project in Tables D-1 and D-2 are expressed in terms of levels under 'Calm' and 'P10' meteorological conditions to allow for accurate comparison of noise emissions between the Revised Project and the previous UEP assessment.

Predictions during the early morning shoulder period were not included in the comparison since the previous UEP assessment did not consider early morning shoulder period activities. Similarly, schools were not included in Tables D-1 and D-2 as they were not addressed in the UEP assessment.

Whilst some residual exceedances are noted with the previous UEP assessment, the main observations to be made from Tables D-1 and D-2 are the appreciable reductions in predicted noise levels under the Revised Project, compared with the UEP assessment. Under calm meteorological conditions, reductions are found to range 1-9 dB, 2-11 dB, and 1-11 dB for the day, evening and night periods, respectively. Under P10 conditions, reductions range 0-9 dB, 4-10 dB, and 1-9 dB for the day, evening and night periods, respectively. These reductions are noted to be considerable.

Table D-1 Russell Vale – Predicted $L_{Aeq,15min}$ Noise Levels – Revised Project Compared with Previous UEP Modification Predictions – Considering Calm Isothermal Conditions

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)								
	Day			Evening			Night		
	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL
	Calm	Calm		Calm	Calm		Calm	Calm	
R1	**48**	41	44	**48**	38	43	40-**44**	35	42
R2	**51**	42	44	**51**	40	43	42-**46**	35	42
R3	**50**	42	44	**50**	40	43	41-**45**	34	42
R4	**46-47**	40	44	**46-47**	38	43	38-42	33	42
R5	**47**	44	48	**47**	42	45	35-38	33	42
R6	46-47	43	48	**46-47**	41	45	36-39	34	42
R7	41-42	40	48	41-42	39	45	35-38	31	42
R8	42-44	40	48	42-44	39	45	37-41	33	42
R9	41-44	37	44	41-43	36	43	38-**42**	32	39

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)								
	Day			Evening			Night		
	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL
	Calm	Calm		Calm	Calm		Calm	Calm	
R10	38-40	37	44	38-40	35	43	36-39	33	39
R11	37-38	36	44	37-38	34	43	34-36	33	39
R12	39-41	37	44	39-41	35	43	36-39	34	39
R13	41-42	39	44	41	37	43	37-39	36	39
R14	40-42	37	44	39-41	35	43	37-**40**	35	39

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 7.00am for the UEP Modification noise predictions, and the period from 10.00pm to 5.00am for the Revised Project.

Table D-2 Russell Vale – Predicted $L_{Aeq,15min}$ Noise Levels – Revised Project Compared with Previous UEP Modification Predictions – Considering Adverse Meteorological Conditions

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)								
	Day			Evening			Night		
	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL	UEP Mod (WM 2014)	Revised Project	PNTL
	P10	P10		P10	P10		P10	P10	
R1	**50-51**	44	44	**52**	**44**	43	**43-46**	42	42
R2	**52-53**	44	44	**54**	**44**	43	**44-48**	41	42
R3	**52**	44	44	**53-54**	**44**	43	**44-47**	41	42
R4	**49**	44	44	**53**	43	43	**43-46**	41	42
R5	**49-50**	45	48	**52**	45	45	41-**44**	39	42
R6	48-**49**	47	48	**54**	45	45	41-**44**	40	42
R7	43-44	43	48	**49**	45	45	42-**44**	39	42
R8	44-46	42	48	**48-49**	44	45	**43-46**	40	42
R9	43-**45**	39	44	**46-48**	40	43	**43-47**	38	39
R10	40-42	39	44	**44-47**	40	43	**43-46**	39	39
R11	38-39	37	44	41-42	37	43	39-**40**	36	39
R12	40-42	38	44	42-**44**	37	43	39-**42**	36	39
R13	42	40	44	43-**44**	39	43	39-**40**	38	39
R14	42-44	39	44	**44-46**	39	43	**40-43**	38	39

Notes:
Day: the period from 7.00am to 6.00pm.
Evening: the period from 6.00pm to 10.00pm.
Night: the period from 10.00pm to 7.00am for the UEP Modification noise predictions, and the period from 10.00pm to 5.00am for the Revised Project.

APPENDIX E

HISTORICAL NOISE LEVELS AT RUSSELL VALE COLLIERY

A review of previously measured noise levels provides an understanding of how noise emissions associated with the Russell Vale Colliery have evolved throughout the years.

Section 7.4 of WM's 2014 assessment (Report No 14141 Ver C) provides a detailed discussion of historical noise levels at Russell Vale Colliery and provides a review of past monitoring reports prepared between 1980 and 1991. This offers some understanding of the Site's noise impact on the surrounding community during the time of the operation of the old washery, which was in use until 2002. In summary, night time noise levels during the time of the washery were measured at:

- 56 dBA at R1;
- 52-59 dBA at R2;
- 48 dBA at R4; and
- low 40's-47 dBA at R12.

Pacific Environment (PE) has undertaken a number of attended noise monitoring surveys between 2012 and the time the site switched to care and maintenance in 2015. Measurements conducted along West Street and Broker Street on the northern side of the site and along Midgley Street and Lyndon Street on the southern side correspond best with the representative receivers addressed in the assessment.

Comparison between the PE measurement results (2012-2015) and the noise predictions presented in this assessment (full operation) is summarised in Table E-1. The comparison focuses on night time noise levels and is based on monitoring locations corresponding to receivers R2, R3, R5, R9, R12 and R13. Project noise trigger levels, as discussed in Section 5.0, are shown in yellow shading.

Table E-1 Comparison of Historical Measured Levels (2012-2015) & Revised Project Noise Predictions

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)							
	PE Measurement Results						Revised Project Night Prediction	Night Time PNTL
	Nov 12	Jun 13	Mar 14	Jul 14	Dec 14	May 15		
R2	44	43-45	<39	36-37	41	43-44	43	42
R3	44	39-40	<38	37-38	40	42	42	42
R5	38	34-37	36	33	<30	<37	41	42
R9	35	33-35	<37	35-38	33	39	41	39
R12	38	37-38	<38	39-40	39	40-41	37	39
R13	38	40-41	<37	39-40	38	37-38	38	39

Measured noise levels captured during the operation of the old washery and between 2012 and 2015 show how the various site designs and mitigation measures have reduced noise emissions throughout the years. Measured noise levels on the northern side (R2) were reportedly once up to 16 dB higher than the predictions associated with the Revised Project. Similarly, measured levels on the southern side (R12) were up to 10 dB higher.

The upper end of the range of levels measured during the 2012-2015 period should be used for comparison with predictions associated with the Revised Project, as the latter represent noise emissions for full operation under noise-enhancing conditions. Levels were found to have decreased by 2 to 4 dB at receivers R2, R3, R12 and R13. Measurement results for R5 and R9 show lower levels than the Revised Project's noise predictions. Due to access restrictions, measurements at those two locations seem to have been carried out on the road behind the house (i.e. Broker Street for R5 and Midgley Street for R9), thus benefiting from some level of shielding provided by the row of houses directly adjacent to the Site.

APPENDIX F

RESPONSES TO PAC SECOND REVIEW REPORT COMMENTS

The Commission summarises its findings, as they do relate to the previous Russell Vale Colliery noise assessments, in Section 4.5.5 of its Second Review Report, as follows:

> **4.5.5 Commission's Findings**
>
> The Commission finds:
>
> 1. The Department's adoption of the modelled noise levels as existing noise levels is not reasonable or sufficiently justified.
> 2. The setting of benchmarks should have regard to the 2011 approved noise limits, the 2012 noise audit results and the *Industrial Noise Policy*.
> 3. If the PSNLs are accepted as the benchmark for assessment of impact, the proposed project would have significant residual noise impact on certain nearby residences, notwithstanding the already implemented and proposed on site mitigation measures.
> 4. The draft recommended noise criteria for the identified receivers are not reasonable, particularly the criteria for "all other privately-owned land" especially to those who are neighbours to the identified receivers.
>
> The Commission notes the advice from the EPA that the Industrial Noise Policy that where acceptable noise levels cannot be achieved with reasonable and feasible measures then the determining authority should consider the impacts against the social and economic benefits of the project. The Commission addresses this balance in its conclusions for this Review.

In its concluding comments relating to noise in Section 5 of its report, the Commission notes the following:

> The operational noise from the pit top site would have significant impact on nearby residences if the noise criteria derived from the *Industrial Noise Policy* is used for assessment instead of the modelled existing noise levels. Similarly, the traffic noise impact on residences along Bellambi Lane is likely to be higher than assessed if actual existing truck movements were used as a base for the assessment. As a result of under-assessment of the level of impacts, it is likely that extra mitigation measures including mitigation on private residences are required to reduce the noise impact to acceptable level.

The following sections aim to address the above PAC comments.

F.1 Response to PAC Comment 4.5.5.1

This assessment has considered background noise levels measured in 2014 and 2016 as the basis of assessment.

F.2 Response to PAC Comment 4.5.5.2

In relation to PAC comment 4.5.5.2, WM maintains its position that the 2011 approved noise limits are inappropriate as they are the outcome of a flawed assessment approach, that was not undertaken in full accordance with the *NSW Industrial Noise Policy*.

As previously reported to the PAC, WM has found a general inconsistency with the approved limits, the PSNLs (determined by the ERM 2010 assessment) and the predicted noise levels (determined by the ERM 2010 assessment). It has been noted that the limits developed from the predicted levels are based on "under-predictions" that seemingly did not incorporate the appropriate meteorological conditions and sound power levels. Additionally, based on these under-predicted levels some of the approved limits are lower than the determined PSNLs.

Due to these inconsistencies, it is considered appropriate that the approved limits are reconsidered based on the findings of the Revised Project noise assessment.

As previously noted, the 2012 audit results indicated that the Site complied with its limits during the brief period of the audit. Whilst this may provide a benchmark in terms of the site's compliance status for the period of the audit, WM considers that due to the temporal variations in site noise emissions, the most appropriate assessment would consider the site emissions at full capacity and under relevant meteorological conditions.

WM considers the provisions of the *NPfI* are appropriate in the setting of noise criteria. The Revised Project noise assessment has drawn on long-term background noise monitoring data collected on-site over the full 2016 year and over a 12-day period in June 2014, whilst the site was not operational. It is considered that this long-term site-specific data provides the best estimation of the background noise environment around the site and new Project noise trigger levels have been re-evaluated on this basis.

F.3 Response to PAC Comment 4.5.5.3

The Revised Project noise assessment has re-evaluated impacts, with consideration of a significant site reconfiguration, substantial changes to operational processes and the adoption of extensive noise mitigation measures as detailed in Table 6-4 of this report. Additionally, Project noise trigger levels have been re-evaluated based on long-term site-specific background noise data, collected on-site over the full 2016 year and over a 12-day period in June 2014, whilst the site was not operational. It is considered that this long-term data provides the best estimation of the background noise environment around the site and new Project noise trigger levels are justified on this basis.

With these proposed changes, significantly reduced operational noise levels are predicted, in comparison with the pre-existing operation of the site and when compared with the recently proposed site arrangement (as detailed in WM report dated 9 October 2014 – Report No 14141 Ver C).

Despite the implementation of feasible and reasonable mitigation, some residual exceedances of the operational criteria are predicted to remain:

- Night time noise levels during phase-in and full operations are predicted to exceed the Project noise trigger levels by up to 1 dB at representative receivers R1, R2 and R3 and by up to 2 dB at representative receivers R9 and R10.

It should be noted that the extent of these exceedances is significantly less than previously assessed by WM, indicating a marked environmental noise reduction (i.e. according to the UEP assessment, residual noise impact with upgrades in place would have ranged up to 11 dB, 13 dB and 9 dB during the day, evening and night periods, respectively). Additionally, whilst some residual exceedances are predicted, they are considered negligible and indiscernible by the average listener. No noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.

F.4 Response to PAC Comment 4.5.5.4

As noted in Section 3.0 of this report and consistent with WM's 2014 assessment, the sensitive receivers considered by this assessment (as identified in Table 3-1) are deemed representative of the potentially most impacted receivers surrounding the Site.

Noise catchment areas have been identified (Figure 4-1) to represent areas of similar background noise levels. As illustrated in the noise contour figures (Appendix B), those noise catchment areas are in turn used to define Project noise trigger level applicability areas. All receivers located within the same Project noise trigger level applicability area are subject to the same Project noise trigger levels.

F.5 Response to PACs Concluding Comments

With respect to the above PAC comments, WM notes that the proposed Revised Project has been developed by WCL to address the noise issues raised.

The extent of the exceedances identified by this assessment is significantly less than previously assessed by WM (2014), indicating a marked improvement (i.e. according to the UEP assessment, residual noise impact with upgrades in place would have ranged up to 11 dB, 13 dB and 9 dB during the day, evening and night periods, respectively). Additionally, whilst some residual exceedances are predicted, they are considered negligible and indiscernible by the average listener. No noise impact due to maximum noise level events from the Revised Project is expected at any of the noise-sensitive receivers surrounding the site.

WCL's commitment to continue to undertake real-time noise monitoring would allow for evaluation of its compliance with the proposed Project noise trigger levels and consideration of remedial action in the case of any material exceedances.

The traffic generation from the Revised Project will be similar to the previous traffic generation of the Russell Vale Colliery, when it was operational. With respect to the existing traffic volumes on Bellambi Lane, traffic generation from the Revised Project is expected to result in acceptable relative traffic noise increases, of no more than 2 dB.

APPENDIX 6

Air Quality Assessment

Russell Vale Colliery Underground Extension

Air Quality Assessment

12 July 2019

Project No.: 0481296

The business of sustainability

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12 July 2019

Russell Vale Colliery Underground Extension

Air Quality Assessment

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1. INTRODUCTION

Wollongong Coal Limited (WCL) is proposing a revised mine plan and revised surface facilities for the Russell Vale Underground Expansion Project (UEP), referred to as the Revised Preferred Project. The revised UEP surface facilities include a new coal processing plant and new truck loading bin and revised operating practices. The revised mine plan also results in lower production rates relative to earlier UEP mine plan proposals. The primary aspects in terms of potential air quality impacts will be particulate matter (PM) emissions due to the surface facilities. Umwelt (on behalf of WCL) has commissioned ERM Australia Pacific (ERM) to prepare a particulate emission inventory and undertake a modelling assessment to evaluate these impacts.

2. PROJECT DESCRIPTION

The key elements of the Revised Preferred Project are:

- Mining by means of first working mining techniques only with the workings designed to be long term stable with minimal subsidence impacts;
- Extraction of approximately 3.7 million tonnes (Mt) of Run-of-Mine (ROM) coal at a reduced production rate of up to 1 million tonnes of product coal per year (equivalent to approximately 1.2 million tonnes of ROM coal per year);
- Construction and use of a coal processing plant to improve the quality of product coal;
- Redesign of the Pit Top layout to relocate infrastructure to more shielded locations to reduce amenity impacts;
- Operation of surface facilities and product transport typically limited to daytime hours (7.00am to 6.00pm Mondays to Friday, 8.00am to 6.00pm Saturday, no Sundays and Public Holidays); with provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions;
- Reduced product trucking rates relative to the previous UEP mine plan; and
- Extension to the height of existing bunds within the surface infrastructure area for improved noise mitigation.

The following provides a description of the proposed surface operations with the existing and new infrastructure identified in Figure 2.1. It is noted all surface conveyors described will be enclosed.

2.1 Construction and Phase-In Operations

The construction of the new Processing Plant and associated infrastructure will occur over a 12 to 24 month period. During this period, mining operations will be phased in with up to 500,000 tonnes per annum of ROM coal transported from the underground workings for sale as a ROM product. ROM coal will be transported via the existing underground conveyor system to the primary sizer building where it will be crushed. The ROM coal is then fed onto the ROM coal stockpile via the existing conveyor and tripper arrangement. A front end loader will load ROM coal onto trucks to be transported off site to Port Kembla.

The extension to the height of existing bunds shown in Figure 2.1 will also occur during the 12 to 24 month construction and phase-in period. The extension to Bund 1 will be completed prior to phase-in operations commencing in order to minimise the amenity impacts associated with construction and phase-in operations (i.e. ROM coal production). The construction of the remaining bunds shown on Figure 2.1 will be completed within 12 months of commencing phase-in operations.

2.2 Full Operations

Once the new Processing Plant and associated infrastructure is fully operational, ROM coal processing will commence. At full operation, up to 1.2 million tonnes per annum (Mtpa) ROM coal will be transported from the underground workings via the existing underground conveyor system for up to five years. ROM coal is fed from the ROM stockpile into an existing underground coal reclaim using a dozer, then conveyed to the new screening and sizing station where oversize material is removed. From the screening and sizing station, coal will be transferred by a new conveyor to a new surge bin and Processing Plant where rock material will be removed via a heavy media cyclone. Product coal will then be transferred to a new truck loading bin via a new clean coal conveyor from where it will be either loaded onto road trucks for transportation to Port Kembla Coal Terminal or transferred to the emergency clean coal stockpile area for temporary stockpiling. Coal will be loaded from the emergency clean coal stockpile onto road trucks by front end loader. It is anticipated that the contingency stockpile will be required infrequently when direct haulage to the Port is not available due to logistical issues outside the control of WCL, e.g. during periods when the Port is closed or there are restrictions on transferring coal to the stockpiles at the Port.

Rocky material that is separated by the Processing Plant will be transferred to a rejects stockpile by a separate rejects conveyor from where it will be either loaded onto road trucks to be sold as inert fill material, or will be transferred to the mine portal and emplaced underground. This is anticipated to make up approximately 200,000 t of the 1.2 Mtpa ROM throughput.

ROM coal may also continue to be transferred from the site as a ROM coal product as described for the construction and phasing in period above.

The Russell Vale operations are relatively close to a number of sensitive receptors. Figure 2.1 shows the existing site and the nearest sensitive receptors. The current particulate monitoring sites (TEOM1 and TEOM2) are also shown.

Figure 2.1 Existing site, proposed layout and dust monitoring sites

3. AIR QUALITY ASSESSMENT CRITERIA

The Approved Methods specifies air quality assessment criteria relevant for assessing impacts from air pollution (NSW EPA, 2016). These criteria are health-based (i.e. they are set at levels to protect against health effects) and for PM_{10} and $PM_{2.5}$ are consistent with the revised National Environment Protection Measure for Ambient Air Quality (referred to as the Ambient Air-NEPM). Table 3.1 presents the air quality criteria for concentrations of particulate matter that that are relevant to this study.

Table 3.1 NSW EPA impact assessment criteria for particulate matter concentrations

Pollutant	Criterion	Averaging period	Source
PM_{10}	50 µg/m³ 25 µg/m³	24-Hour Annual	NSW EPA (2016)
$PM_{2.5}$	25 µg/m³ 8 µg/m³	24-Hour Annual	NSW EPA (2016)

Note: µg/m³ – micrograms per cubic metre

In addition to health impacts, airborne dust also has the potential to cause nuisance dust effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fall out relatively close to the source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts. Table 3.2 shows the maximum acceptable increase in deposited dust levels over the existing dust levels and the maximum total deposited dust level. These criteria for deposited dust levels are set to protect against nuisance impacts (NSW EPA, 2016).

Table 3.2: NSW EPA impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase (due to project)	Maximum total level (cumulative)
Deposited dust (insoluble solids)	Annual average	2 g/m²/month	4 g/m²/month

4. EXISTING ENVIRONMENT

4.1 Local meteorology

Local meteorological conditions are measured by an Automated Weather Station (AWS) at the Russell Vale Colliery (see Figure 2.1) and the 2016 data have been used for modelling purposes. Figure 4.1 shows the annual and seasonal wind roses for 2016.

On an annual basis, winds are predominantly from the western and southern quadrants, with those from the west significantly stronger. The majority of these occur in winter. The highest hourly average wind speed for the year was 14.7 m/s, with an annual average of 3.3 m/s.

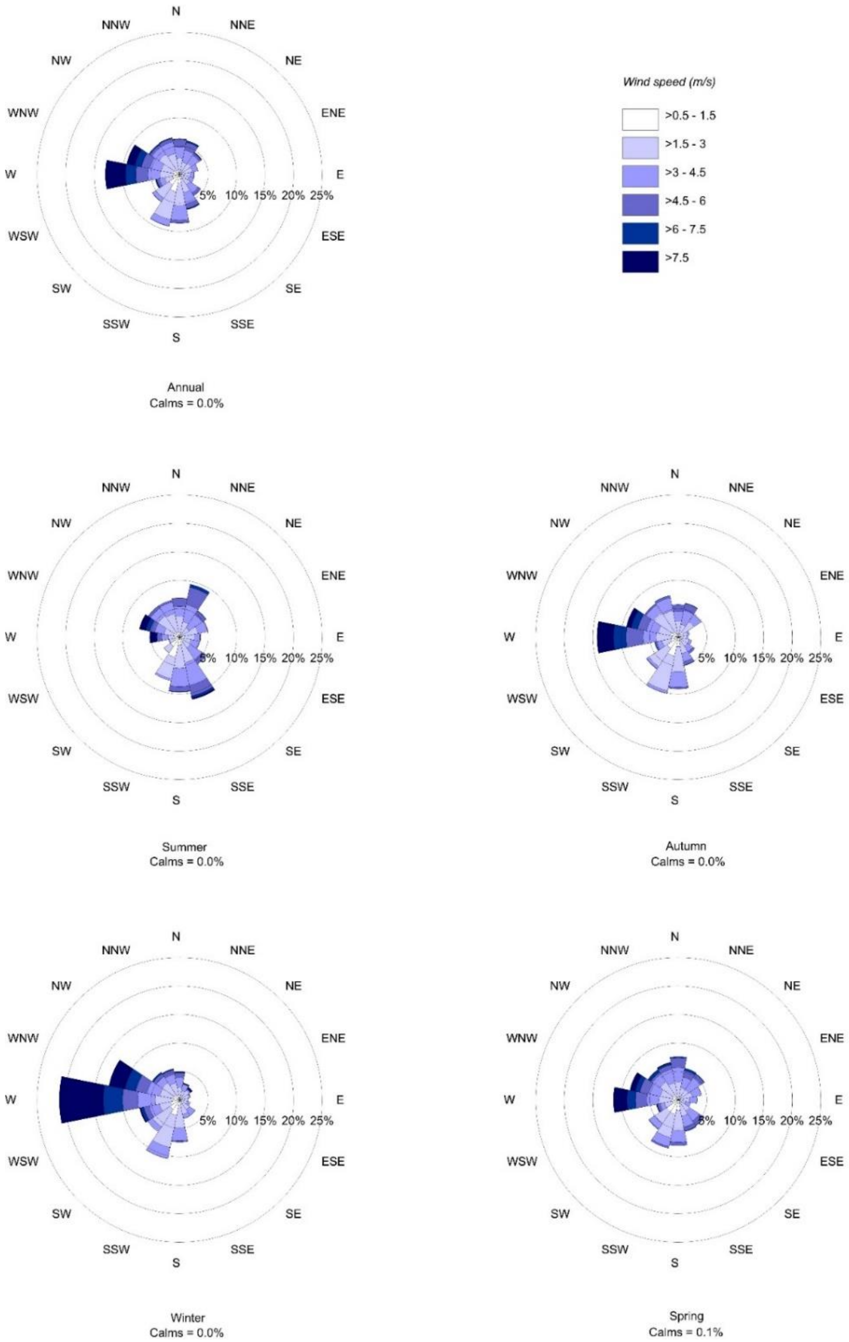


Figure 4.1: Annual and seasonal wind roses for Russell Vale – 2016

4.2 Air quality monitoring

WCL maintains two TEOM monitors at their northern and southern boundaries (see Figure 2.1) that continuously monitor PM_{10} and $PM_{2.5}$ concentrations. One of the most recent years of data (2016), which corresponds to the modelling year, is shown in Figure 4.2 for PM_{10} and Figure 4.3 for $PM_{2.5}$. There were no exceedances of 24 hour PM_{10} criteria during 2016. 24-hour average concentrations for $PM_{2.5}$ exceeded the assessment criteria on two occasions (two exceedances at each TEOM on the same days). These exceedances both occurred during May when there was a significant hazard reduction burning event within the region.

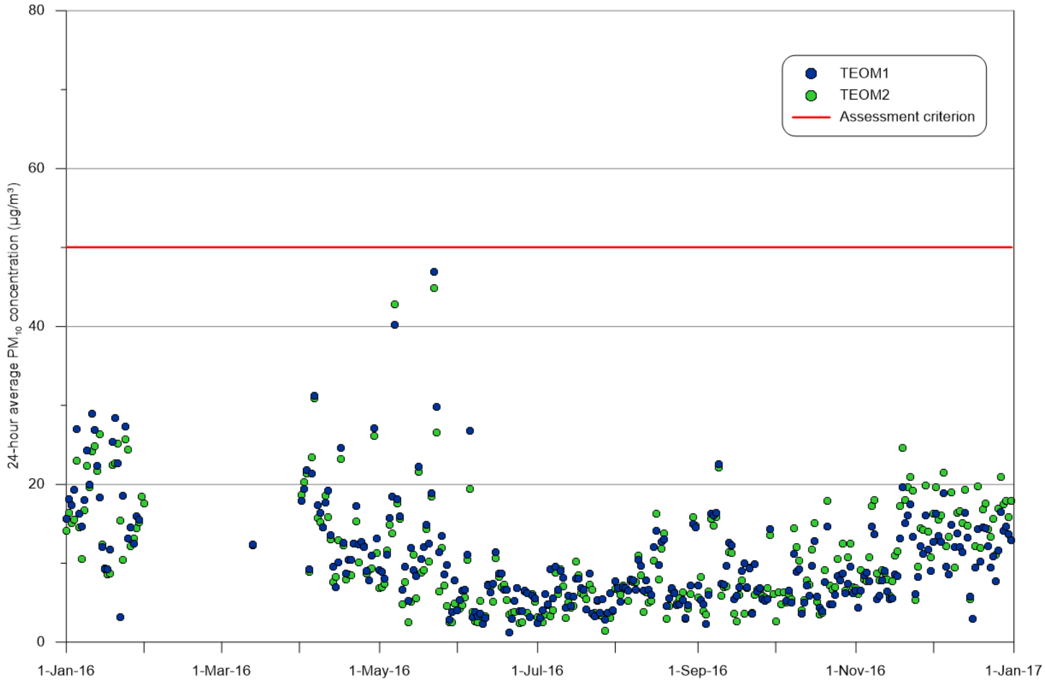


Figure 4.2: 24-hour average PM_{10} concentrations at TEOM1 and TEOM2

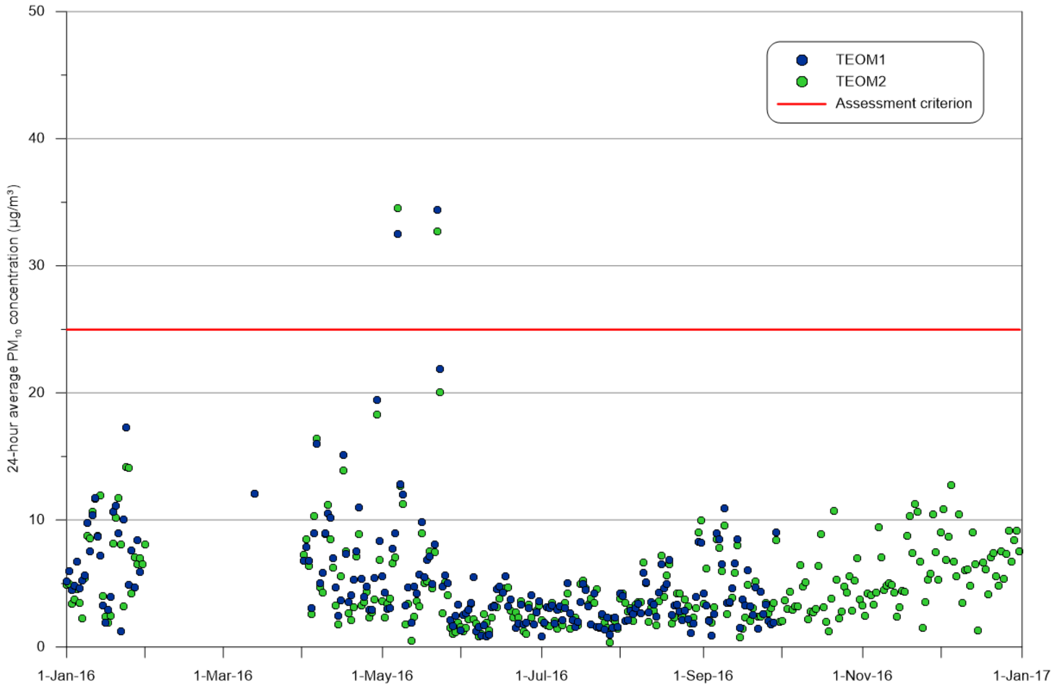


Figure 4.3: 24-hour average $PM_{2.5}$ concentrations at TEOM1 and TEOM2

The PM_{10} and $PM_{2.5}$ data collected by WCL at TEOM2 has been used to provide a conservative evaluation of background concentrations for the cumulative assessment. The assumed background levels are conservative because the contributions from existing operations will already be captured to some extent in the 2016 monitoring data. The Russell Vale Colliery was in care and maintenance during 2016 therefore contributions from existing operations relate primarily to emissions from exposed areas around the surface infrastructure site (as shown in Figure 2.1) and Russell Vale Emplacement Area to the north.

The 24-hour background levels for PM_{10} and $PM_{2.5}$ are also conservative as they have adopted the 95th percentile measured values. As can be seen from Figure 4.2 and Figure 4.3, the vast majority of measured levels fall well below the adopted background levels. TEOM2 data was used for background concentrations because, for predominant wind directions, this monitor is located upwind of the major particulate matter sources at the mine, in close proximity to sensitive residential receptors.

For the purposes of estimating background concentrations of PM_{10} and $PM_{2.5}$, the following has been assumed:

- 24-hour average PM_{10} concentration equivalent to the 95th percentile 24-hour average values collected at TEOM2 during 2016 (22.6 µg/m^3)
- Annual average PM_{10} concentration at TEOM2 during 2016 (10.7 µg/m^3)
- 24-hour average $PM_{2.5}$ concentration equivalent to the 95th percentile 24-hour average values collected at TEOM2 during 2016 (11.2 µg/m^3)
- Annual average $PM_{2.5}$ concentration at TEOM2 during 2016 (5.0 µg/m^3)

Values for 2016 were used as this aligns with the meteorological data used for modelling purposes.

5. EMISSIONS TO AIR

Two emission scenarios were considered in the air quality impact assessment, as described below:

- **Scenario 1** considered the construction and phasing in period for the new processing plant described in Section 2. This scenario included emissions from the activities where ROM coal is delivered to the ROM stockpile at a rate of up to 500,000 tpa, then loaded to trucks and transported off site without processing. Also included are construction related emissions associated with construction of new processing plant and noise bunds around the Pit Top.
- **Scenario 2** considered full operation and included emissions generated when the new processing plant and associated infrastructure is fully operational. While construction of noise bunds is likely to be completed prior to the commencement of full operation, it has been conservatively assumed that construction of noise berms is continuing during Scenario 2. This scenario is indicative of emissions at the full production rate of up to 1 Mtpa of product coal.

The assumptions made for calculating the annual emissions from both scenarios are listed in Table 5.1.

Table 5.1: Summary of key assumptions for Scenario 1 and 2

	Scenario 1	Scenario 2
ROM throughput (t/y)	500,000	1,200,000
Product coal (t/y)	500,000	1,000,000
Rejects (t/y)	-	200,000
Dozer hours (h/day)	1	2
Mitigation / control measure	**Control factor**	
Operations in enclosed areas	99%	
Moisten dozer travel routes	50%	
Water carts on unsealed haul routes	75%	
Water sprays during construction activities	50%	

The main sources of particulate emissions in Scenario 1 are FEL loading to trucks, wind erosion and haulage (of ROM coal material). Haul roads will be watered twice per day to control dust from both spillage and vehicle movement. There are a number of other minor emission sources and these are all listed in Table 5.2 with the estimated annual total PM_{10} and $PM_{2.5}$ emissions.

Table 5.2: Estimated annual emissions from the proposed operations (Scenario 1)

Activity	$PM_{2.5}$ (kg/y)	PM_{10} (kg/y)
ROM – transfer to primary sizer building	0.3	2
ROM – crushing in the primary sizer building	6	6
ROM – transfer to ROM stockpile area	25	168
ROM – dozers on ROM stockpile	67	645
FEL loading ROM coal to trucks	348	2,814
ROM coal-haulage off site (unsealed road)	94	936
FELs loading berm material to trucks	139	1,125
Haulage to berms for construction	37	374
Dumping material to berms	3	21
Dozers pushing material	46	409
Construction of new infrastructure	1	13
Wind erosion - ROM stockpile area	105	701
Wind erosion - inactive areas	66	438
Total	**937**	**7,651**

Annual emissions for scenario 2 were developed assuming full operational scenario of the new processing plant. The key sources of emission are likely to be haulage on/off site and transfer of coal to trucks. Table 5.3 lists all the possible emission generating activities and estimated emissions for PM_{10} and $PM_{2.5}$.

Table 5.3: Estimated annual emissions from the proposed operations (Scenario 2)

Activity	$PM_{2.5}$ (kg/y)	PM_{10} (kg/y)
ROM - transfer to primary sizer building	1	4
ROM - crushing in primary sizer building	14	14
ROM – transfer to ROM stockpile area	61	404
ROM – dozers on ROM stockpile area	133	1,289
ROM - transfer to secondary sizer building	1	4
ROM - crushing in secondary sizer building	14	14
ROM - transfer to surge bin	1	4
ROM - transfer to processing plant	7	7
Clean coal - transfer to trucks for loadout	22	146
Clean coal - haulage off site (unsealed road)	187	1,872
Clean coal - transfer to emergency stockpile	2	14
Clean coal - loading from emergency stockpile with FEL	35	281
Rejects - transfer to reject stockpile	3	21
Rejects - FELs loading to trucks	139	1,125
Rejects - haulage to berms for construction	125	1,248
Rejects - dumping to berms	3	21
Rejects - dozers pushing material	92	817
Wind erosion - ROM stockpile area	105	701
Wind erosion - Clean coal stockpile area	33	219
Wind erosion - inactive areas	66	438
Total	**1,043**	**8,645**

Each activity was modelled as a volume source at its appropriate location. Predictions were made at each sensitive receptor, shown in Figure 2.1, using the modelling package AERMET / AERMOD. Predictions were also made across a grid which covered a wider area of approximately 2 km x 2 km.

6. IMPACT ASSESSMENT

A summary of the predicted maximum 24-hour average and Annual Average PM_{10} and $PM_{2.5}$ concentration and deposition levels due to the proposed operations combined with the estimated background levels (as per Section 4.2) is presented in Table 6.1 and Table 6.2. The incremental increase in dust deposition due to the proposed operations is also shown, as it has an incremental criterion (Table 3.2). The contour plots across the modelling domain are presented in Figure 6.1 to Figure 6.12.

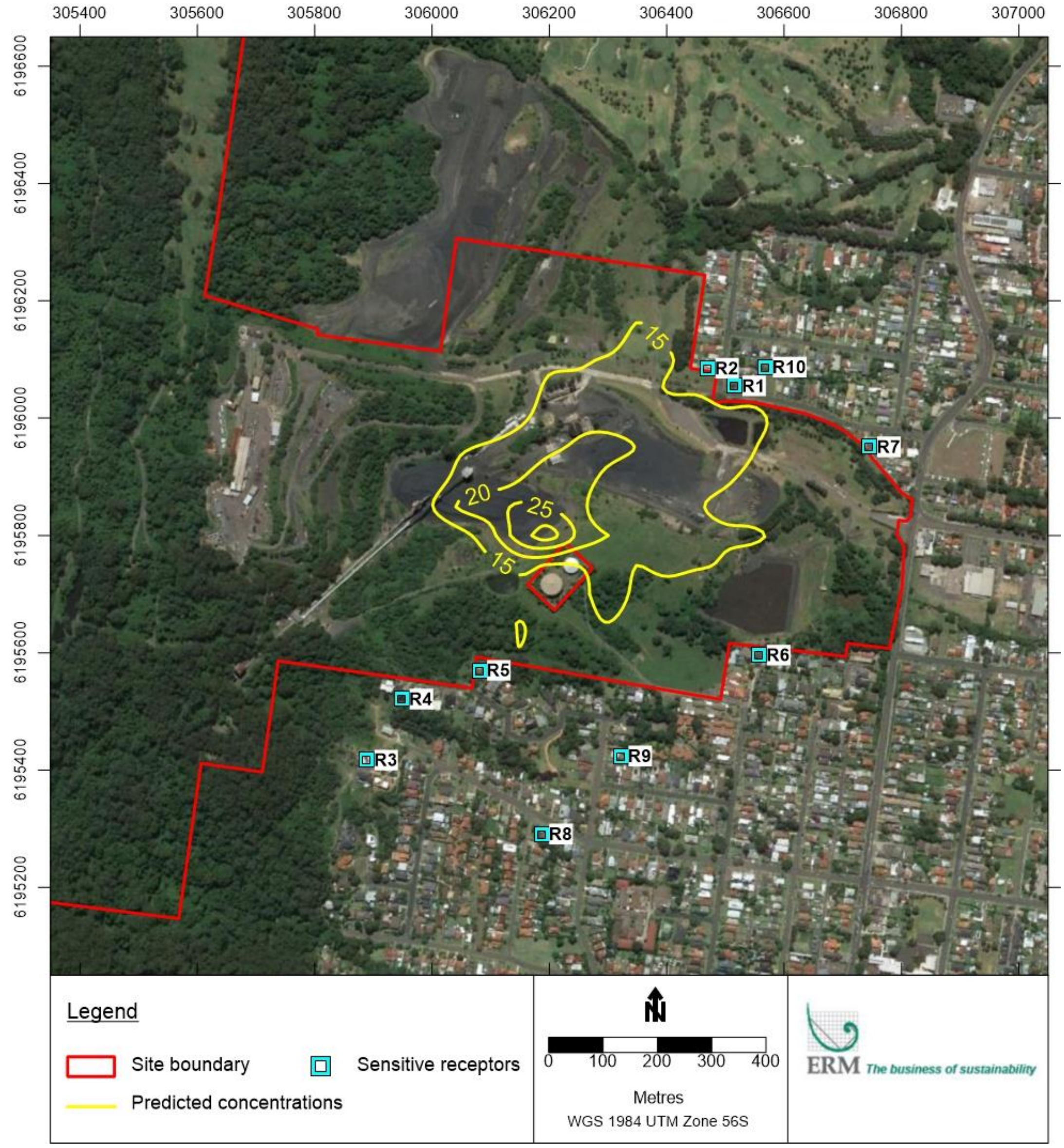
As shown in the tables and plots, there are no predicted exceedances of the respective air quality assessment criteria, due to emissions from the proposed operations combined with background levels. The maximum 24-hour average PM_{10} totals are highest at R1, R2 and R10 on the northern site boundary. As shown in Figure 6.13 – Figure 6.15, these high values are due to the elevated background concentrations on those particular days. The cumulative 24-hour PM_{10} concentrations are predominantly less than 30 µg/m³.

6.1 Scenario 1

The model predictions for $PM_{2.5}$, PM_{10} and dust deposition for Scenario 1 at the sensitive receptors identified on Figure 2.1 are presented in Table 6.1.

Table 6.1: Predicted concentrations and deposition levels due to the proposed operations (Scenario 1)

Receptor ID	24-hour average (µg/m³) Increment (Total)		Annual average (µg/m³) Increment (Total)		Increment (g/m²/month)	Total (g/m²/month)
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	Deposition	Deposition
R1	2.8 (13.9)	22.4 (45.0)	0.2 (5.2)	2.1 (12.8)	0.5	2.5
R2	2.7 (13.9)	19.0 (41.6)	0.3 (5.3)	2.35 (13.0)	0.6	2.6
R3	0.3 (11.5)	3.5 (26.1)	0.0 (5.0)	0.2 (10.9)	0.2	2.2
R4	0.4 (11.6)	6.0 (28.6)	0.1 (5.1)	0.4 (11.1)	0.3	2.3
R5	1.6 (12.7)	16.6 (39.2)	0.1 (5.1)	1.1 (11.8)	0.5	2.5
R6	1.7 (12.9)	16.9 (39.5)	0.1 (5.1)	1 (11.7)	0.2	2.2
R7	1.3 (12.5)	10.4 (33.0)	0.1 (5.1)	0.8 (11.5)	0.2	2.2
R8	1.1 (12.3)	8.7 (31.3)	0.0 (5.0)	0.3 (11.0)	0.1	2.1
R9	1.2 (12.4)	13.4 (36.0)	0.1 (5.1)	0.7 (11.4)	0.1	2.1
R10	2.3 (13.5)	18.8 (41.4)	0.2 (5.2)	1.4 (12.1)	0.3	2.3
Criterion	**25**	**50**	**8**	**25**	**2**	**4**
Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

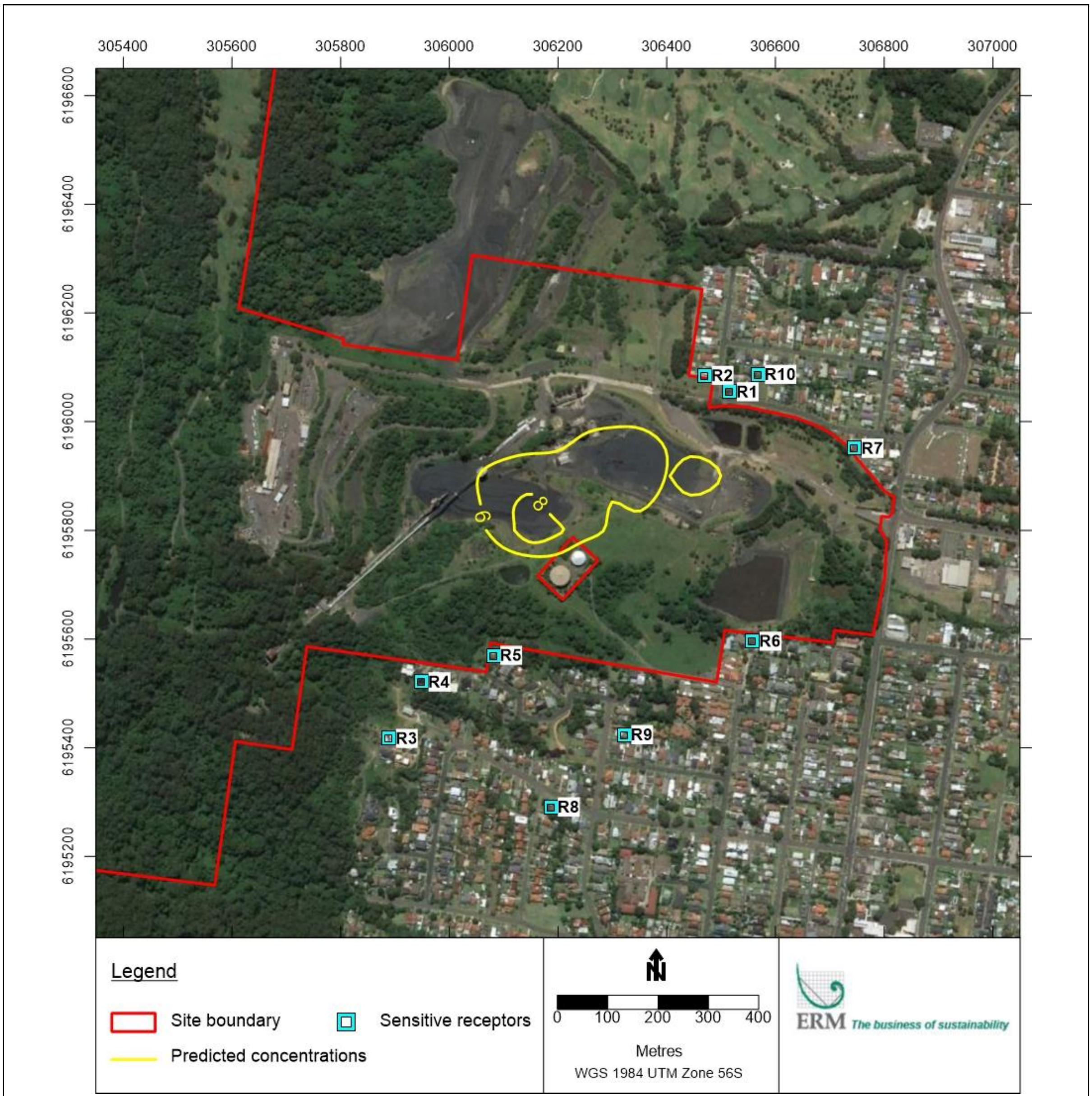


Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Russell Vale	Scenario 1	N/A	24-hour
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	$\mu g/m^3$	25	2016	T. Dar

Figure 6.1: Predicted maximum cumulative 24-hour average $PM_{2.5}$ concentrations due to the proposed operations and background concentrations

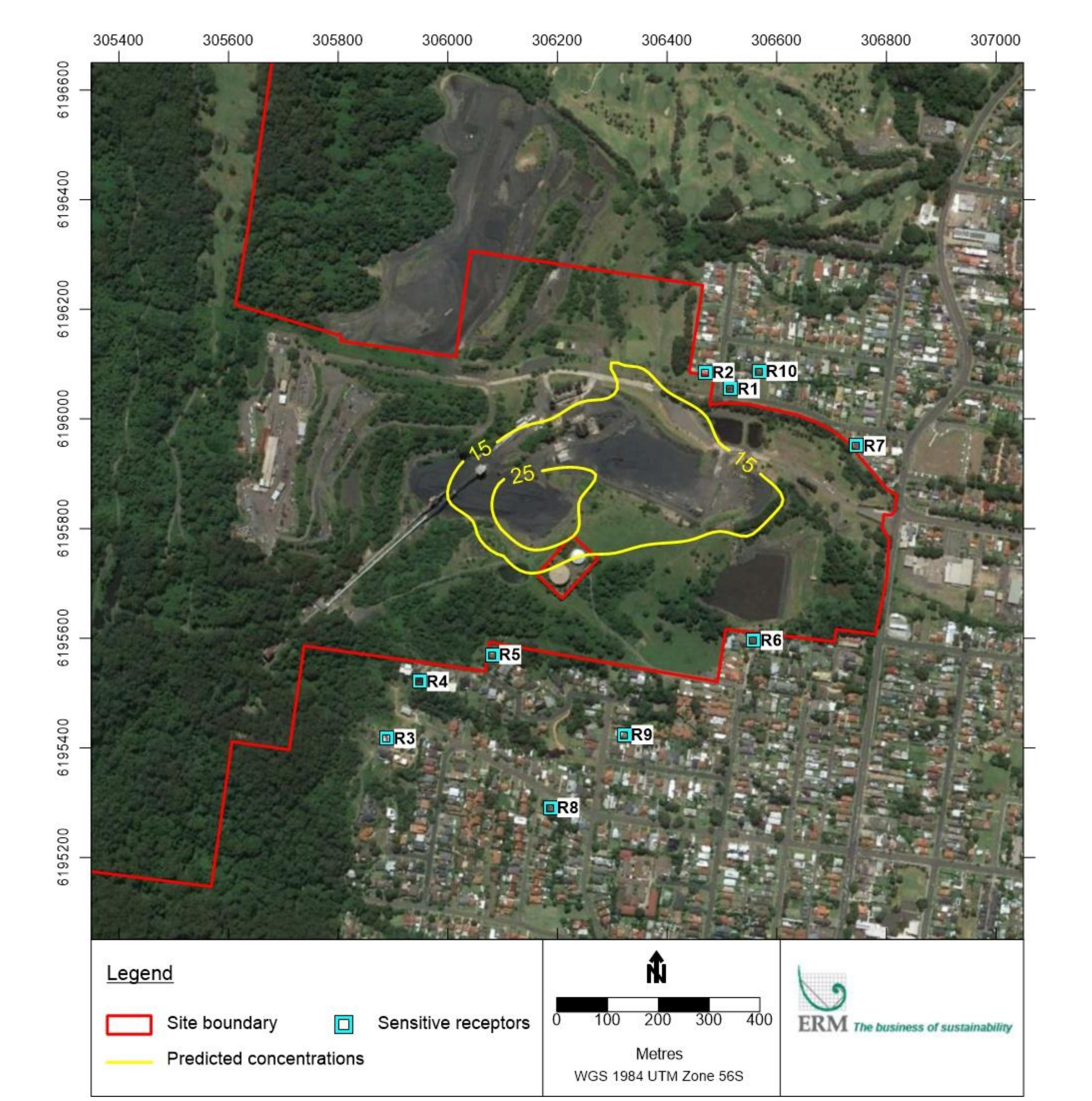
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Russell Vale	Scenario 1	N/A	24-hour
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	50	2016	T. Dar

Figure 6.2: Predicted maximum cumulative 24-hour average PM_{10} concentrations due to the proposed operations and background concentrations



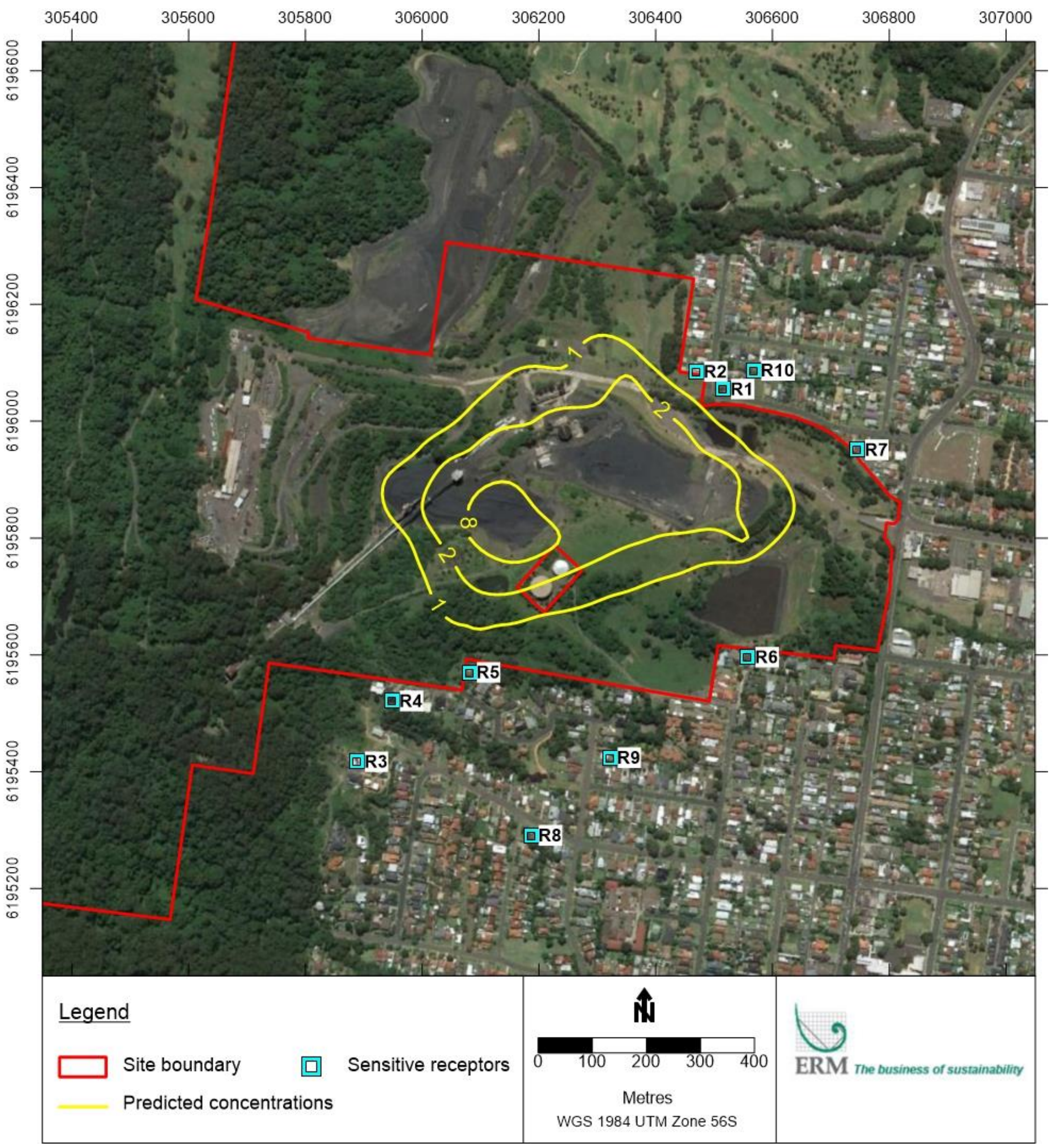
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Russell Vale	Scenario 1	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	8	2016	T. Dar

Figure 6.3: Predicted annual average cumulative $PM_{2.5}$ concentrations due to the proposed operations and background concentrations



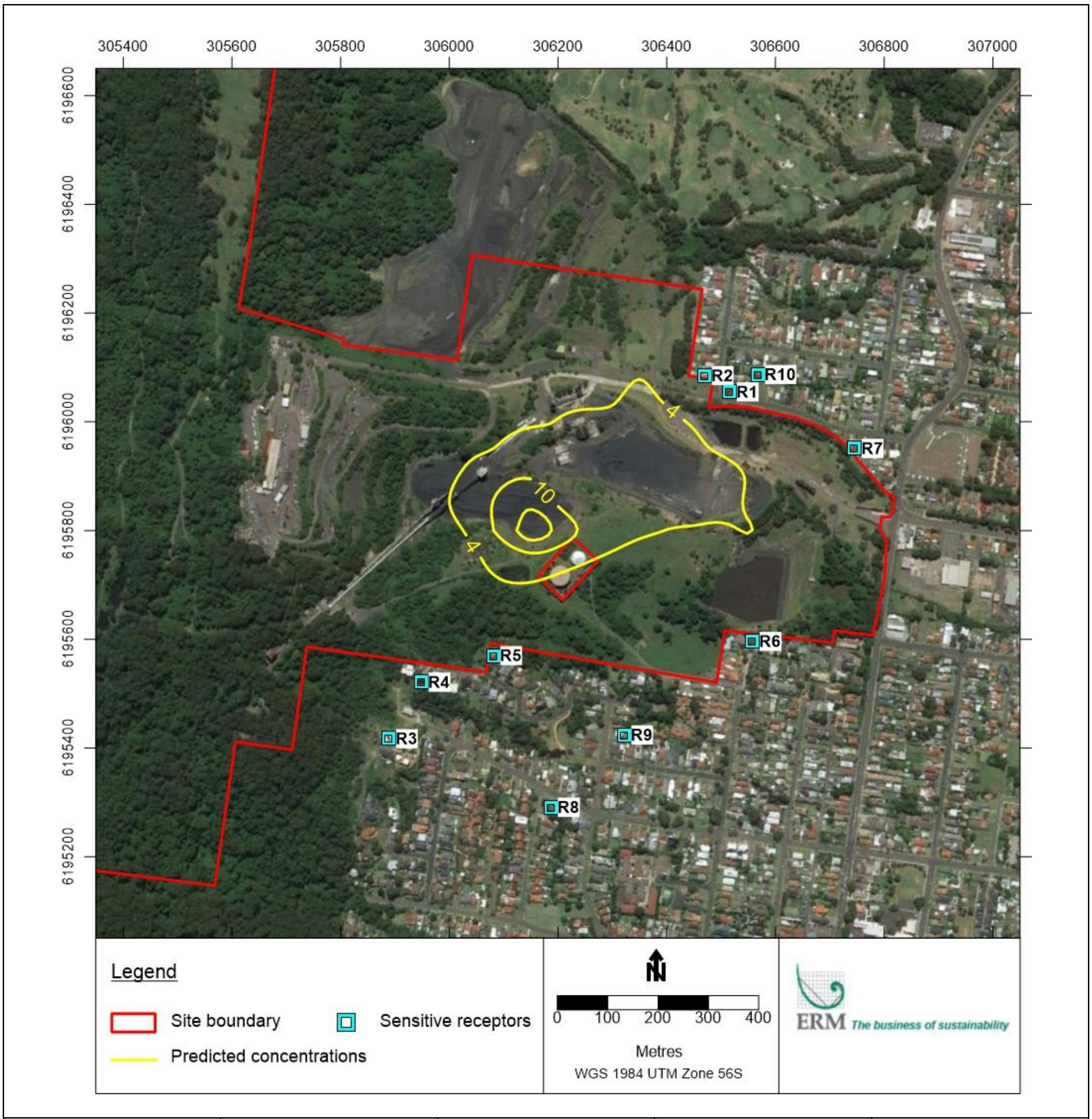
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Russell Vale	Scenario 1	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	$\mu g/m^3$	25	2016	T. Dar

Figure 6.4: Predicted annual average cumulative PM_{10} concentrations due to the proposed operations and background concentrations



Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
Dust deposition	Russell Vale	Scenario 1	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	g/m^2/month	2	2016	T. Dar

Figure 6.5: Predicted incremental annual average dust deposition due to the proposed operations



Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
Dust deposition	Russell Vale	Scenario 1	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	$g/m^2/month$	4	2016	T. Dar

Figure 6.6: Predicted annual average cumulative dust deposition due to the proposed operations and background levels

6.2 Scenario 2

The model predictions for Scenario 2 are presented in Table 6.2 showing compliance with the NSW EPA criteria.

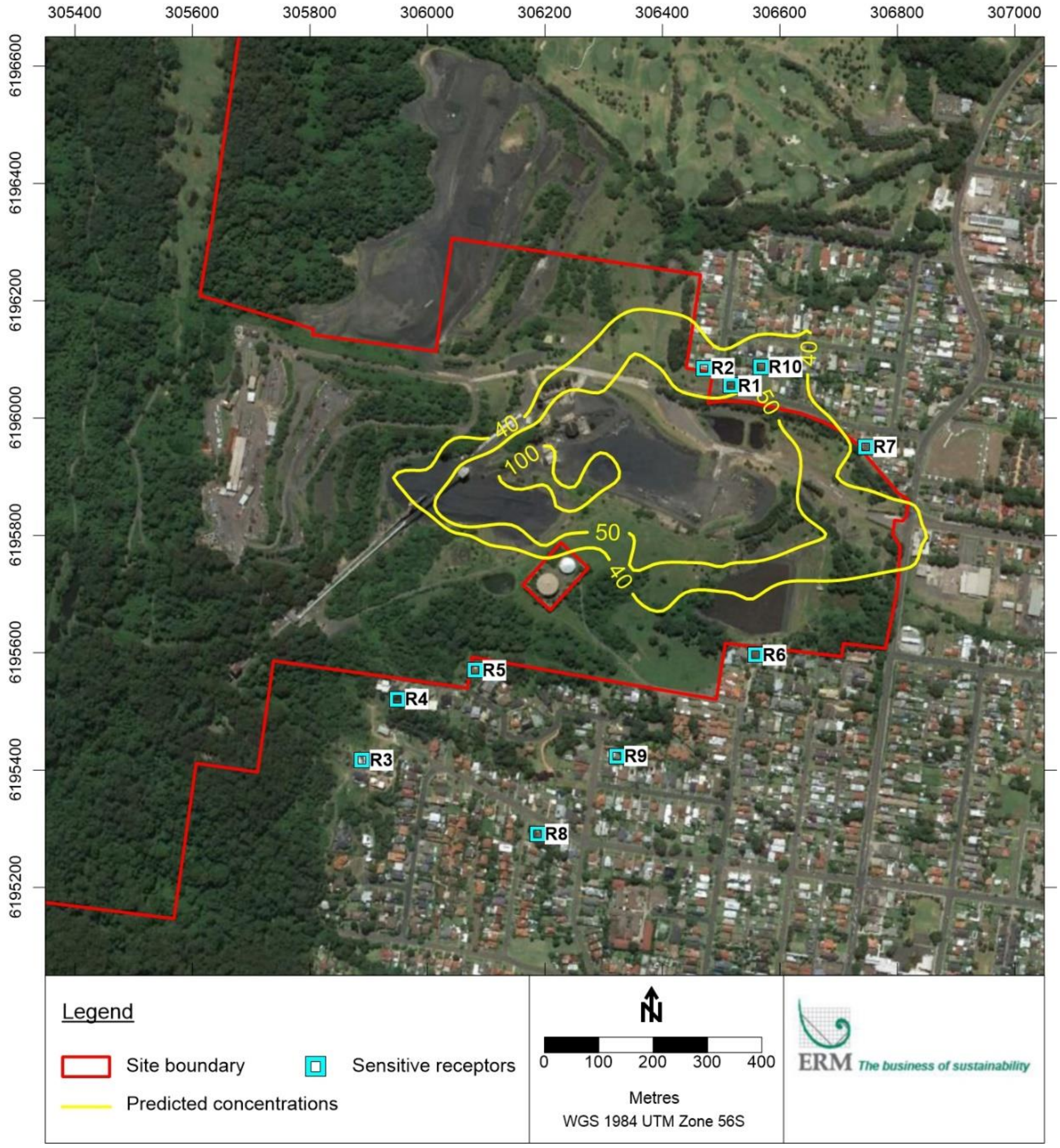
Table 6.2: Predicted concentrations and deposition levels due to the proposed operations (Scenario 2)

Receptor ID	24-hour average (µg/m³) Increment (Total)		Annual average (µg/m³) Increment (Total)		Increment (g/m²/month)	Total (g/m²/month)
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	Deposition	Deposition
R1	3.1 (14.3)	23.9 (46.5)	0.4 (5.4)	3.2 (13.9)	0.8	2.8
R2	2.6 (13.8)	19.9 (42.5)	0.4 (5.4)	3.0 (13.7)	0.7	2.7
R3	0.2 (11.4)	1.7 (24.3)	0.0 (5.0)	0.2 (10.9)	0.1	2.1
R4	0.3 (11.5)	2.5 (25.1)	0.0 (5.0)	0.4 (11.1)	0.2	2.2
R5	0.8 (12.0)	5.8 (28.4)	0.1 (5.1)	0.7 (11.4)	0.3	2.3
R6	1.3 (12.5)	9.1 (31.7)	0.2 (5.2)	1.3 (12.0)	0.3	2.3
R7	1.9 (13.1)	15.4 (38.0)	0.1 (5.1)	1.2 (11.9)	0.2	2.2
R8	0.7 (11.9)	4.7 (27.3)	0.0 (5.0)	0.3 (11.0)	0.1	2.1
R9	0.9 (12.1)	7.0 (29.6)	0.1 (5.1)	0.6 (11.3)	0.1	2.1
R10	2.9 (14.1)	22.0 (44.6)	0.3 (5.3)	2.2 (12.9)	0.5	2.5
Criterion	**25**	**50**	**8**	**25**	**2**	**4**
Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

With regard to the cumulative 24-hour PM_{10} predictions, it was noted earlier that there may be an element of double counting leading to higher than likely ground level concentrations. It should also be noted that the results show the maximum 24-hour average prediction at each gridded and discrete receptor, independent of the day on which it occurs.

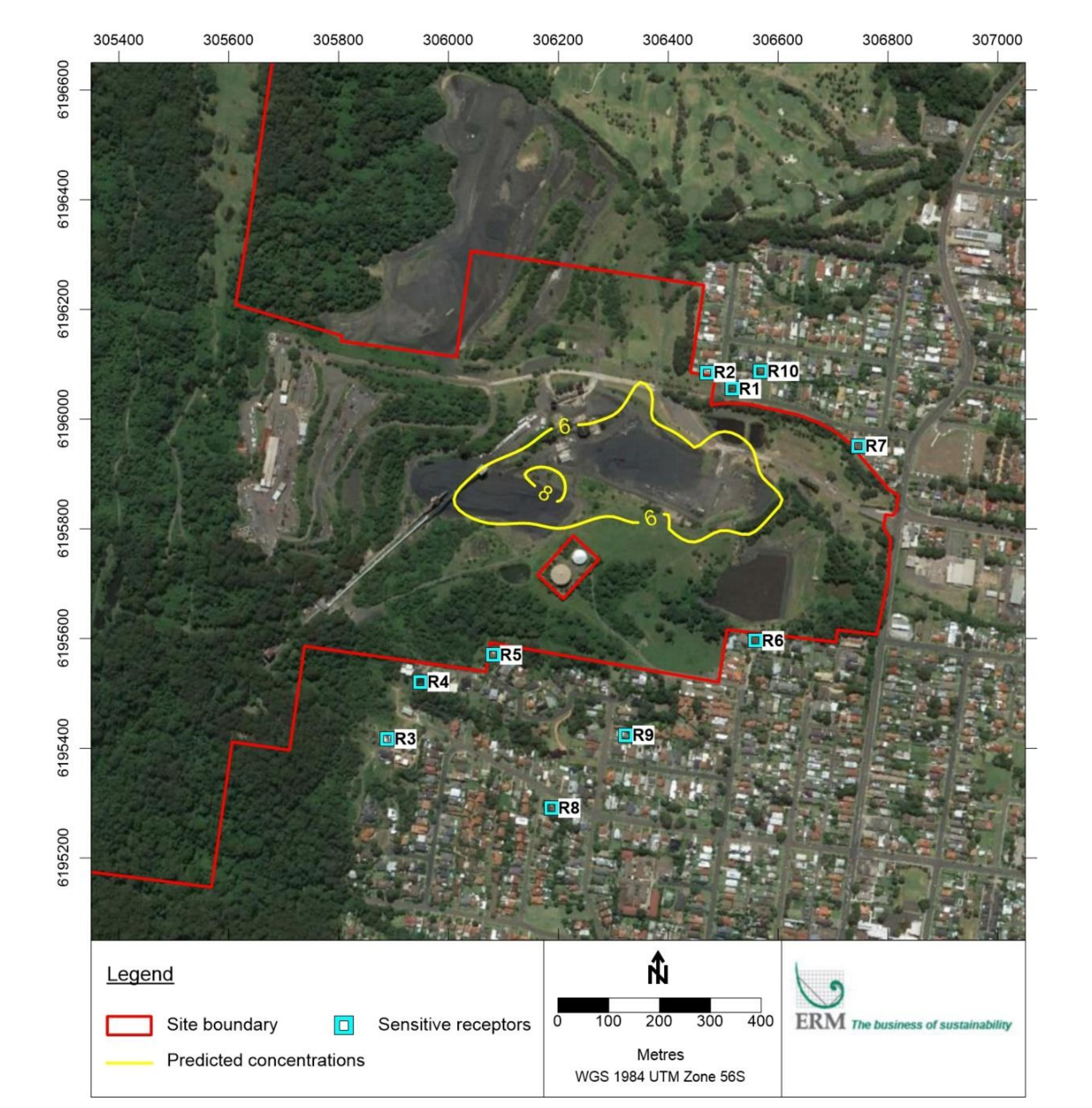
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Russell Vale	Scenario 2	N/A	24-hour
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	25	2016	T. Dar

Figure 6.7: Predicted maximum cumulative 24-hour average $PM_{2.5}$ concentrations due to the proposed operations and background concentrations



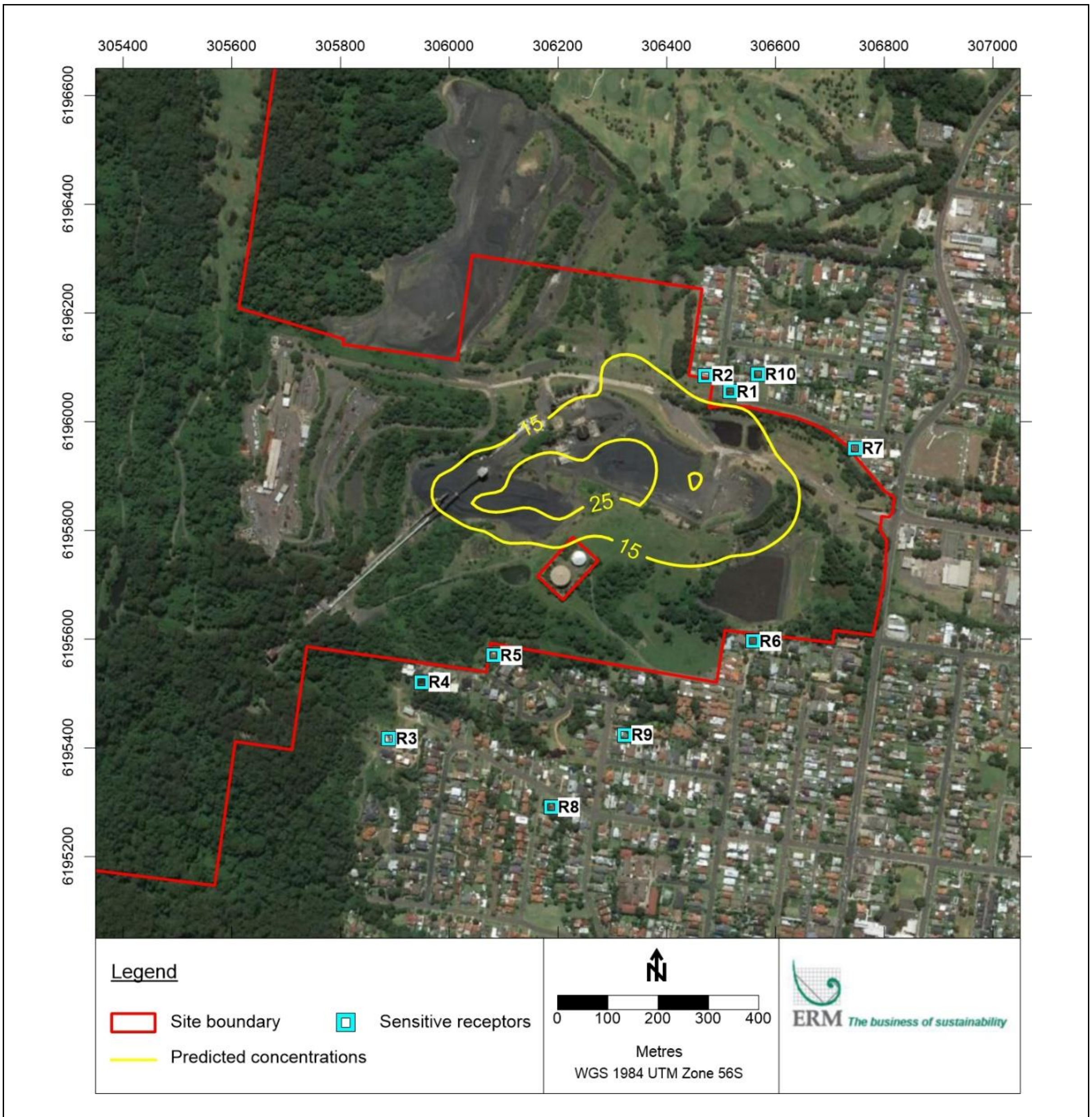
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Russell Vale	Scenario 2	N/A	24-hour
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	50	2016	T. Dar

Figure 6.8: Predicted maximum cumulative 24-hour average PM_{10} concentrations due to the proposed operations and background concentrations



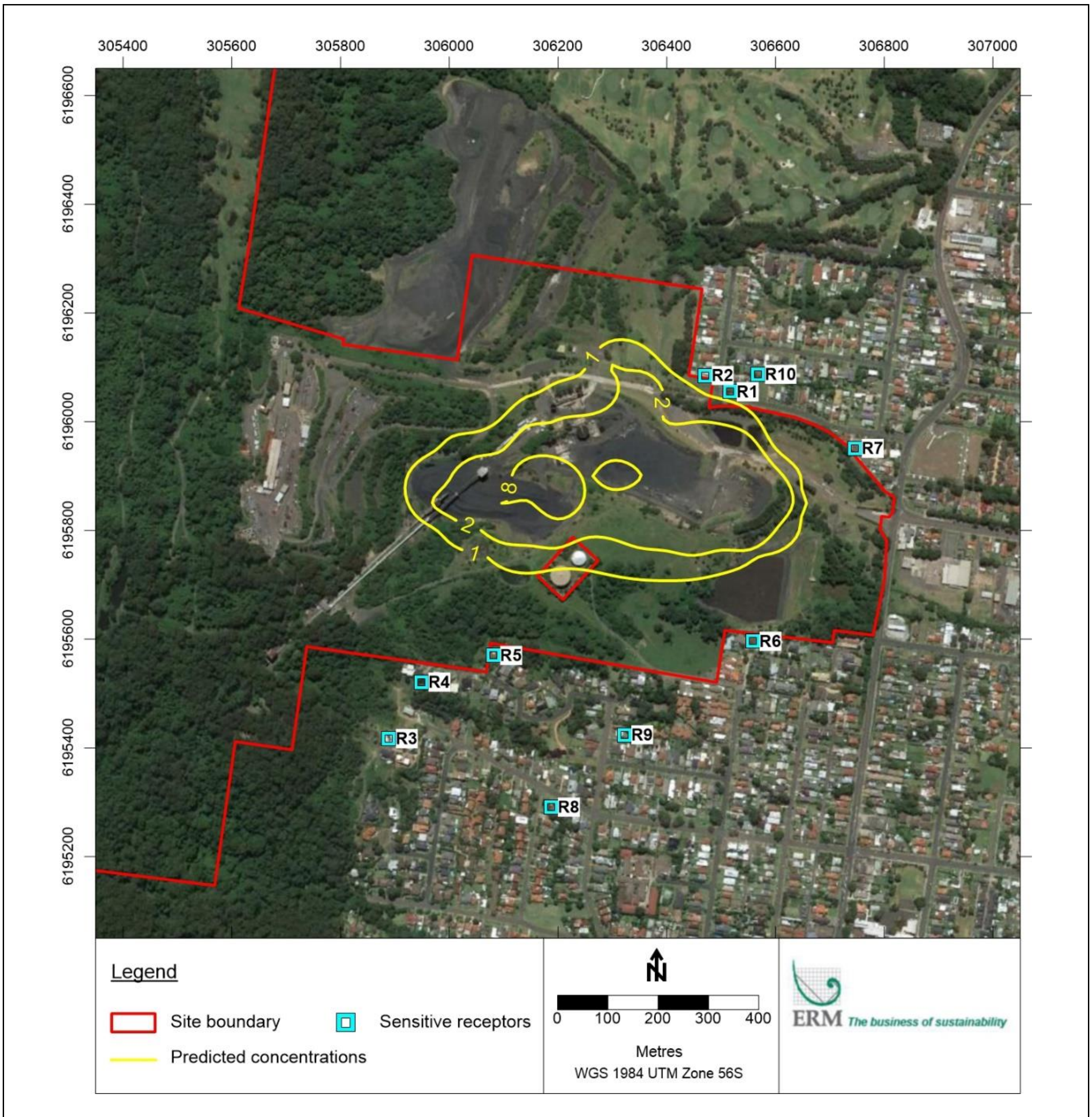
Pollutant:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
$PM_{2.5}$	Russell Vale	Scenario 2	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	8	2016	T. Dar

Figure 6.9: Predicted annual average cumulative $PM_{2.5}$ concentrations due to the proposed operations and background concentrations



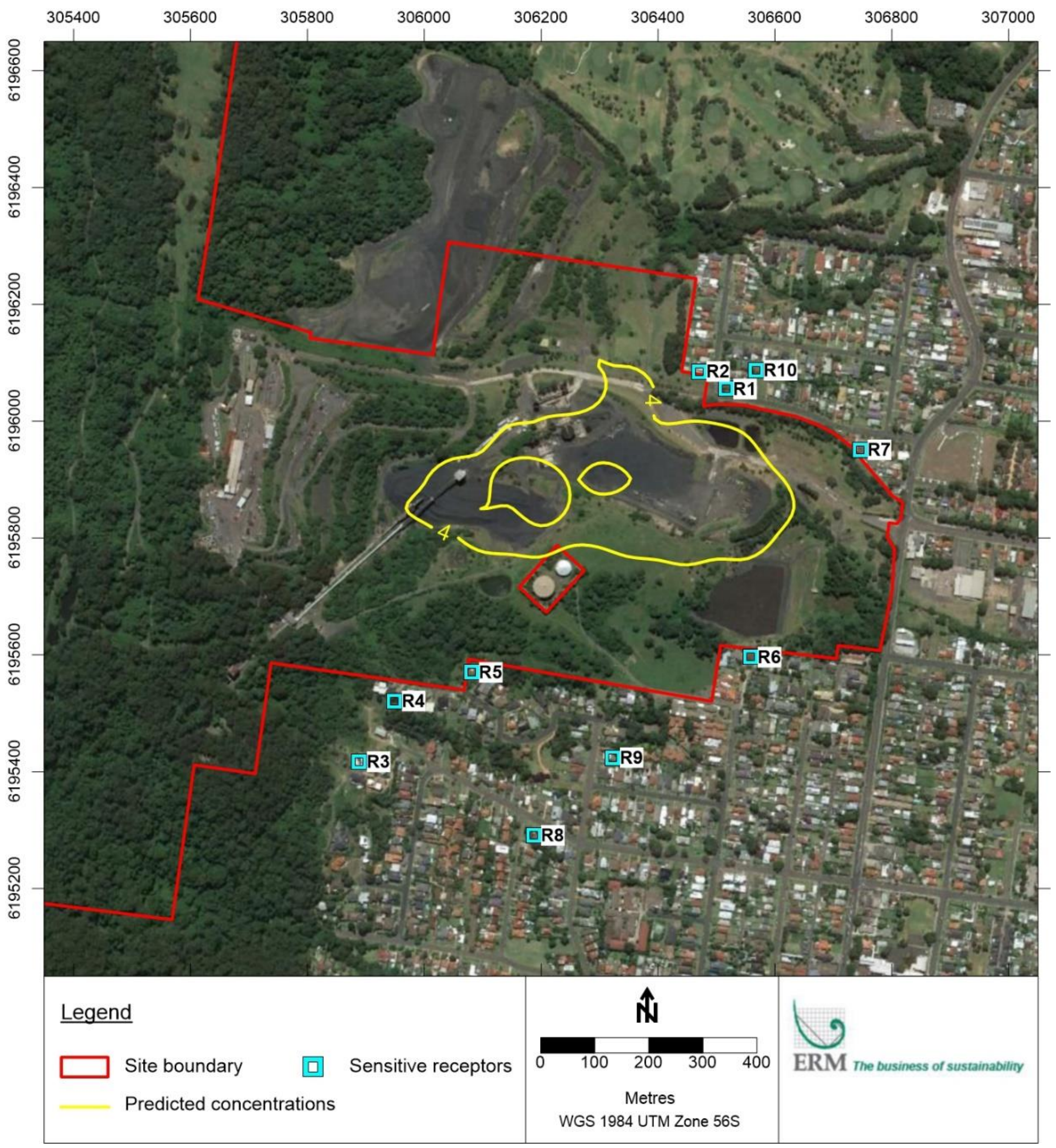
Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Russell Vale	Scenario 2	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	µg/m^3	25	2016	T. Dar

Figure 6.10: Predicted annual average cumulative PM_{10} concentrations due to the proposed operations and background concentrations



Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
Dust deposition	Russell Vale	Scenario 2	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	$g/m^2/month$	2	2016	T. Dar

Figure 6.11: Predicted incremental annual average dust deposition due to the proposed operations



Pollutant:	Location:	Scenario:	Percentile:	Averaging Time:
Dust deposition	Russell Vale	Scenario 2	N/A	Annual
Model:	**Units:**	**Standard:**	**Met Data:**	**Plot:**
AERMOD	$g/m^2/month$	4	2016	T. Dar

Figure 6.12: Predicted annual average cumulative dust deposition due to the proposed operations and background levels

To show the variation in daily PM_{10} measurements combined with predictions, each component has been plotted for each day over the modelled year. The results for receptors R1, R2 and R10 are shown in Figure 6.13, Figure 6.14 and Figure 6.15, respectively. Not only is the background below the criterion, but the measured levels combined with predicted PM_{10} concentrations are also well below 50 µg/m^3. Note that where monitoring data are unavailable (through February and March), the 95th percentile has been adopted as the background level for that day.

This same time series information for $PM_{2.5}$ is presented in Figure 6.16, Figure 6.17 and Figure 6.18. It shows that there were two exceedances of the maximum 24-hour average criterion but that these were due to background levels already exceeding 25 µg/m^3. The modelled maximum 24-hour average concentrations are very low and not predicted to cause any additional exceedances.

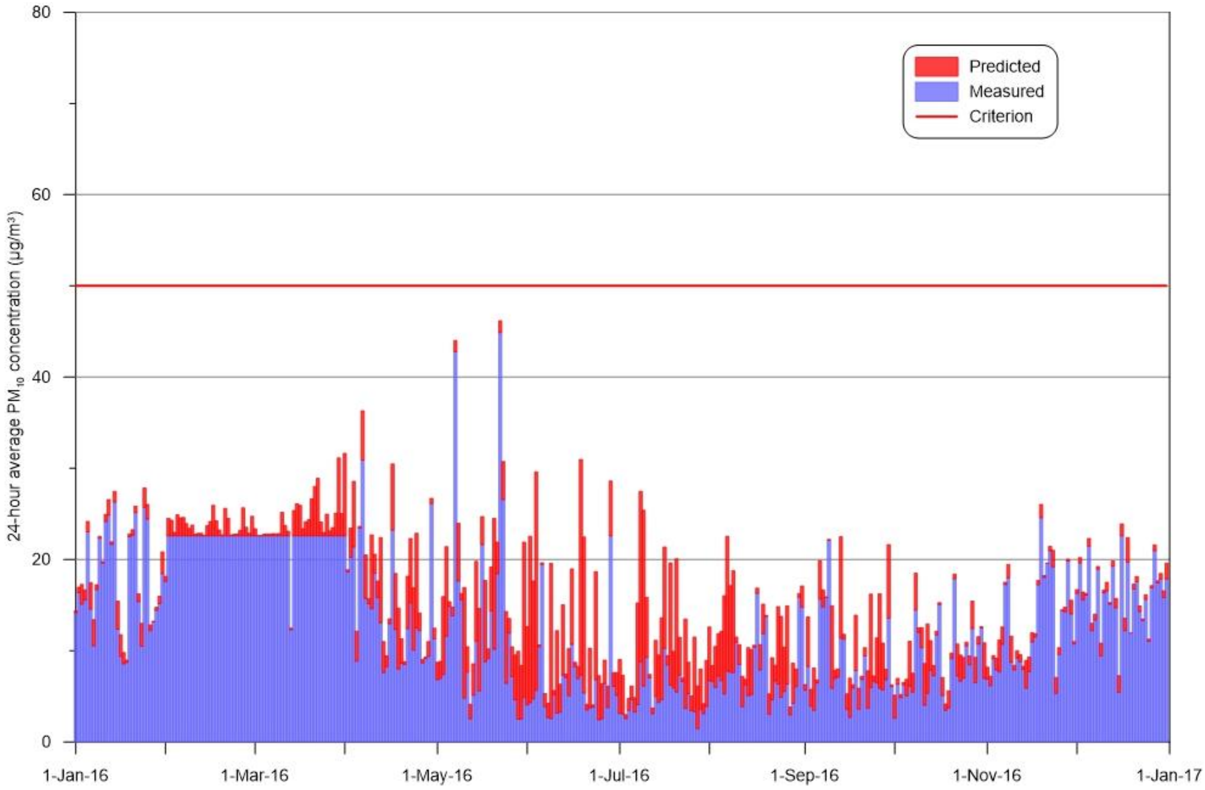


Figure 6.13: Cumulative 24-hour average PM_{10} concentrations at R1

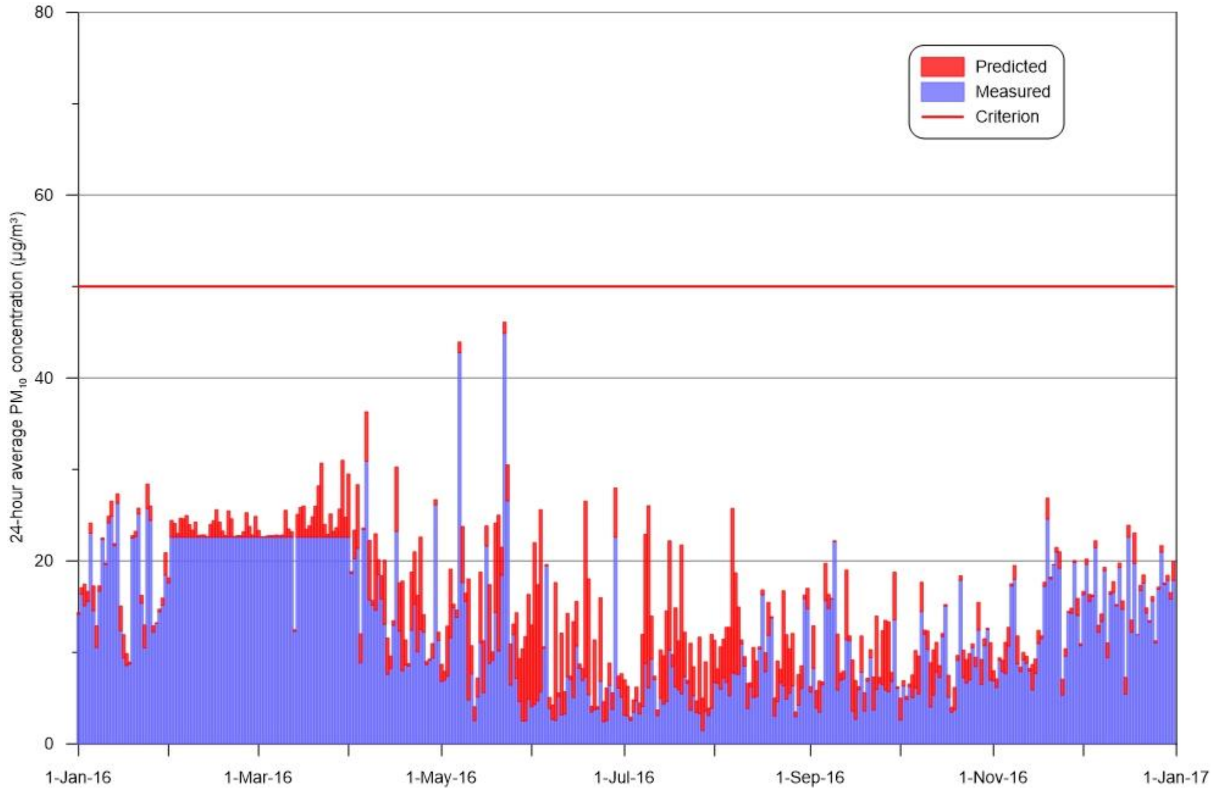


Figure 6.14: Cumulative 24-hour average PM_{10} concentrations at R2

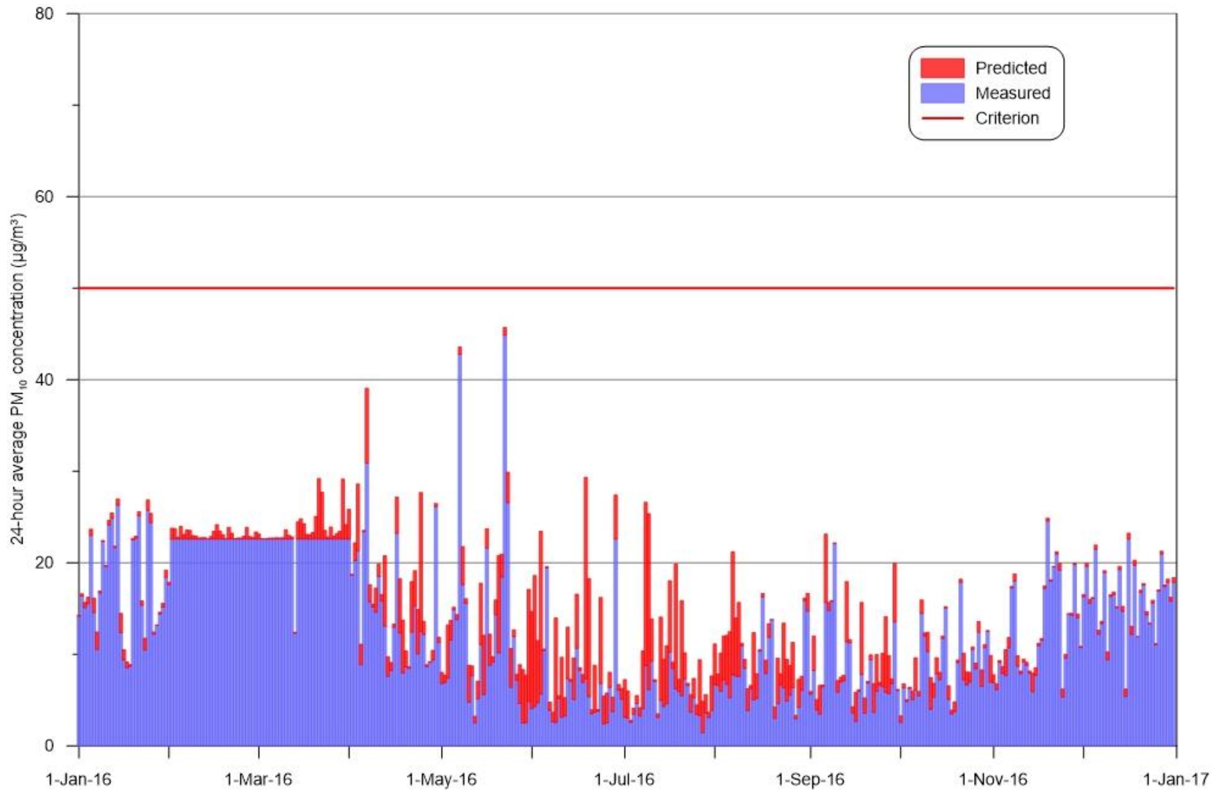


Figure 6.15: Cumulative 24-hour average PM_{10} concentrations at R10

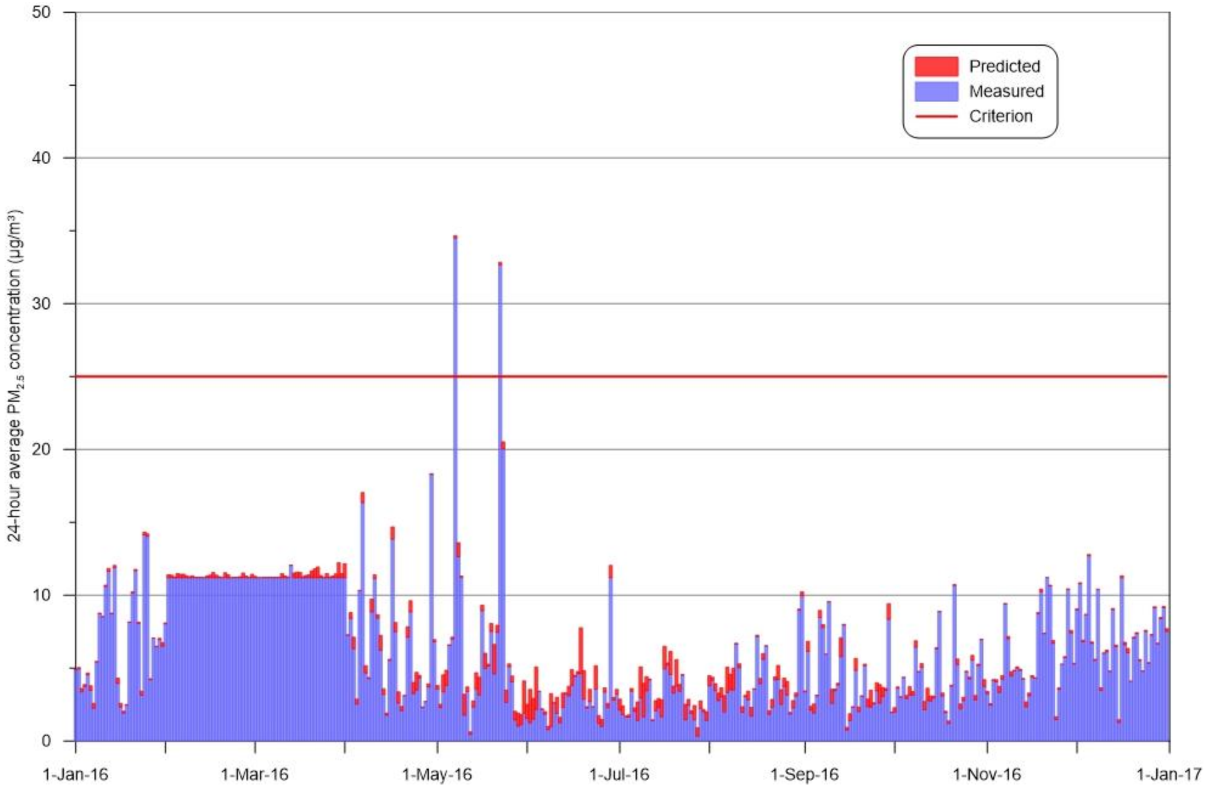


Figure 6.16: Cumulative 24-hour average $PM_{2.5}$ concentrations at R1

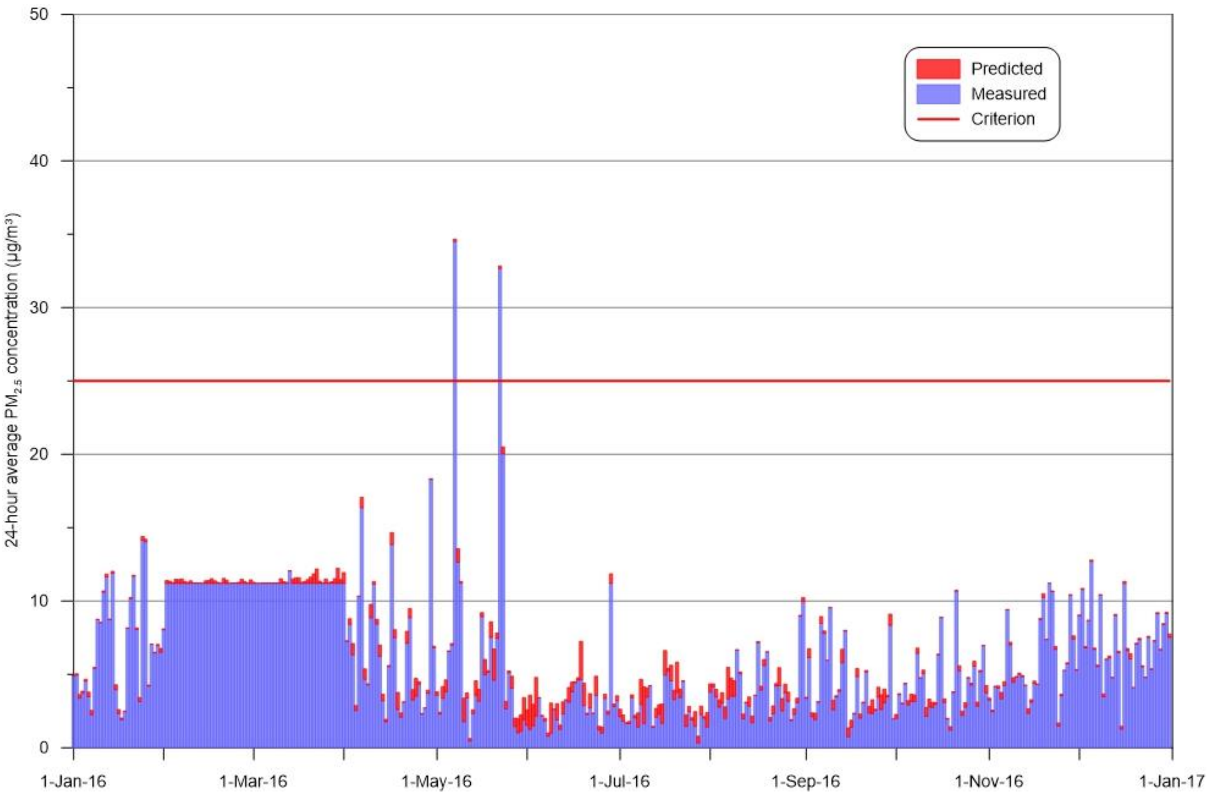


Figure 6.17: Cumulative 24-hour average $PM_{2.5}$ concentrations at R2

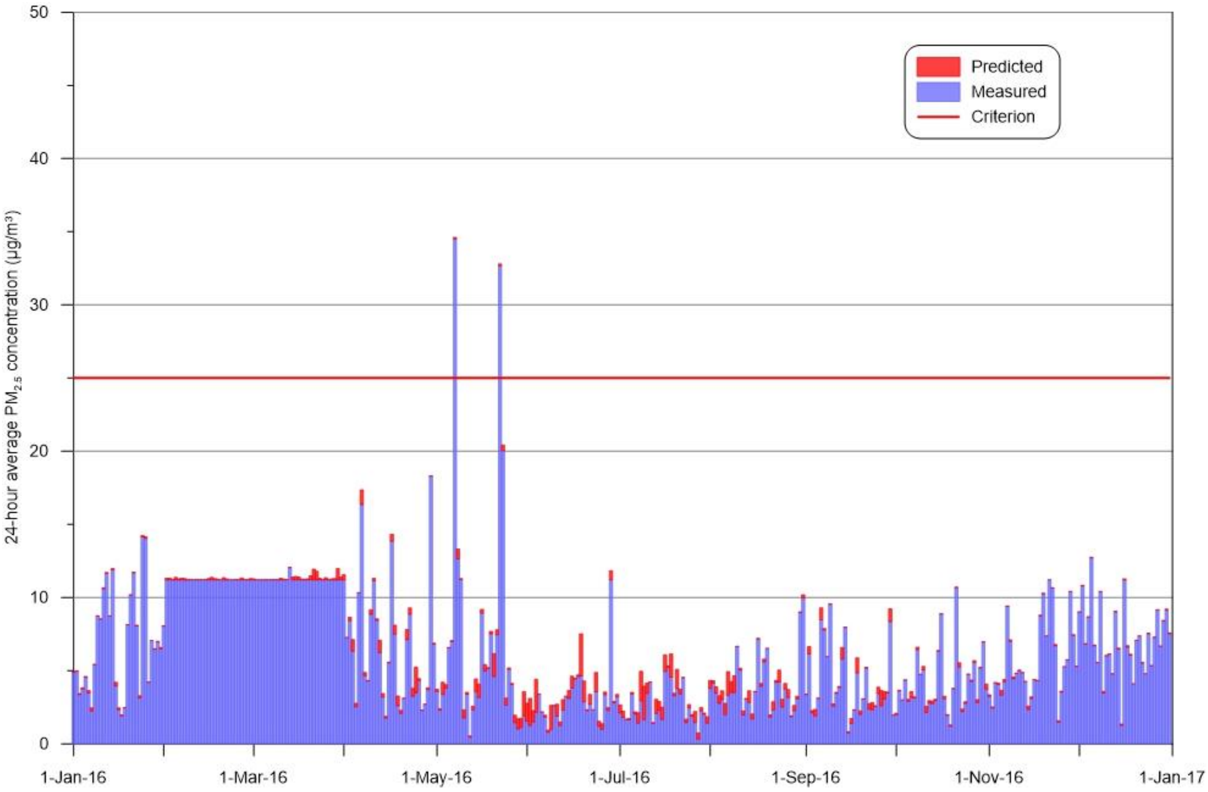


Figure 6.18: Cumulative 24-hour average $PM_{2.5}$ concentrations at R10

7. MITIGATION MEASURES

An Air Quality Management Plan (AQMP) should be produced to cover both the construction and operational phases of the project. Best practice dust control measures already accounted for in the modelling results for this assessment include:

- Enclosure of conveyors and material transfer points
- Enclosure of processing plant
- Water sprays on ROM stockpile
- Water carts on unsealed haul routes
- Water sprays on stockpiles and exposed areas triggered during periods of high winds
- Trucks to be covered before leaving the site
- Trucks to be washed before leaving the site.

Additional control measures that will be undertaken as part of the project include:

- Water sprays on the noise berms during construction
- Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes
- Revegetation / rehabilitation of exposed disturbed areas

There are a number of proactive and reactive dust control measures that WCL is considering as part of the AQMP. These include:

- Proactive measures
  - Use daily forecasting tools to anticipate high dust emission days
  - Plan site activities ahead of time considering forecasts
  - Modify activities to align with expected conditions and minimise dust emissions
- Reactive measures
  - Modify or suspend activities if certain meteorological conditions are triggered, such as high winds towards sensitive receptors and extended periods of dry weather
  - Alert drivers if dust is visible above wheel height and reduce speeds

8. CONCLUSIONS

This assessment has evaluated the particulate emissions for the Revised Preferred Project. The emission estimates include relevant PM reduction strategies implemented as a result of the currently-applied best practice dust management onsite. These emission estimates and local meteorological data were input into AERMOD dispersion model to predict the 24-hour maximum and annual average ground-level concentrations for PM_{10}, $PM_{2.5}$ concentrations and deposited dust. Predictions were made at specific sensitive receptors and the wider modelling domain.

Background PM concentrations were added to these predictions, calculated based on 2016 measurement data undertaken at the site boundary by WCL.

The assessment results were compared with relevant air quality criteria for PM_{10}, $PM_{2.5}$ and deposited dust. No exceedances were predicted at any sensitive receptor locations off site.

9. REFERENCES

NSW EPA (2016), “Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales”. NSW Department of Environment & Conservation. Sydney.

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APPENDIX 7

Traffic Assessment

TRAFFIC AND TRANSPORT IMPACT ASSESSMENT

FOR

RUSSELL VALE COLLIERY REVISED UNDERGROUND EXPANSION PROJECT AT RUSSELL VALE

RESPONSE TO PAC SECOND REVIEW REPORT

Ref. 17066r

16 July 2019

Prepared By

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APPENDICES

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1.0 INTRODUCTION

1.1 Introduction

Russell Vale Colliery is located within the Southern Coalfields Region of NSW, approximately 8 kilometres (KM) north of Wollongong and 70km south of Sydney. **Figure 1** shows the location.

Russell Vale Colliery is owned and operated by Wollongong Coal Limited (WCL) and is currently in care and maintenance. Mining in Longwall 6 in the Wongawilli seam finished in May 2015 and the colliery has been in care and maintenance since that date. Coal trucks associated with the transport of coal off the site operated up until 30 September 2016.

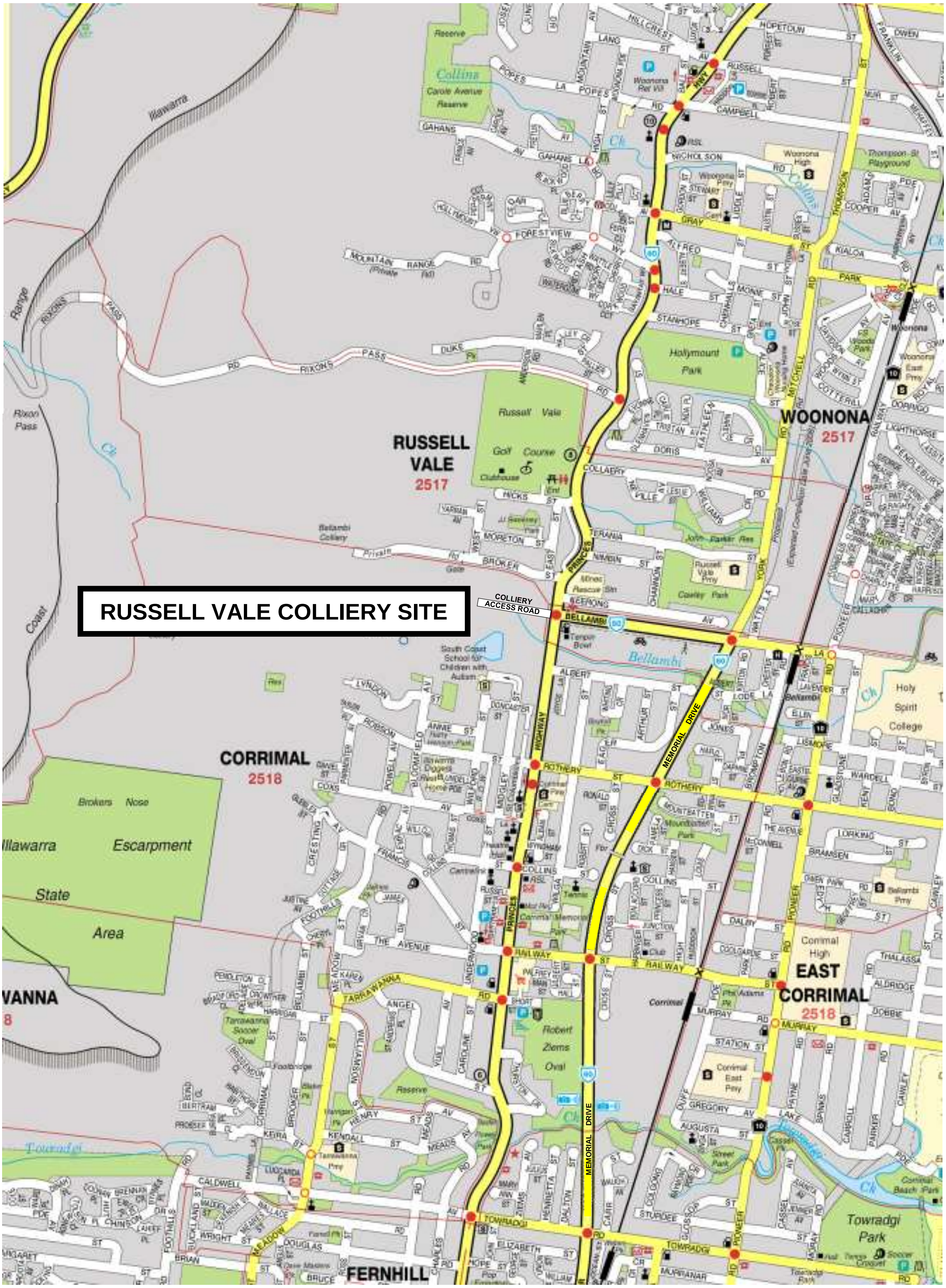
Umwelt (Australia) Pty Limited (Umwelt) is preparing the environmental assessment (EA) for a revised plan for the Russell Vale Colliery Underground Extension Project (hereafter referred to as the Revised Project) on behalf of WCL. The Revised Project will continue to be assessed under the current UEP application process under Part 3A of the EP&A Act.

The Revised Project proposes a revised mine plan design which addresses the concerns raised by the Planning Assessment Commission (PAC) during its first and second Assessment Reports on the Russell Vale Underground Expansion Project (UEP). The updated assessment is a response to the latest PAC report (i.e. PAC Second Review Report).

This Traffic and Transport Impact Assessment has been prepared by Transport and Urban Planning Pty Ltd on behalf of Umwelt as part of the environmental assessment for the Project and addresses the traffic and transport issues identified in the PAC Second Review Report, as well as examining the impacts of the Revised Project.

1.2 Traffic and Transport Issues Identified in PAC Second Review Report

Table 1.1 details the traffic and transport issues raised in Section 4.8 of the PAC Second Review Report and where these issues are addressed in this assessment, or elsewhere in the Revised Preferred Project Report and Response to PAC.



TRANSPORT AND URBAN PLANNING TRAFFIC, TRANSPORT & PROJECT MANAGEMENT CONSULTANTS 5/90 Toronto Parade, Sutherland NSW 2232 Phone 02 9545 1411 Fax 02 9545 1556 admin@transurbanplan.com.au	N NOT TO SCALE	FIGURE 1 RUSSELL VALE COLLIERY SITE LOCATION JOB NO. 17066 29/11/18

TABLE 1.1
TRAFFIC AND TRANSPORT ISSUES IDENTIFIED IN PAC SECOND REVIEW REPORT

Issue	Where Addressed
i) The predicted traffic noise increase of 1.7dBA is not credible and should be reassessed having regard to the then existing truck movements not modelled movements.	i) This is a noise matter and is addressed in the Noise Assessment Report prepared by Wilkinson Murray.
ii) The proposed truck parking area is in close proximity to a number of residences near the entrance to the pit top site. The review of the need for the construction of a noise barrier and/or mitigation measures on private residences should have regard to the noise impact arising from truck queuing.	ii) This matter is also a noise matter and is addressed by the Revised Site Layout and also in the Noise Assessment Report.
iii) The proponent's offer to make a contribution to the RMS for pavement upgrade along Bellambi Lane is reasonable and should be accepted as a condition of approval, if the project were to be approved. However, the contribution should be made to the relevant roads authority.	iii) The proponent will make a contribution to the pavement upgrade/maintenance in Bellambi Lane and this will be included in a Planning Agreement (or similar) with Wollongong City Council. See Section 4.6.
iv) There is insufficient justification to increase production level to 3Mtpa based on the predicted production levels provided by the proponent.	iv) Production will not exceed 1 million tonnes per year. This traffic assessment report is based on the transportation of 1 million tonnes per year.

It is noted that in Section 4.8.2 of the PAC Second Review Report when discussing Road Maintenance Contributions, the following statement was made by the commission concerning previous RMS advice.

The Department also directed attention to the RMS's advice via its letter to the Department dated 28 May 2015 that the proposed increase in traffic would not have a significant impact on the operation and performance of the main road network and raised no objections in principle to the application.

1.3 Structure of this Report

This report has been prepared to support the Revised Preferred Project Report and Response to PAC, to assess the road transport and traffic impacts associated with the Revised Project.

The assessment has been undertaken in accordance with the requirements of Roads and Traffic Authority's Guide to Traffic Generating Developments October 2002.

Other technical standards/publications referenced in this assessment include:

- Austroads Guide to Road Design and RMS supplements
- Austroads Guide to Traffic Management and RMS supplements

The remaining sections of this report address the following;

- Section 2 – describes the Revised Project focusing on the traffic and transport components;
- Section 3 – examines the existing traffic conditions on the road network;
- Section 4 – evaluates the traffic impacts of the Revised Project and addressed those issues identified in the PAC Second Review Report;
- Section 5 – presents conclusions.

2.0 DESCRIPTION OF REVISED PROJECT

2.1 Overview of Revised Proposal

This section outlines the proposed amendments to the Russell Vale Underground Expansion Project (UEP) by Wollongong Coal Limited (WCL) in response to concern raised by government agencies, the PAC and the community. WCL have revised the UEP to address potential subsidence, biodiversity and water impacts within the Cataract Reservoir catchment and noise and traffic impacts associated with surface operations (Revised Project). The key elements of the Revised Project are:

- Mining using first working mining techniques only with the workings designed to be long term stable with minimal subsidence impacts;
- Extraction of approximately 3.7 million tonnes of ROM coal at a reduced production rate that would not exceed 1 million tonnes of product coal per year;
- Substantial redesign of the Pit Top layout to relocate infrastructure to more shielded locations to reduce amenity impacts;
- Operation of surface facilities and product transport typically limited to daytime hours (7.00am to 6.00pm Mondays to Friday, 8.00am to 6.00pm Saturday, no Sundays and Public Holidays); with provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruption;
- Construction and use of a coal processing plant to improve the quality of product coal; and
- Reduced product trucking rates relative to the previous Preferred Project mine plan.

A summary of the key components of the Revised Project is provided in **Table 2.1.**

Table 2.1 – Project Components

Project Component	Summary of the Project
Mining Method	Non-caving first workings panels within the Wonga East area only. Longwall mining is no longer included in the proposed mine design.
Resource	Wongawilli Seam
Annual ROM Production	Up to 1 Mtpa
Product Coal	Up to 1 Mtpa
Mine Life	5 years
Total Resource Recovered	Approximately 3.7Mt ROM
Coal Processing	Construction and use of coal processing plant to improve product coal
Hours of Operation – Mining and Coal Processing	Underground Mining - 24 hours per day, 7 days per week

Project Component	Summary of the Project
	Surface Facilities and Product Transport: 7.00am to 6.00pm, Mondays to Friday, 8.00am to 6.00pm Saturday. No Sundays and Public Holidays. Provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions.
Management of Mining Waste	Coarse rejects from the processing plant will be trucked off site as fill if it meets requirements for Virgin Excavated Natural Material (VENM), stockpiled for emplacement underground or used in the rehabilitation of the site.
General Infrastructure	o Establishment of new emergency clean coal and rejects stockpiles within Pit Top disturbance area. o Management of ROM Coal Stockpile to a maximum height of 7 metres and avoid loading over the inlet of the Bellambi Gully Diversion Pipeline (as committed to in MOD4 Preliminary Works Project Approval) o Construction and use of new Processing Plant to improve coal quality. o Enclosed structures (where possible) on the surface to reduce noise and dust impacts on the community. o Construction and use of a new Secondary Sizing Plant. o Construction and use of new Surge Bin in more shielded location. o Construction and use of enclosed conveyors for transfer of ROM coal to Secondary Sizer, Processing Plant and truck loading facility. o Construction of new truck loading facility. o Construction of noise barriers and extension to height of existing bunds. o Establishment of a designated truck parking area.
Product Transport	Product coal will be transported by truck to Port Kembla via Bellambi Lane and Memorial Drive.
Transport Hours and Rates	An average rate of 16 laden (coal or reject) outbound trucks per hour leaving the site between 7.00am and 6.00pm. Monday to Friday. An average rate of 16 laden (coal or reject) outbound trucks per hour leaving the site between 8.00am and 6.00pm Saturday. No coal transport Sundays and Public Holidays. If coal transport is required during the evening to cater for unexpected Port closures or interruptions, these movements would be limited to an average of 12 trucks per hour leaving the site between 6.00pm and 10.00pm Mondays to Fridays only. Trucks arriving at the site between 6.00am and 7.00am Monday to Friday or 6.00am and 8.00am Saturday will be required to proceed to the truck parking area on site and turn off engine until loading commences at 7.00am Monday to Friday or 8.00am Saturday.
Operational Workforce	Approximately 205 personnel
Construction Workforce	22 over a 12 to 24-month period

Figure 2 shows the Current and Future Plant Infrastructure at Russell Vale Colliery.

2.2 Coal Production Rates

Product coal production rates will not exceed 1 Million tonnes per annum (Mtpa).

2.3 Coal Transport

Product coal will be transported by truck to Port Kembla utilising road registered semi-trailer trucks and B-double trucks. Consistent with previously approved operations, the transport route would be via Bellambi Lane and Memorial Drive which is the route that has historically been used for the transport of coal from the Russell Vale site. Bellambi Lane and Memorial Drive is an approved 25/26 metre B Double route, as is the remainder of the transport route to Port Kembla. **Figure 3** shows the transport route.

On-site truck movements will access the truck loading bins and Product stockpile area using the road layout shown on **Figure 2**. Alternative on-site layouts that may be developed over time and will be monitored to ensure they can achieve the impact criteria imposed in subsequent approvals, should the project be approved.

Truck loading operations will be limited to between 7.00am and 6.00pm, Monday to Friday, and 8.00am to 6.00pm on Saturdays, with no Sundays and Public Holidays. These loading hours have been reduced from the previously approved operations at the site under the Preliminary Works Approval.

Outbound laden (coal or reject) truck movements will be limited to an average of 16 per hour between the hours of 7:00am and 6:00pm (Mondays to Fridays) and 8.00am to 6.00pm on Saturdays, with no truck movements on Sundays and Public Holidays.

Truck loading and coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closure or supply interruption, however such circumstances would be rare and as a result of unexpected events. This operation during the evening has been considered in this assessment.

Inbound trucks may arrive on site prior to 7.00am (Monday to Friday) and 8.00am (Saturdays), predicted at a maximum rate of 12 trucks over a 30 minute period (being 6.30am to 7.00am for Monday to Friday; and 7.30am to 8.00am Saturday). Trucks awaiting loading will be parked within the Russell Vale site and trucks entering the site prior to the commencement of loading operations will be required to turn off their engines while parked. Adequate truck parking will be available on site to avoid trucks queuing on the road outside of the Russell Vale site. See **Figure 2**. A noise barrier will be constructed along the site access road between the site entrance and the truck parking area entrance to minimise noise impacts from heavy vehicles accessing the site.

The sign posted speed limit for vehicles using Bellambi Lane is 60 km/h. Under the Preliminary Works Approval, coal truck movements along Bellambi Lane were subject to a voluntary speed limit of 50km/hr. This voluntary speed limit for trucks has been monitored through the use of Geographical Positioning Systems (GPS) equipment fitted to the trucks and monitored centrally by the trucking company. While there has been an extremely high compliance with this limit (99.9986% from 2,162 truck movements), three minor exceedances have occurred with all exceedances being below the signposted 60km/hr limit. The voluntary speed limit for coal/reject trucks of 50km/hr along Bellambi Lane will be maintained for the Revised Project with WCL aiming to achieve 95% compliance with the voluntary speed limit and 100% compliance with the sign posted 60km/h speed limit. All coal/reject trucks will be subject to GPS monitoring to monitor compliance with this speed limit.

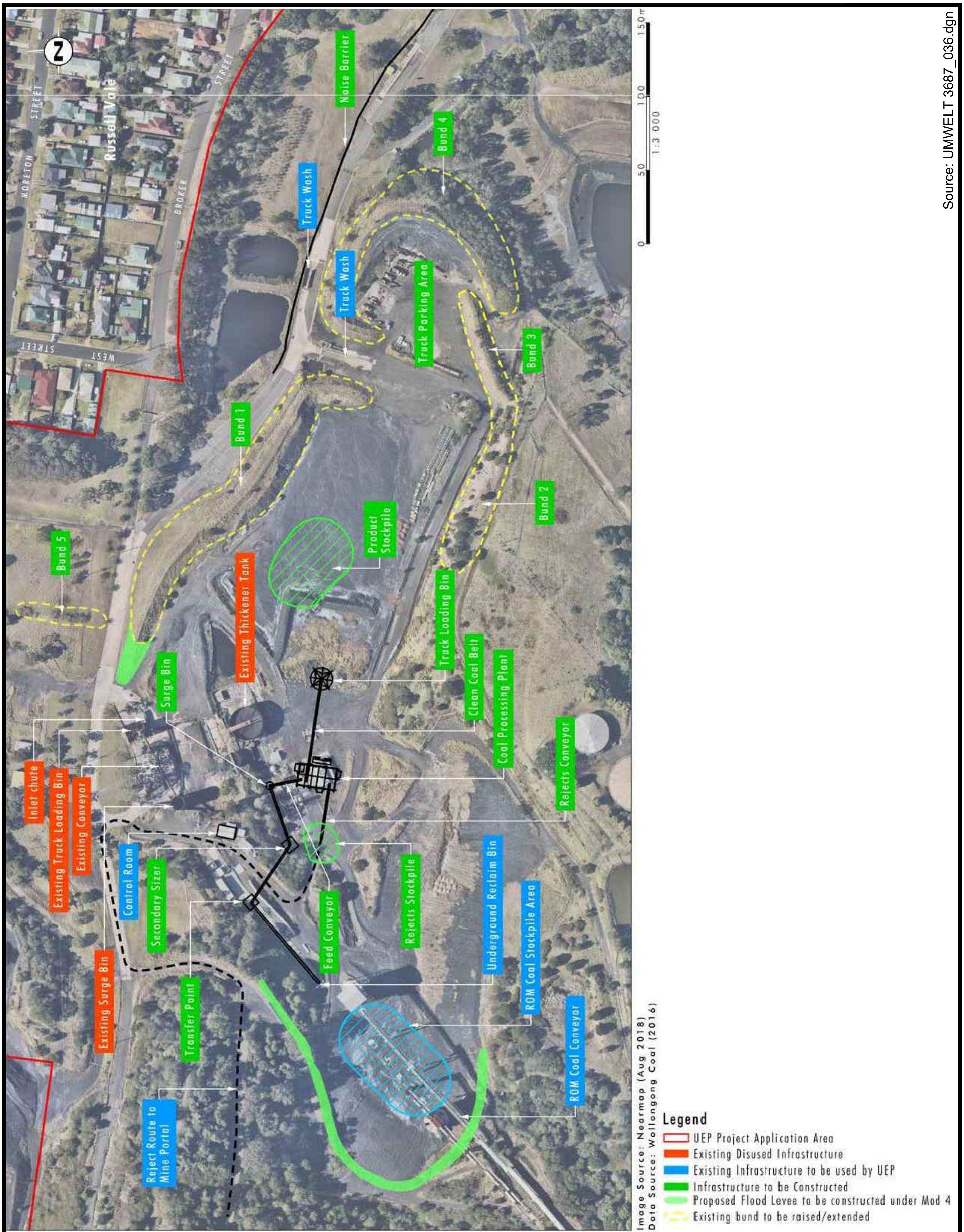


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FIGURE 2

RUSSELL VALE COLLIERY

CURRENT & FUTURE PLANT INFRASTRUCTURE

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2.4 Operational Workforce

The operation of the Revised Preferred Project will require up to approximately 205 staff. There are 20 people currently working at the mine, predominantly management and other office and support staff.

Underground mining operations would be undertaken 24 hours a day, 7 days per week. Office management and support staff will generally work Mondays to Fridays typically from 6.00am to 4.00pm and will total approximately 30 staff.

The operations shift workforce will indicatively comprise 35 staff currently proposed to work on the following shift rotations, noting this may change from time to time:

- Mondays to Thursdays – 3 shifts per day (each 9 hours) overlapping – change at face:
  - 7.00am – 4.00pm
  - 3.00pm – 12.00pm
  - 11.00pm – 8.00am
- Fridays to Saturdays – 2 shifts per day (each 12 hours) back to back – change at surface:
  - 6.00am – 6.00pm
  - 6.00pm – 6.00am

2.5 Construction Activities

Construction of the Processing Plant and associated infrastructure, and demolition works will be staged to meet production requirements and is planned to be undertaken within a 12-24 month timeframe (subject to delays such as weather and logistical issues), with an average construction workforce of 22 people. Construction works will be undertaken during standard construction hours 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm Saturday. No construction activities will be undertaken on Sunday and public holidays.

3.0 EXISTING TRAFFIC CONDITIONS

3.1 Principal Road Network

The coal produced by Russell Vale Colliery is transported by road to Port Kembla Coal Loader. The principal road network that services Russell Vale Colliery includes, the Colliery Access Road, Bellambi Lane, Memorial Drive, M1 Princes Motorway, Masters Road, Springhill Road and Port Kembla Road. The public roads that form the transport route between the Colliery and Port Kembla are all approved 25/26 metre B Double routes. **Figure 3** shows the transport route.

Russell Vale Colliery Access Road provides the main vehicle access to the Colliery. It is a two lane road (i.e. single lane in each direction) with widening to provide four lanes at the Princes Highway intersection. It is signposted with a 40km/h speed limit.

The Colliery Access Road forms a signalised cross junction intersection with Princes Highway and Bellambi Lane.

Bellambi Lane between the Princes Highway and Memorial Drive is an east west road which is approximately 730 metres in length and marked as a four lane road. The northern side has no stopping restrictions providing for two traffic lanes eastbound towards Memorial Drive. The westbound direction provides for one (1) travel lane (towards the Princes Highway) with parking in the kerbside lane.

Bellambi Lane forms cross junction intersections with Princes Highway and with Memorial Drive. Both of these intersections are controlled by traffic signals.

This section of Bellambi Lane is a former main/state road but is now a road under the control of Wollongong City Council with a posted speed limit of 60km/h.

Development on the northern side of Bellambi Lane is predominantly the back of residential properties that face Keerong Avenue, which is the next parallel east west street north of Bellambi Lane. The development on the southern side of Bellambi Lane is a mixture of residential and light industrial uses.

Memorial Drive is a state road. It generally provides a four lane divided road between Bellambi Lane and the M1 Motorway (i.e. two lanes in each direction) with additional right and left turning lanes at the at grade signalised intersections.

Memorial Drive is access controlled, except at major at grade intersections. There are four (4) at grade intersections controlled by traffic signals along its length between (and including) Bellambi Lane and the M1 Motorway.

Memorial Drive connects with the M1 Motorway via a grade separated interchange.

The speed limit along Memorial Drive is 80km/h and 90km/h.

M1 Motorway between the Memorial Drive and Masters Road is a state road which provides freeway conditions with 2 lanes of travel in each direction, as well as deceleration and acceleration lanes at off and on ramp locations. The speed limit in this section is a mixture of 80km/h and 90km/h.

Masters Road and Springhill Road are four to six lane divided arterial state roads generally providing for 2-3 travel lanes in each direction as well as left and right turning lanes at intersections. Principal intersections on Masters Road and Springhill Road are signalised.

The speed limit on Masters Road and the section of Springhill Road south/west of Port Kembla Road is 80km/h.

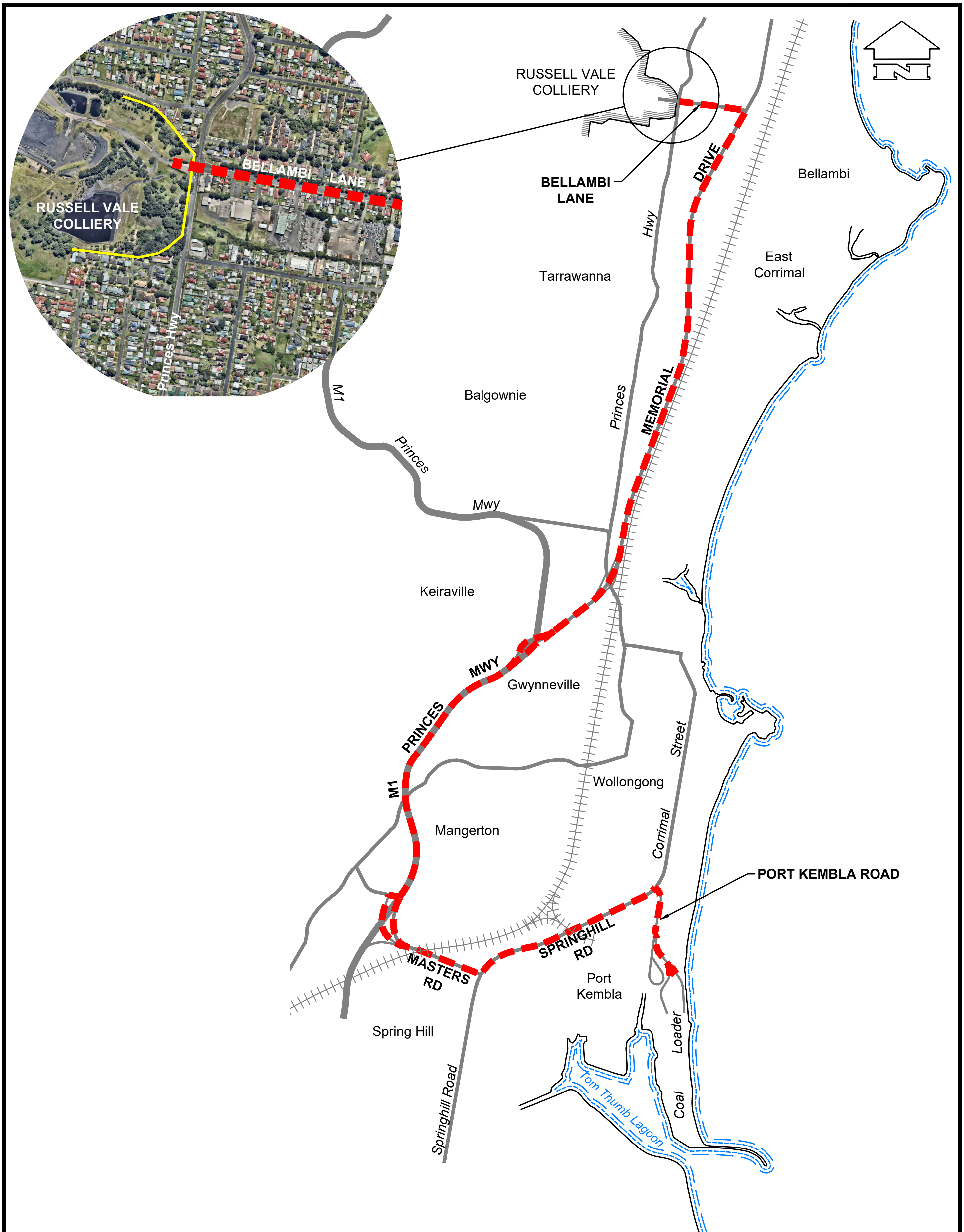

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FIGURE 3
RUSSELL VALE COLLIERY

TRANSPORT ROUTE

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Port Kembla Road provides access to the Coal Loader and is a 2 lane road (single lane in each direction) with additional lanes at its intersection with Springhill Road. The intersection of Spring Hill Road/Port Kembla Road is signalised.

3.2 Principal Intersections

The principal intersections adjacent to Russell Vale Colliery that provide vehicle access to Memorial Drive include:

- Princes Highway/Bellambi Lane/Russell Vale Colliery Access Road; and
- Memorial Drive/Bellambi Lane.

As previously noted both intersections are controlled by traffic signals.

The geometry of these intersections is shown in **Figures 4** and **5**, respectively.

The Princes Highway/Bellambi Lane/Russell Vale Colliery Access Road intersection generally provides for 2 lanes in all approaches of the intersection. The traffic signal operation includes a 2 phase operation with filtering right turn movements in all approaches.

Memorial Drive/Bellambi Lane intersection includes 2 through lanes in both directions of Memorial Drive together with left and right turn lanes in both approaches. Bellambi Lane has 3 approach lanes in the eastern approach and 2 lanes in the western approach. The eastern leg of Bellambi Lane was recently reconfigured as part of the upgrade works for the adjacent Bunnings Warehouse store and **Figure 5** shows the intersection with the upgrade works.

The traffic signal operation provides for right turn arrows in all approaches of the intersection, based on a double diamond overlap phasing operation.

3.3 Existing Traffic Conditions

3.3.1 Existing Traffic Volumes

Traffic counts were undertaken in Bellambi Lane and Memorial Avenue near the Russell Vale site to establish current traffic volumes using the road network.

This included daily volume and vehicle classification counts in Bellambi Lane east of Princes Highway and in Memorial Drive, south of Bellambi Lane which were undertaken for a 7 day period between 2 May and 21 May 2017.

In addition, intersection turning and through traffic volume counts, as well as pedestrian counts were undertaken between 6am and 10am and 2pm to 6pm on Tuesday 2 May 2017, at the intersections of:

- Princes Highway/Bellambi Lane/Russell Vale Colliery Access Road; and
- Memorial Drive/Bellambi Lane.

3.3.2 Daily Volumes and Vehicle Classifications

Tables 3.1 and 3.2 show the daily vehicles including heavy vehicles using Bellambi Lane, east of Princes Highway and Memorial Drive, south of Bellambi Lane respectively. **Figure 6** summarises these volumes and **Appendix 1** includes a copy of the counts.

Reference to Table 3.1 shows that two way traffic volumes using Bellambi Lane are 5,525vpd on an average weekday (i.e. 5 day average) and 5,124vpd on an average day (i.e. 7 day

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FIGURE 4

RUSSELL VALE COLLIERY

EXISTING INTERSECTION

PRINCES HIGHWAY, BELLAMBIE LANE & COLLIERY ACCESS

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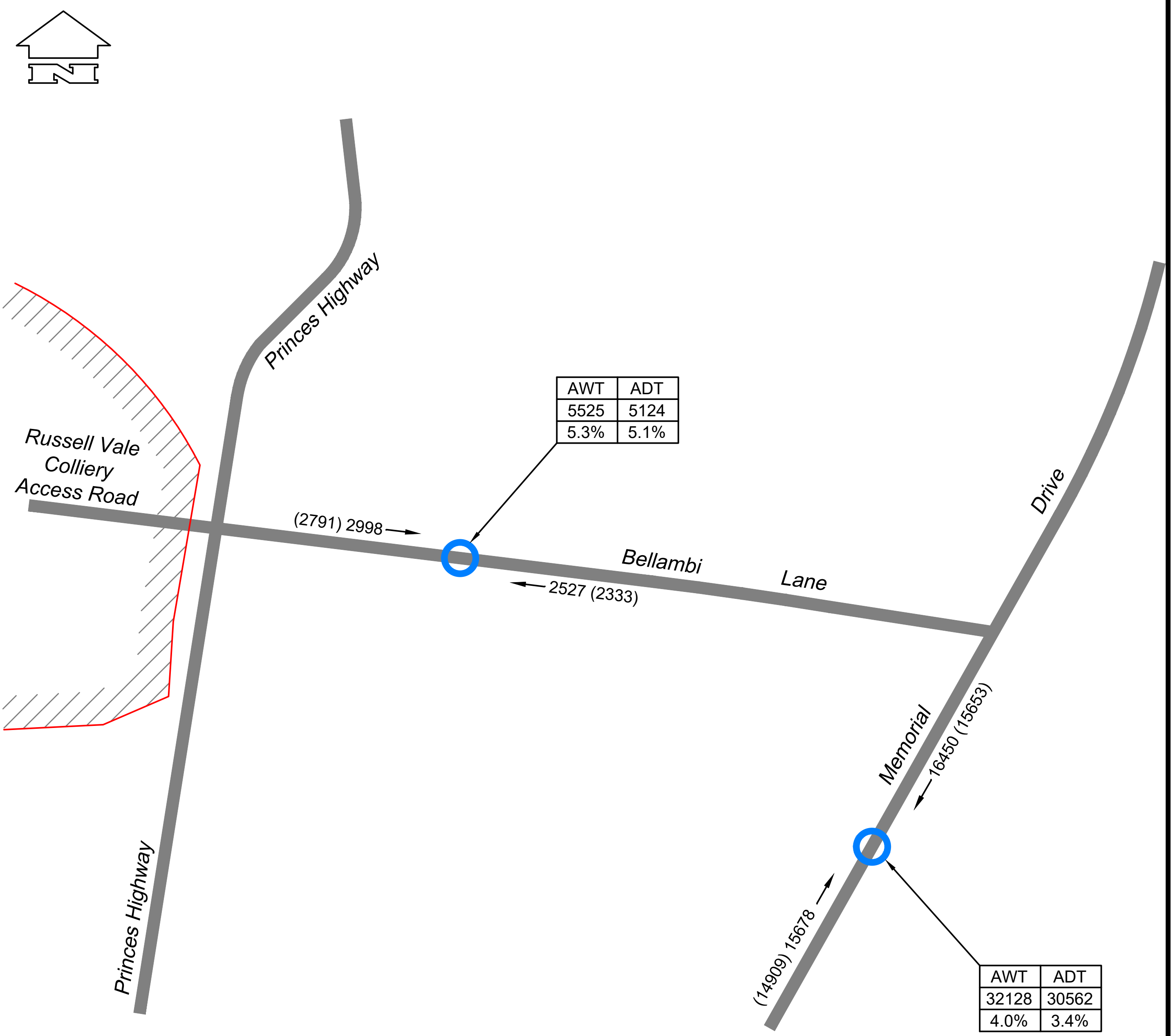
FIGURE 5

RUSSELL VALE COLLIERY

EXISTING INTERSECTION

BELLAMBIE LANE & MEMORIAL DRIVE

JOB NO.17066 06/06/17



AWT	ADT
5525	5124
5.3%	5.1%

AWT	ADT
32128	30562
4.0%	3.4%

LEGEND

AWT	AVERAGE WEEKDAY VOLUME (5 DAY) TWO WAY
ADT	AVERAGE DAILY VOLUME (7 DAY) TWO WAY
270	DIRECTIONAL TOTAL WEEKDAY VOLUME (5 DAY)
(93)	DIRECTIONAL TOTAL OF DAILY VOLUME (7 DAY)
7.7%	% OF HEAVY VEHICLES (AUSTROADS CLASS 3-12)

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FIGURE 6

RUSSELL VALE COLLIERY

EXISTING DAILY VOLUMES AND VEHICLE CLASSIFICATIONS

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average). Heavy vehicles (Austroads Class 3-12) represent 5.3% and 5.1% of the total volumes on weekdays and per day respectively.

Reference to Table 3.2 shows that two way traffic volumes in Memorial Drive are 32,128vpd on an average weekday (5 day average) and 30,562vpd on an average day (7 day average). Heavy vehicles (Austroad Class 3-12) represent 4.0% and 3.4% of total vehicles on weekdays and per day.

Table 3.3 shows the hourly volumes using Bellambi Lane on an average weekday and daily (7 day average). Reference to this table shows that two way hourly volumes between 7am and 10pm range between 90-519vph on an average weekday day and between 86-451vph per day.

TABLE 3.1

BELLAMBI LANE EAST OF PRINCES HIGHWAY
5 DAY AVERAGE AND 7 DAY AVERAGE
TRAFFIC VOLUMES AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)			7 Day Average (ADT)		
	Light[1]	Heavy[2]	Total	Light[1]	Heavy[2]	Total
East	2847	151	2998	2670	121	2791
West	2383	144	2527	2195	138	2333
Total	5230	295	5525	4865	259	5124
Proportion of Total	94.7%	5.3%	100.0%	94.9%	5.1%	100.0%

Source: Traffic Counts undertaken 2-8 May 2017
[1]Light Vehicles – Austroads 1 and 2 vehicle classification and motorbikes
[2]Heavy Vehicles – Austroads 3-12 vehicle classifications

TABLE 3.2

MEMORIAL DRIVE SOUTH OF BELLAMBI LANE
5 DAY AVERAGE AND 7 DAY AVERAGE
TRAFFIC VOLUMES AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)			7 Day Average (ADT)		
	Light[1]	Heavy[2]	Total	Light[1]	Heavy[2]	Total
North	15036	642	15678	14390	519	14909
South	15813	637	16450	15144	509	15653
Total	30849	1279	32128	29534	1028	30562
Proportion of Total	96.0%	4.0%	100.0%	96.6%	3.4%	100.0%

Source: Traffic Counts undertaken 15-21 May 2017
[1]Light Vehicles – Austroads 1 and 2 vehicle classification and motorbikes
[2]Heavy Vehicles – Austroads 3-12 vehicle classifications

TABLE 3.3

HOURLY TRAFFIC VOLUMES IN BELLAMBI LANE EAST OF PRINCES HIGHWAY FOR AVERAGE WEEKDAY AND AVERAGE DAY

Time	5 Day Average			7 Day Average		
	*West	*East	Total	*West	*East	Total
Midnight – 1am	6	4	10	8	9	17
1am-2am	4	3	7	6	4	11
2am-3am	2	3	5	4	4	7
3am-4am	3	6	9	3	5	8
4am-5am	7	13	19	6	11	17
5am-6am	28	59	87	24	47	71
6am-7am	88	140	228	72	114	186
7am-8am	138	207	345	113	168	281
8am-9am	183	336	519	156	278	434
9am-10am	162	231	393	151	224	374
10am-11am	145	193	339	147	209	356
11am-12 noon	139	190	328	152	208	360
12 noon-1pm	148	173	320	154	179	334
1pm-2pm	152	178	330	155	181	337
2pm-3pm	172	201	373	168	186	354
3pm-4pm	245	268	513	215	237	451
4pm-5pm	265	229	494	232	207	439
5pm-6pm	231	202	433	198	178	376
6pm-7pm	156	133	289	135	123	258
7pm-8pm	94	90	183	82	79	161
8pm-9pm	67	57	124	62	53	116
9pm-10pm	48	43	90	43	43	86
10pm-11pm	30	28	58	32	30	63
11pm-Midnight	14	13	26	16	15	31

Source: Traffic Counts undertaken 2-8 May 2017
**Direction of Travel*

NB: Hourly directional volumes may not total due to rounding.

3.3.3 Intersection Traffic Volumes

Figure 7 and **8** show the weekday peak hour traffic volumes together with pedestrian crossing volumes using the two principal intersections adjacent the Russell Vale Colliery site. These peak hour volumes include the traffic generated by the Bunnings Warehouse store as detailed in the traffic and parking assessment report for the Bunnings Development[1] .

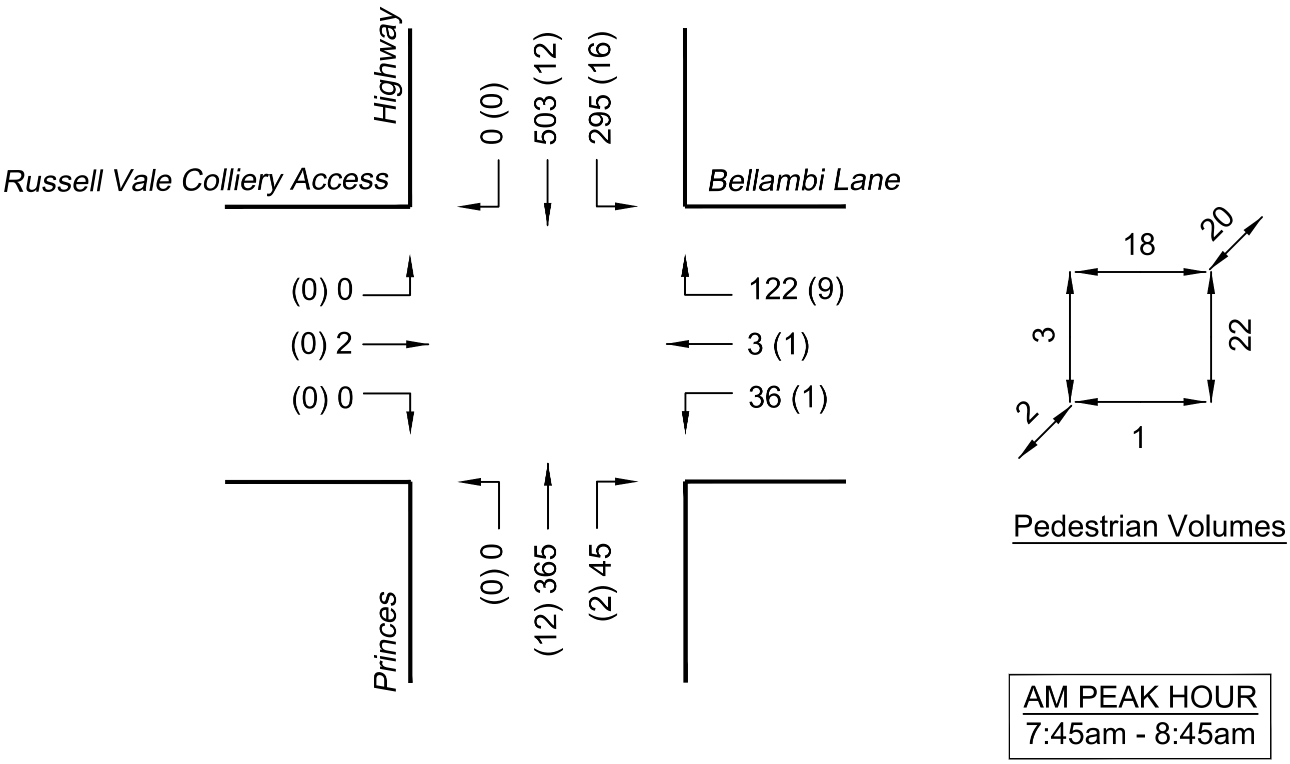
The peak hours occurred at slightly different times at both intersections, due to the level of the traffic volumes using Princes Highway and Memorial Drive.

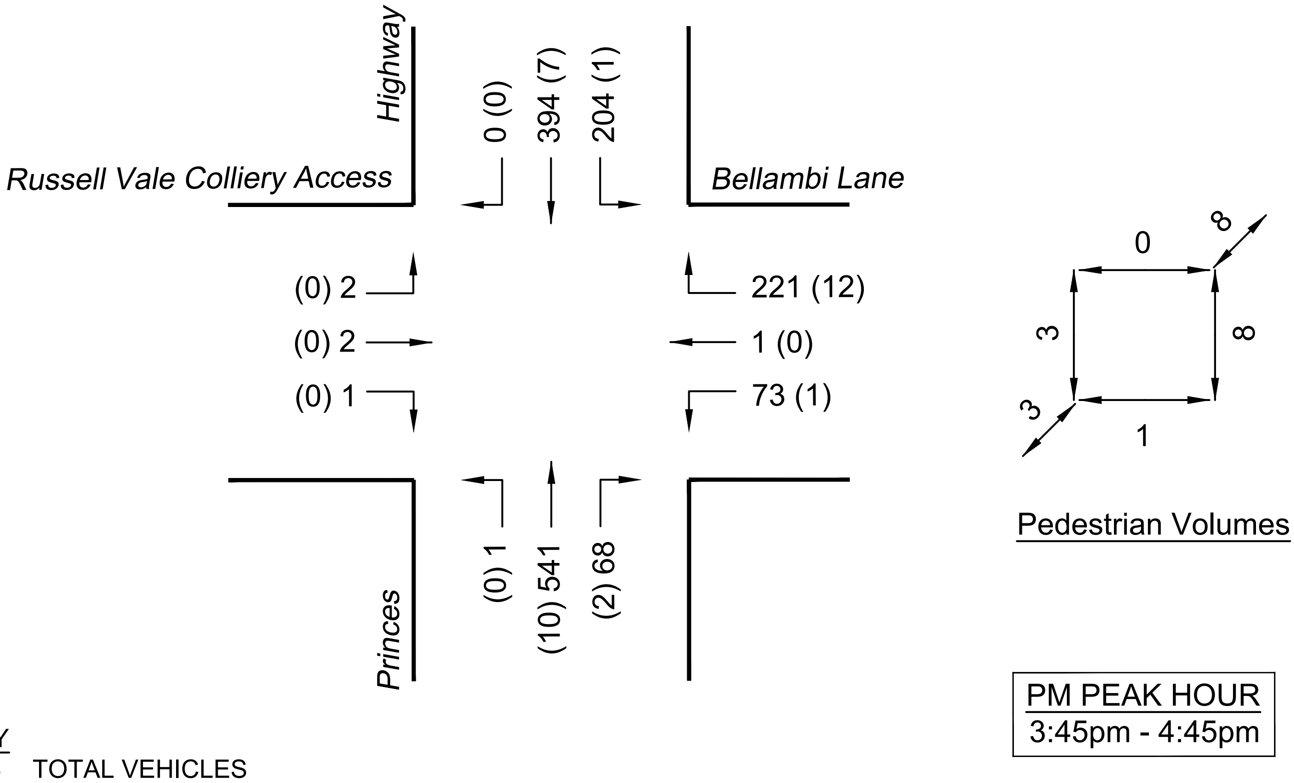
For the purposes of this assessment the hours between 7.45-8.45am and 3.45-4.45pm were adopted as the AM and PM peak hours for both intersections. These times coincide with the maximum traffic levels that will be generated by the Revised Project.

The major traffic movements to and from Bellambi Lane at both intersections are:

- The left turn into Bellambi Lane from the Princes Highway and the corresponding right turn from Bellambi Lane into Princes Highway; and the left turn into Bellambi Lane from Memorial Drive and the corresponding right turn from Bellambi Lane into Memorial Drive.

[1] *Proposed Bunnings Development Bellambi Lane, Bellambi, Assessment of Traffic and Parking Implications Revision B, December 2015, TTPA*





KEY
344 TOTAL VEHICLES
(27) HEAVY VEHICLES

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FIGURE 7

RUSSELL VALE COLLIERY

WEEKDAY AM & PM PEAK HOUR TRAFFIC VOLUMES AT PRINCES HIGHWAY, BELLAMBI LANE & COLLIERY ACCESS ROAD

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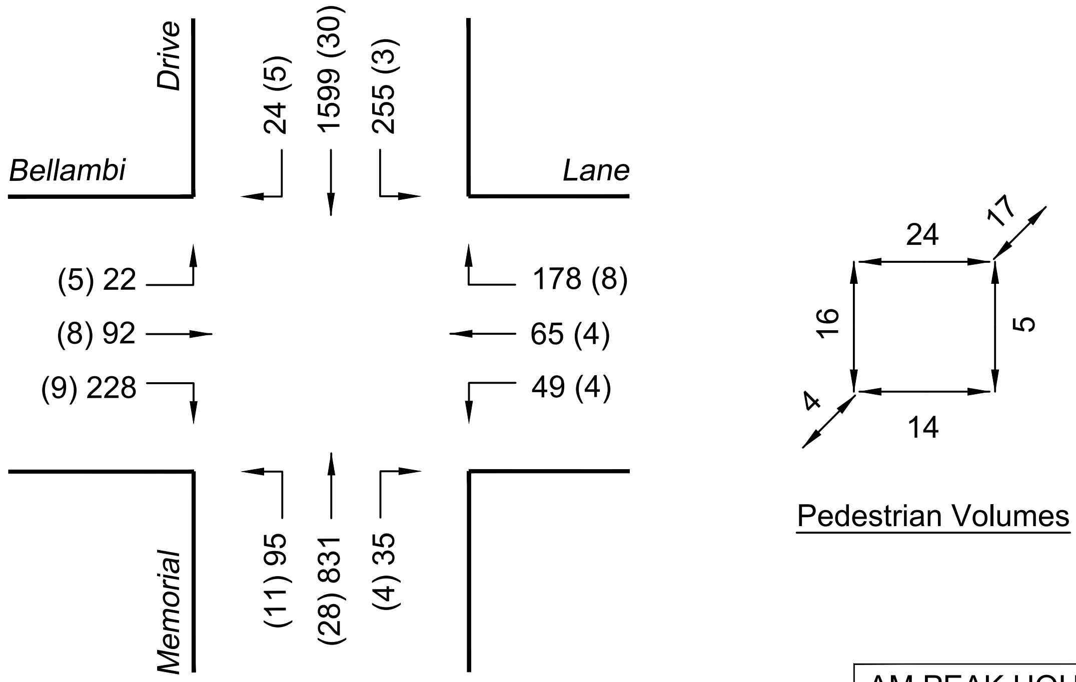
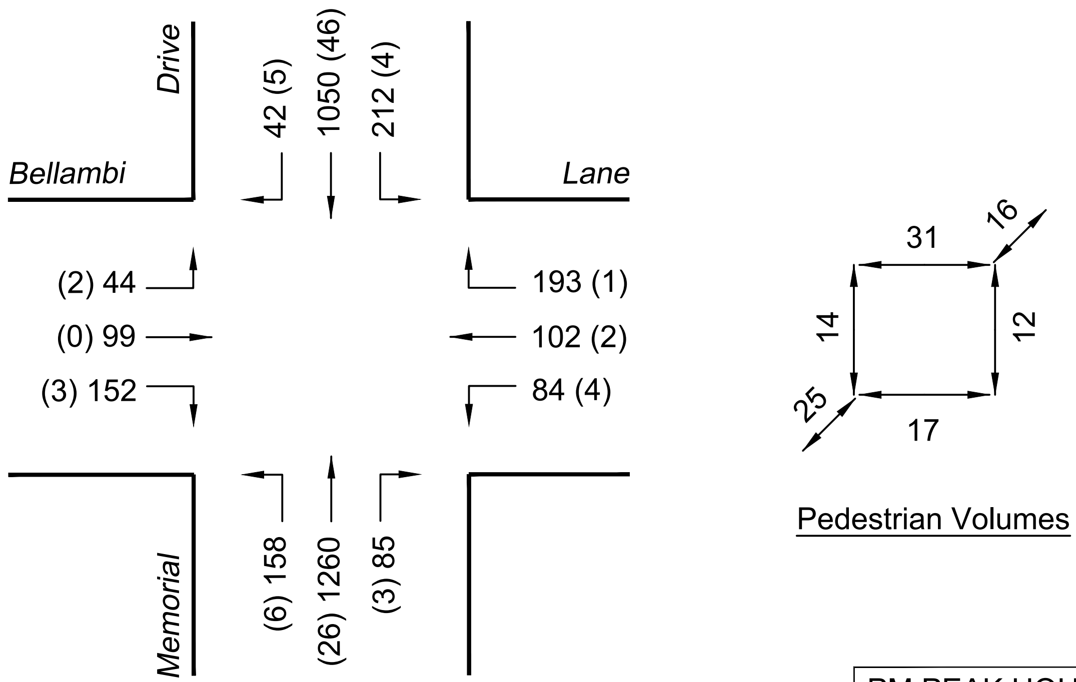


AM PEAK HOUR
7:45am - 8:45am



PM PEAK HOUR
3:45pm - 4:45pm

KEY
344 TOTAL VEHICLES
(27) HEAVY VEHICLES

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FIGURE 8

RUSSELL VALE COLLIERY

WEEKDAY AM & PM PEAK HOUR TRAFFIC VOLUMES AT MEMORIAL DRIVE & BELLAMBI LANE

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3.3.4 Intersection Operation

To examine the operational capacity of the two principal intersections adjacent the Russell Vale site traffic modelling using the SIDRA 8 software package has been undertaken, adopting the peak hour traffic volumes shown in **Figure 5** and **6** and the traffic signal phasing and parking controls at both intersections.

SIDRA assesses the operational performance of intersections under traffic signal, roundabout or sign control. The best criteria for assessing intersections controlled by traffic signals are Level of Service (LS), Degree of Saturation (DS) and Average Vehicle Delay (AVD). Table 4.1 shows the Level of Service Criteria for intersections as presented in the RMS (formerly RTA) Guide to Traffic Generating Developments.

For intersections controlled by traffic signals, the Level of Service of the intersection is determined by the average vehicle delay for all vehicles using the intersection (i.e. not individual movements).

RMS Guidelines indicate that a Level of Service D operation, or better (i.e. A, B, C or D) is desirable design criteria for intersections.

TABLE 4.1

LEVEL OF SERVICE CRITERIA FOR INTERSECTIONS

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Intersection is oversaturated	Oversaturated, requires other control mode
Source: Table 4.1 Guide to Traffic Generating Developments October 2002			

Site observations confirmed that:

- The Princes Highway/Bellambi Lane/Colliery Access Road intersection operated as an isolated intersection with variable cycle lengths between 39 seconds and 70 seconds; and

- The Memorial Drive/Bellambi Lane intersection operated with cycle lengths that varied between 110 seconds and up to 150 seconds, although the higher cycle lengths were not required by the traffic demands at this intersection. The higher cycle lengths appeared to be associated with traffic signal co-ordination with other signalised intersections in Memorial Drive.

For the purpose of the traffic modelling a cycle length of 70 seconds was adopted for the Princes Highway/Bellambi Lane/Colliery Access Road intersection and 120 seconds was adopted for Memorial Drive/Bellambi Lane intersection.

A network benefit of 10% was adopted for the through lanes in Memorial Drive to account for the benefits of traffic signal co-ordination in Memorial Drive.

The results of the modelling are shown in Tables 3.4 and 3.5.

Reference to Table 3.4 shows that the Princes Highway/Bellambi Lane/Colliery Access Road intersection has a very good operation in the AM and PM peak hours with a Level of Service A operation and average vehicle delays in the order of 11.0 to 14.4 seconds per vehicle.

Reference to Table 3.5 shows that Memorial Drive/Bellambi Lane intersection has a satisfactory operation in both peak hours with a Level of Service C operation and average vehicle delays of 28.4 to 30.3 seconds per vehicle.

The SIDRA Traffic Modelling Outputs are contained in Appendix 2.

TABLE 3.4

SIDRA MODELLING RESULTS FOR PRINCES HIGHWAY/BELLAMBI LANE/COLLIERY ACCESS INTERSECTION ROAD FOR EXISTING CONDITIONS AT CYCLE LENGTH OF 70 SECONDS

Criteria	Existing	
	AM	PM
LS	A	A
DS	0.277	0.401
AVD (secs)	11.0	14.4

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

TABLE 3.5

SIDRA MODELLING RESULTS FOR MEMORIAL DRIVE/BELLAMBI LANE INTERSECTION FOR EXISTING CONDITIONS AT CYCLE LENGTH OF 120 SECONDS

Criteria	Existing	
	AM	PM
LS	C	C
DS	0.811	0.704
AVD (secs)	28.4	30.3

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

3.4 Road Safety

Road crash statistics for the 5 year period between 1 October 2011 to 30 September 2016 for Bellambi Lane between Princes Highway and Memorial Drive, including the two intersections, were obtained from the RMS.

- During this period there were two (2) non injury road crashes at the intersection of Princes Highway/Bellambi Lane/Colliery Access Road, including one (1) rear end crash and one (1) cross traffic crash; and

- Seven (7) crashes at the intersection of Memorial Drive/Bellambi Lane, three (3) of which were injury crashes. The seven (7) crashes included three (3) rear end crashes, two (2) cross traffic crashes and two (2) right turn/through vehicle crashes.

Trucks were involved in one (1) crash and each of the intersections (ie 2 in total). Both crashes were non injury crashes.

There were no midblock crashes in Bellambi Lane between Princes Highway and Memorial Drive in this period.

There was a fatal head on crash in the Princes Highway, 10 metres south of Keerong Avenue, which is north of the Bellambi Lane/Colliery Access Road/Princes Highway intersection. There was also an injury crash involving a cyclist in Bellambi Lane, 40 metres east of Memorial Drive. Neither of these 2 crashes occurred at Bellambi Lane intersections with the Princes Highway and or Memorial Drive.

There is no particular treatable pattern to the road crashes at either intersection.

3.5 Future Development, Road Network Changes and Traffic Growth

The Revised Project, if approved is expected to have a life of 5 years.

Background traffic growth from developments in this part of the Wollongong Region is expected to be in the order of 1%-2% per year over the next 5-10 years (i.e. average of 1.5% per year).

The RMS have recently completed the upgrade of the northbound exit ramps from Memorial Drive to Princes Highway at North Wollongong.

Other RMS proposed upgrade plans in the Illawarra Region will not have any traffic impact on the road transport associated with the Revised Project.

1. *Proposed Bunnings Development Bellambi Lane, Bellambi Assessment of Traffic and Parking Implications. Dec 2015 (Rev B) TTPA.*

4.0 ASSESSMENT OF TRAFFIC IMPACTS

4.1 Traffic Generation

Operational Phase

The Revised Project will limit coal truck movements to an average of 16 outbound laden trucks per hour between 7.00am to 6.00pm (Monday - Friday) and 8.00am to 6.00pm (Saturdays). Coal transport may occasionally be required until 10.00pm Monday to Friday as a result of unexpected Port closures or interruptions. If this is the case, outbound laden truck movements will be further limited to an average of 12 trucks per hour between 6.00pm and 10.00pm, Monday to Friday. No evening truck movements are proposed on weekends.

On Monday to Friday trucks may arrive on site prior to the commencement of coal loading operations at 7.00am (Monday – Friday) and 8.00am (Saturdays) and these trucks will enter the Colliery site and park in the designated truck parking areas with their engines switched off. A maximum of up to 12 trucks may arrive between 6.30am and 7.00am and these may occur over a 30 minute period of time.

The above truck numbers are based on the use of 19 metre articulated vehicles (i.e. semi-trailers, truck and dog trailers). WCL may, in the future, use B double vehicles which will reduce the average number of outbound trucks to 12 laden trucks per hour.

Up to a maximum of one (1) truck per hour associated with fuel supplies, deliveries, maintenance etc. may arrive during the day between 7.00am and 6.00pm Monday to Friday.

Assuming the return trip within the hour, then the average heavy vehicle truck traffic generation will be 17 inbound/17 outbound trucks per hour between 7.00am to 6.00pm Monday to Friday.

Workforce trips (i.e. light vehicles) will include:

- Management and support staff which would number 30 people, who work between 6am-4pm Monday to Friday. Arrival and departure times for this personnel will be between 5am-6am and 4pm-5pm;

- Mining and operational staff who total approximately 200 people and who will work 3 shifts per day of 35 personnel Monday to Thursday and 2 longer shifts per day on Friday to Sunday.

The table below shows the arrival and departure trips of the workforce per day for Monday to Thursday which will be the busiest days.

WORKFORCE SHIFT TRIPS MONDAY TO THURSDAY (LIGHT VEHICLES)

Shift Time and Workers	TRIPS PER HOUR											
	5am-6am	6am-7am	7am-8am	8am-9am	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	10pm-11pm	11pm-12am	12am-1am
Management and Office Staff 6am-4pm 30 Staff	30 in						30 out					
Mining Day Shift 7am-4pm 35 workers		35 in					35 out					
Mining Afternoon Shift 3pm-12.00am 35 workers					35 in							35 out
Mining Night Shift 11pm-8am 35 workers				35 out						35 in		

Based on the above assumptions, the average weekday AM and PM peak hour traffic generation of Russell Vale Colliery under the Revised Project during the operational phase will be as follows:

AM Peak Hour

- 17 inbound/17 outbound heavy vehicles; and
- 35 outbound light vehicle trips

PM Peak Hour

- 17 inbound/17 outbound heavy vehicle trips; and
- 65 outbound light vehicle trips

Figure 9 shows the additional Operational Traffic Volumes associated with the Revised Project assigned to the Road Network in the weekday AM and PM peak hours.

Based on 300 days of transportation per year and average load of 28 tonnes (assumes semi-trailers or truck and dog trailers) the number of coal trucks generated on an average day would be 119-120 outbound laden tucks (i.e. 238-240 truck movements per day with return trip).

Daily truck numbers would be reduced if B-Double vehicles are used.

It is noted that the total traffic generation of coal truck trips for the Revised Project is similar to the previous levels generated by Russell Vale Colliery. The July 2010 Traffic Study report prepared by Consultants Cardno for Russell Vale for a previous proposal (to continue mining operations at NRE No. 1 Colliery) noted that the 2009 coal transport from the colliery was 1,000,000 tonnes.

Construction Phase

Construction works is expected to be undertaken over a 12-24 month time period and will involve an average of 22 people in the construction workforce.

Construction hours will be 7.00am – 6.00pm Monday to Friday and 8.00am to 1.00pm Saturday.

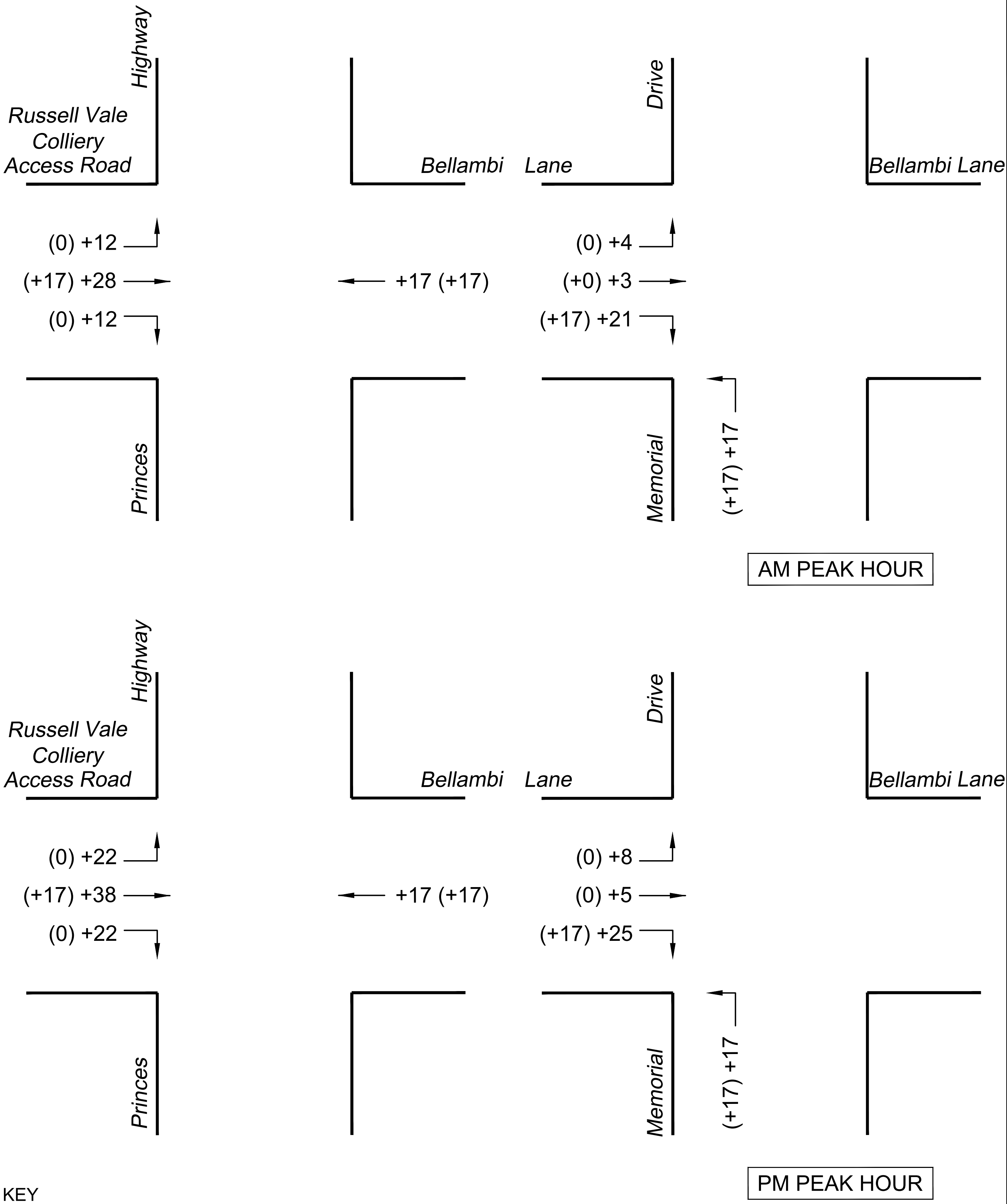
The traffic generation during the construction phase is estimated to be:

- 22 workers (i.e. light vehicle trips) who will arrive generally between 6.00am – 7.00am and depart between 6.00pm – 7.00pm; and

- Up to 8 heavy vehicles per day (i.e. 8 in/8 out) including 2 oversize vehicles per week.

All oversize vehicles delivering equipment or materials during the Construction Stage or in the Operational Stage will have the appropriate permits as required.

The transport of coal off site will be phased in over the construction period. The total traffic generation of the construction phase plus phase-in coal transport off the site will be managed within the total traffic generation assessed for the Operational Phase, with the Operational Phase representing the worst case traffic generation of the Revised Project for assessment purposes.



KEY
+344 ADDITIONAL TOTAL VEHICLES
(+27) ADDITIONAL HEAVY VEHICLES

TRANSPORT AND URBAN PLANNING
TRAFFIC, TRANSPORT & PROJECT MANAGEMENT CONSULTANTS
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FIGURE 9
RUSSELL VALE COLLIERY

TRAFFIC GENERATION OF REVISED PROJECT IN WEEKDAY AM & PM PEAK HOURS

JOB NO.17066 29/11/18

4.2 Traffic Impacts

4.2.1 Revised Project Operational Phase

To assess the impacts of the traffic generation of the Revised Project on the principal adjacent intersections, SIDRA traffic modelling has been undertaken for the AM and PM peak hours, adopting the additional traffic generation as shown on **Figure 9**, which has been overlaid onto the existing AM and PM peak hour traffic volumes.

The modelling has adopted the traffic management and traffic signal operation for the Princes Highway/Bellambi Lane/Colliery Access Road and the Memorial Drive/Bellambi Lane intersections as outlined in Section 3.3.4.

The traffic modelling results are shown in Table 4.1 and 4.2. Reference to Tables 4.1 and 4.2 shows that the additional traffic associated with the Revised Project will have relatively minor impacts on both intersections.

The intersection of Princes Highway/Bellambi Lane/Colliery Access Road will have a Level of Service A/B operation which is a good operation in terms of capacity with average vehicle delays in the order of 11.5 seconds to 15.3 seconds per vehicle.

The intersection of Memorial Drive/Bellambi Lane will also continue to have a satisfactory operation with a C Level of Service and average vehicle delays in the order 33.6 to 34.2 seconds per vehicle.

Appendix 2 contains a copy of the traffic modelling outputs.

TABLE 4.1

SIDRA MODELLING RESULTS FOR PRINCES HIGHWAY/BELLAMBI LANE/COLLIERY ACCESS INTERSECTION ROAD WITH REVISED PROJECT AT CYCLE LENGTH OF 70 SECONDS

Criteria	Existing		With Revised Project	
	AM	PM	AM	PM
LS	A	A	A	B
DS	0.277	0.401	0.289	0.420
AVD (secs)	11.0	14.4	11.5	15.3

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

TABLE 4.2

SIDRA MODELLING RESULTS FOR MEMORIAL DRIVE/BELLAMBI LANE INTERSECTION ROAD WITH REVISED PROJECT AT CYCLE LENGTH OF 120 SECONDS

Criteria	Existing		With Revised Project	
	AM	PM	AM	PM
LS	B	C	C	C
DS	0.811	0.704	0.859	0.748
AVD (secs)	28.4	30.3	34.2	33.6

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

4.2.2 Cumulative Impacts

The future 2023 cumulative impacts for both intersections has also been examined using SIDRA modelling. The cumulative impacts include;

- An additional 1.5% lineal growth per year up to 2023 to account for background traffic growth; and
- The traffic generation of the Revised Project as shown on **Figure 9.**

The results of this modelling are shown in Tables 4.3 and 4.4. Reference to Table 4.3 and 4.4 shows that:

- Princes Highway/Bellambi Lane/Colliery Access Road intersection will continue to operate at a good level of service (A/B operation) with low average vehicle delays; and

- Memorial Drive/Bellambi Lane will operate at a satisfactory level of service (C/D operation) with average vehicle delays in the order of 35.2 to 42.7 seconds per vehicle.

Appendix 2 includes a copy of the traffic modelling outputs.

TABLE 4.3

SIDRA MODELLING RESULTS FOR PRINCES HIGHWAY/BELLAMBI LANE/COLLIERY ACCESS INTERSECTION ROAD FOR 2023 WITH CUMULATIVE IMPACTS AT CYCLE LENGTH OF 70 SECONDS

Criteria	Cumulative Impacts	
	AM	PM
LS	A	B
DS	0.326	0.461
AVD (secs)	11.9	15.6

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

TABLE 4.4

SIDRA MODELLING RESULTS FOR MEMORIAL DRIVE/BELLAMBI LANE INTERSECTION ROAD FOR 2023 WITH CUMULATIVE IMPACTS AT CYCLE LENGTH OF 120 SECONDS

Criteria	Cumulative Impacts	
	AM	PM
LS	D	C
DS	0.924	0.815
AVD (secs)	42.7	35.2

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds

4.2.3 Higher Levels of Coal Trucks in Peak Hours

Higher levels of coal trucks per hour could occur due to the bunching of arrivals and departures of the trucks, caused by the traffic conditions on the road network and other factors. These higher levels would not occur every hour and every day, but may occur from time to time.

To account for this, a scenario where 25 laden trucks leave the site, as well as 25 return trips has been also modelled for the operational phase of the Revised Project in 2018 and with the cumulative impacts in 2023.

The results of this modelling are shown in Tables 4.5 and 4.6.

Reference to Table 4.5 shows that the intersection of Princes Highway/Bellambi Lane/Colliery Access Road will continue to have a good operation (i.e. Level of Service A/B operation) with the higher truck levels in 2018 and in 2023 with the cumulative impacts of the background traffic growth.

TABLE 4.5

SIDRA MODELLING RESULTS FOR PRINCES HIGHWAY/BELLAMBI LANE/COLLIERY ACCESS INTERSECTION ROAD WITH REVISED PROJECT FOR 2018 AND 2023 WITH HIGHER TRUCK LEVELS AT CYCLE LENGTH OF 70 SECONDS[1]

Criteria	2018		2023[2]	
	AM	PM	AM	PM
LS	A	B	A	B
DS	0.303	0.432	0.338	0.476
AVD (secs)	11.9	15.7	12.3	15.7

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds
[1]Higher Truck Levels
[2]Includes Cumulative Impacts

Reference to Table 4.6 shows that the intersection of Memorial Drive/Bellambi Lane will also continue to operate at a satisfactory Level of Service (Level of Service C operation in 2018 and C/D operation in 2023) with the higher levels of trucks in 2018 and in 2023, with the cumulative impacts of the background traffic growth.

Appendix 2 includes a copy of the traffic modelling outputs.

TABLE 4.6

SIDRA MODELLING RESULTS FOR MEMORIAL DRIVE/BELLAMBI LANE WITH REVISED PROJECT FOR 2018 AND 2023 WITH HIGHER TRUCK LEVELS AT CYCLE LENGTH OF 120 SECONDS[1]

Criteria	2018		2023[2]	
	AM	PM	AM	PM
LS	C	C	D	C
DS	0.865	0.748	0.925	0.834
AVD (secs)	34.5	34.1	43.3	37.3

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay in seconds
[1]Higher Truck Levels
[2]Includes Cumulative Impacts

4.2.4 Impacts at Other Times

The offsite coal truck movements outside the weekday peak hours including the occasional coal transport between 6pm and 10pm on weeknights will have lower overall traffic impacts on the road network than the impacts assessed for the weekday AM and PM peak hours.

The traffic volumes using the road network at these other times are lower than during the weekday AM and PM peak hours, resulting in lower overall traffic impacts.

4.2.5 Construction Phase

The traffic impacts of the construction phase on the adjacent road network will be relatively minor and less than that assessed for the operational phase.

The construction workforce trips of an average of 22 people per day arriving and departing the colliery will occur before and after the weekday AM and PM peak hours and as noted in Section 4.2.1 above, the adjoining principal intersections currently have adequate capacity.

While the transport of the coal off site will be phased in over the construction period, the total traffic generation of the construction phase plus the phase in coal transport will be less than the Operational Phase.

4.3 Impact on Road Safety and Other Road Users

The Revised Project is not expected to have any adverse impacts on road safety on the road network, or on other road users.

While there will be an increase in traffic using the road network due to the Revised Project, the traffic volumes generated by the Revised Project will generally be of the same level as previously generated by the colliery. The transport route via Bellambi Lane/Memorial Drive to Port Kembla uses Bellambi Lane to Memorial Drive and then state arterial roads and motorways. All these roads are approved 25/26 metre B-Double routes.

The principal adjacent intersections to the colliery in Bellambi Lane are signalised.

Traffic conditions at both these intersections are expected to remain satisfactory over the life of the Revised Project.

WCL are proposing to maintain a voluntary 50km/h speed restriction in Bellambi Lane on all trucks generated by the colliery and will continue to maintain the truck speeds aiming to achieve 95% compliance with the voluntary speed restriction and 100% compliance with the signposted 60km/h speed limit. Compliance will be assessed using GPS monitoring.

4.4 Bellambi Lane Pavement

WCL are prepared to negotiate making a contribution to Wollongong City Council towards pavement upgrade and maintenance of Bellambi Lane and this requirement can be included in the Planning Agreement and or included as a Condition of Consent, if approval to the Revised Project is granted.

4.5 On Site Operations

The Russell Vale Colliery site has sufficient truck parking areas as well as car parking areas.

The site has sufficient truck parking areas to prevent any queueing of trucks onto the adjoining public road system, and all trucks awaiting loading will park in one of these areas.

As noted in Section 2.3 and 4.1 some trucks may enter the site before 7.00am on weekdays and 8.00am on Saturday prior to the commencement of loading operations. These trucks will park in the designated truck parking area and switch off their engines.

4.6 Traffic and Transport Issues Identified in PAC Second Review Report

The PAC Second Review Report identified 4 issues under the heading Traffic and Transport Issues. Table 1.1 refers. As noted in Table 1.1, Items 1 and 2 are noise matters and addressed elsewhere in the EIS and in particular in the Noise Assessment Report.

Item 3 is a contribution by the proponent to Wollongong City Council for pavement upgrade works in Bellambi Lane. As noted in Section 4.4 above, the proponent will make a contribution for these works and this will be included in a negotiated Planning Agreement with Wollongong City Council.

Item 4 identified that there was insufficient justification to increase production level to 3Mtpa. The Revised Project nominates a maximum production level of 1 million tonnes per year.

4.7 Summary

In summary, it is concluded that the traffic impacts of the Revised Project on the road network will be satisfactory.

The traffic generation of coal trucks transporting the coal from Russell Vale to Port Kembla for the Revised Project, will be similar to the previous traffic generation of the Colliery as recorded in 2009.

As noted in this report, the transport route to Port Kembla via Bellambi Lane and Memorial Drive and then other state arterial roads and motorways is an approved 25/26 metre B Double route and therefore suitable for use by heavy vehicles.

5.0 CONCLUSIONS

This report documents the response to the traffic and transport issues raised in PAC Second Review report to the Underground Expansion Project at Russell Vale Colliery and provides an updated traffic and transport assessment.

A Revised Plan (Project) has been developed by WCL to address those issues raised in the PAC Second Review Report.

The assessment has concluded that traffic conditions on the road network will remain satisfactory with the Revised Project in place.

The traffic generation of the Revised Project will be similar to the previous traffic generation of the Russell Vale Colliery, when it was operational.

It is also noted that the traffic and transport issues raised in the latest PAC report are addressed by the Revised Project.

REFERENCES

1. Austroads Guide to Road Design
2. Austroads Guide to Road Safety
3. Austroads Guide to Traffic Management
4. RMS Austroads Guide Supplements – Austroads Guide to Traffic Management
5. RMS Supplement to Austroads Guide to Road Design Parts 1-5, 6 and 8
6. RMS Supplements to Austroads Guide to Road Safety
7. Cardno Gujarat NRE No. 1 Mine Traffic Study July 2010
8. Cardno Gujarat NRE No. 1 Mine Traffic Study – Addendum Report September 2010
9. Planning and Assessment Commission Russell Vale Colliery Underground Expansion Project. Second Review Report March 2016

APPENDIX 1

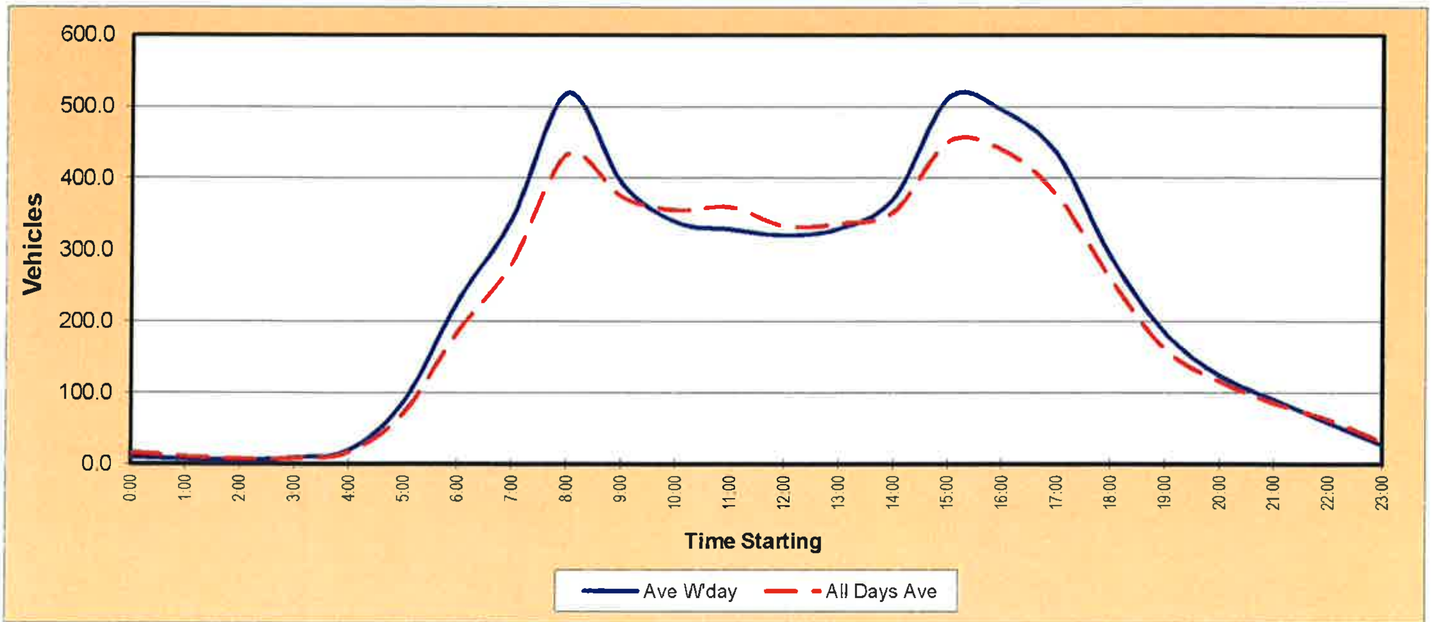
TRAFFIC COUNTS

austraffic

Road	Bellambi Ln
Location	East of Princes Hwy
Site No.	7812_1
Start Date	Tuesday 02/05/2017
Direction	Two ways

Average Weekday	5524
All Day Average	5124
Weekday Heavy's	5.3%
All Day Heavy's	4.6%

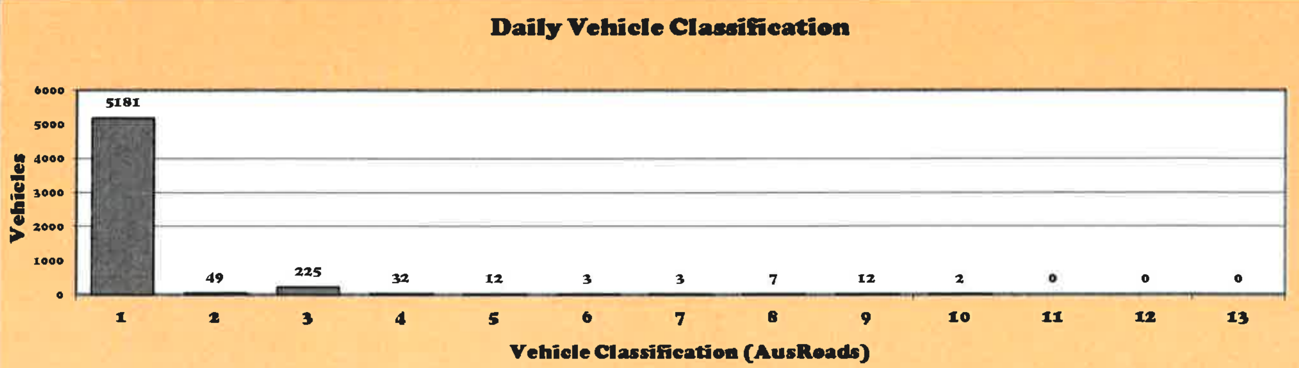
Starting Time	Day of Week							Ave W'day	All Days Ave
	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
	8-May	2-May	3-May	4-May	5-May	6-May	7-May		
AM Peak	**498**	**493**	**526**	**552**	**526**	**495**	**385**		
PM Peak	**489**	**506**	**507**	**531**	**559**	**407**	**341**		
0:00	7	0	13	10	19	36	31	10	17
1:00	9	4	4	9	9	15	24	7	11
2:00	7	5	1	4	10	9	14	5	7
3:00	6	8	8	6	17	3	8	9	8
4:00	18	22	21	16	20	9	11	19	17
5:00	77	89	98	84	86	40	24	87	71
6:00	219	247	214	225	234	96	66	228	186
7:00	326	364	345	383	307	148	93	345	281
8:00	498	493	526	552	526	282	159	519	434
9:00	381	364	414	401	406	369	286	393	374
10:00	317	332	333	338	374	471	324	339	356
11:00	307	292	337	319	387	495	385	328	360
12:00	317	280	352	301	351	393	341	320	334
13:00	306	303	350	322	368	407	300	330	337
14:00	373	333	325	400	434	330	280	373	354
15:00	474	495	506	531	559	326	269	513	451
16:00	489	506	507	528	441	299	304	494	439
17:00	390	445	427	453	451	281	185	433	376
18:00	249	315	271	314	297	180	178	289	258
19:00	150	157	183	201	225	119	89	183	161
20:00	98	129	122	143	127	102	88	124	116
21:00	70	84	72	104	122	98	50	90	86
22:00	54	43	65	57	73	105	42	58	63
23:00	13	25	23	23	48	60	24	26	31
Total	**5155**	**5335**	**5517**	**5724**	**5891**	**4673**	**3575**	**5524**	**5124**
% Heavies	**5.8%**	**5.3%**	**5.4%**	**5.3%**	**5.0%**	**2.7%**	**1.4%**	**5.3%**	**4.6%**



Road	Bellambi Ln	**AADT**	5,524	
Location	East of Princes Hwy	**Ave Speed**	56.9	
Site No.	7812_1	**85%ile**	63	
Start Date	Tuesday 02/05/2017	**% Heavy's**	5.3%	
Displayed	WeekDay Avg			

Peak	Time	Vol
AM	08:00	519
PM	15:00	513

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	Speed 85%ile
0:00	9	0	0	0	0	0	0	0	0	0	0	0	0	9.8	59.2	66.2
1:00	7	0	0	0	0	0	0	0	0	0	0	0	0	7.0	60.9	67.8
2:00	5	1	0	0	0	0	0	0	0	0	0	0	0	5.4	56.2	63.4
3:00	7	0	0	0	0	0	0	1	0	0	0	0	0	9.0	50.0	61.8
4:00	17	0	1	1	0	0	0	0	0	0	0	0	0	19.4	56.6	66.7
5:00	79	0	3	3	1	0	0	0	0	0	0	0	0	86.8	57.4	66.2
6:00	208	2	11	2	2	0	0	0	1	0	0	0	0	227.8	56.7	63.9
7:00	317	5	17	2	2	0	0	0	2	0	0	0	0	345.0	56.5	63.3
8:00	486	3	24	3	1	0	0	0	1	0	0	0	0	519.0	56.5	62.3
9:00	364	5	20	3	1	0	0	1	1	0	0	0	0	393.2	57.1	63.8
10:00	311	3	19	3	0	0	0	0	1	0	0	0	0	338.8	56.6	63.4
11:00	299	3	19	3	2	0	0	0	1	0	0	0	0	328.4	56.0	63.6
12:00	292	5	17	2	1	0	1	1	1	0	0	0	0	320.2	57.0	64.3
13:00	304	3	19	2	0	0	0	0	1	0	0	0	0	329.8	56.5	63.6
14:00	348	3	18	2	1	1	0	1	1	0	0	0	0	373.0	57.0	63.8
15:00	483	5	20	3	0	1	0	0	1	0	0	0	0	513.0	56.7	63.1
16:00	473	3	14	1	1	0	0	1	0	0	0	0	0	494.2	57.0	62.9
17:00	419	2	10	1	0	0	0	0	1	0	0	0	0	433.2	57.1	63.5
18:00	282	3	4	0	0	0	0	0	0	0	0	0	0	289.2	57.2	63.1
19:00	180	0	3	0	0	0	0	0	0	0	0	0	0	183.2	57.5	63.9
20:00	120	1	3	0	0	0	0	0	0	0	0	0	0	123.8	58.1	64.0
21:00	89	0	1	0	0	0	0	0	0	0	0	0	0	90.4	58.0	64.2
22:00	57	0	1	0	0	0	0	0	0	0	0	0	0	58.4	58.4	65.2
23:00	26	0	1	0	0	0	0	0	0	0	0	0	0	26.4	58.7	65.1
Total	5181	49	225	32	12	3	3	7	12	2	0	0	0	5524	56.9	63.4
	93.8%	0.9%	4.1%	0.6%	0.2%	0.1%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

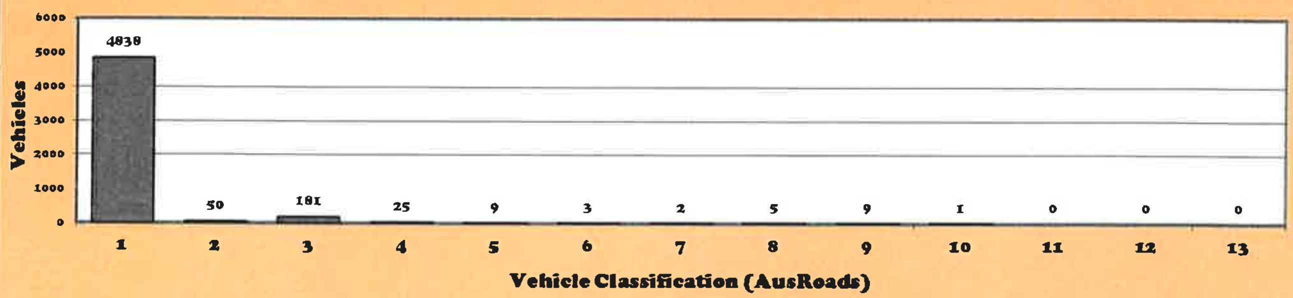


austraffic

Road	Bellambi Ln	**AADT**	5,124	**Peak**	**Time**	**Vol**
Location	East of Princes Hwy	**Ave Speed**	57.2	**AM**	08:00	434
Site No.	7812_1	**85%ile**	63	**PM**	15:00	451
Start Date	Tuesday 02/05/2017	**% Heavy's**	4.6%			
Displayed	Total Avg					

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	16	0	1	0	0	0	0	0	0	0	0	0	0	16.6	59.9	65.8
1:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10.6	61.1	68.3
2:00	6	1	0	0	0	0	0	0	0	0	0	0	0	7.1	58.5	67.2
3:00	7	0	0	0	0	0	0	1	0	0	0	0	0	8.0	52.0	64.0
4:00	14	0	1	1	0	0	0	0	0	0	0	0	0	16.7	57.4	67.7
5:00	65	0	2	2	1	0	0	0	0	0	0	0	0	71.1	57.5	66.0
6:00	170	3	8	2	2	0	0	0	1	0	0	0	0	185.9	57.0	64.3
7:00	258	4	14	1	1	0	0	0	1	0	0	0	0	280.9	56.7	63.4
8:00	406	3	19	3	1	0	0	0	1	0	0	0	0	433.7	56.7	62.8
9:00	350	5	15	2	0	0	0	1	0	0	0	0	0	374.4	57.4	64.2
10:00	331	4	16	3	0	0	0	0	1	0	0	0	0	355.6	57.0	63.6
11:00	334	6	15	2	1	0	0	0	1	0	0	0	0	360.3	56.6	64.0
12:00	310	4	15	2	1	0	0	1	1	0	0	0	0	333.6	57.2	64.0
13:00	315	3	16	2	0	0	0	0	0	0	0	0	0	336.6	56.8	63.9
14:00	333	3	14	1	1	0	0	1	0	0	0	0	0	353.6	57.5	64.1
15:00	427	5	15	2	0	1	0	1	1	0	0	0	0	451.4	57.1	63.5
16:00	422	3	11	1	1	0	0	0	0	0	0	0	0	439.1	57.3	63.1
17:00	364	2	8	0	0	0	0	0	1	0	0	0	0	376.0	57.2	63.5
18:00	251	2	4	0	0	0	0	0	0	0	0	0	0	257.7	57.4	63.3
19:00	158	0	2	0	0	0	0	0	0	0	0	0	0	160.6	57.5	63.8
20:00	113	1	2	0	0	0	0	0	0	0	0	0	0	115.6	58.0	63.7
21:00	85	0	1	0	0	0	0	0	0	0	0	0	0	85.7	58.2	64.3
22:00	62	0	1	0	0	0	0	0	0	0	0	0	0	62.7	58.5	65.0
23:00	30	0	1	0	0	0	0	0	0	0	0	0	0	30.9	59.4	65.8
Total	4838	50	181	25	9	3	2	5	9	1	0	0	0	5124	57.2	63.1
	94.4%	1.0%	3.5%	0.5%	0.2%	0.1%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

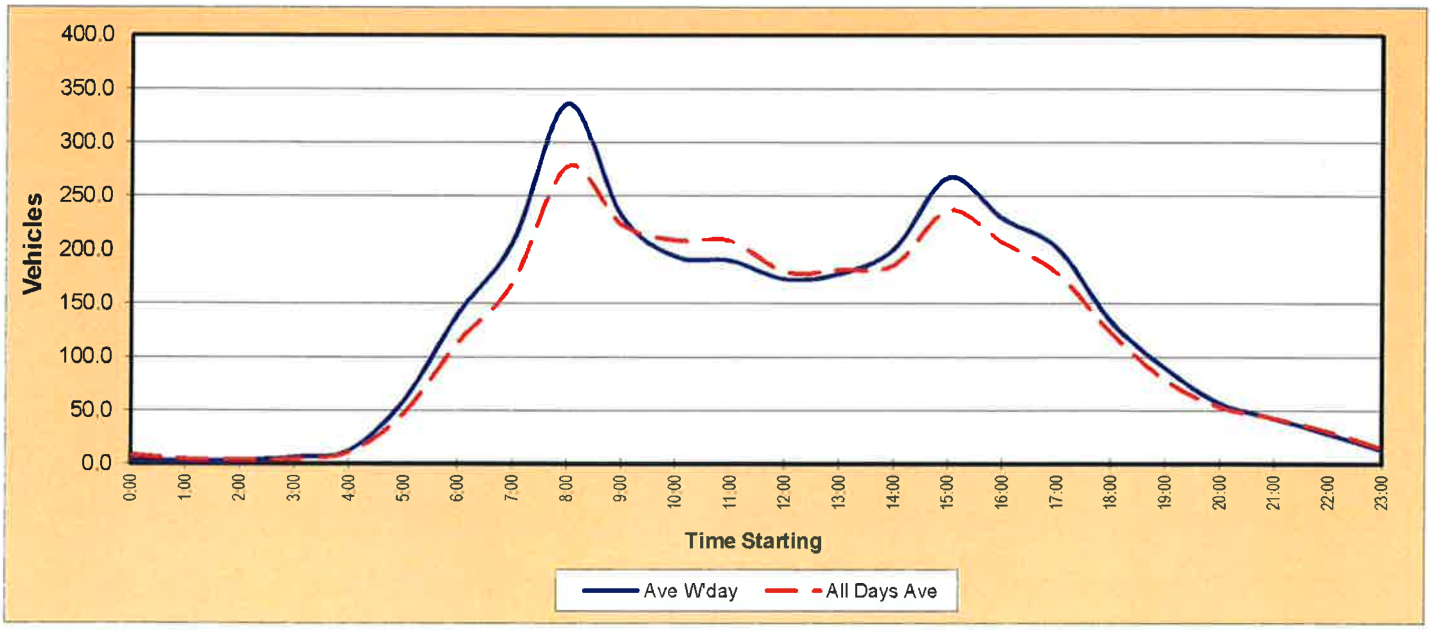
Daily Vehicle Classification



Road	Bellambi Ln
Location	East of Princes Hwy
Site No.	7812_1
Start Date	Tuesday 02/05/2017
Direction	East Bound

Average Weekday	2998
All Day Average	2791
Weekday Heavy's	5.0%
All Day Heavy's	4.4%

Starting Time	Day of Week Mon 8-May	Tue 2-May	Wed 3-May	Thu 4-May	Fri 5-May	Sat 6-May	Sun 7-May	Ave W'day	All Days Ave
AM Peak	319	326	345	348	340	299	215		
PM Peak	251	267	243	284	293	232	192		
0:00	1	0	5	4	10	21	19	4	9
1:00	6	2	0	3	2	4	12	3	4
2:00	3	4	1	2	6	4	5	3	4
3:00	5	6	7	4	9	0	3	6	5
4:00	11	14	15	12	11	6	8	13	11
5:00	56	62	59	61	56	24	10	59	47
6:00	133	156	136	137	138	58	37	140	114
7:00	195	216	218	240	167	82	60	207	168
8:00	319	326	345	348	340	170	96	336	278
9:00	229	211	247	241	229	219	189	231	224
10:00	165	187	190	203	222	299	196	193	209
11:00	189	173	190	182	215	292	215	190	208
12:00	166	151	200	153	193	201	192	173	179
13:00	155	163	192	185	194	232	149	178	181
14:00	217	179	161	223	224	171	127	201	186
15:00	251	267	243	284	293	191	129	268	237
16:00	222	225	230	254	214	144	160	229	207
17:00	175	209	191	225	209	141	99	202	178
18:00	111	143	134	141	137	100	93	133	123
19:00	69	72	81	103	123	59	44	90	79
20:00	36	57	65	61	64	50	41	57	53
21:00	32	30	33	55	64	59	28	43	43
22:00	25	20	37	28	32	54	17	28	30
23:00	3	15	11	9	26	27	13	13	15
Total	2774	2888	2991	3158	3178	2608	1942	2998	2791
% Heavies	5.3%	4.8%	4.6%	5.4%	5.0%	2.7%	1.5%	5.0%	4.4%

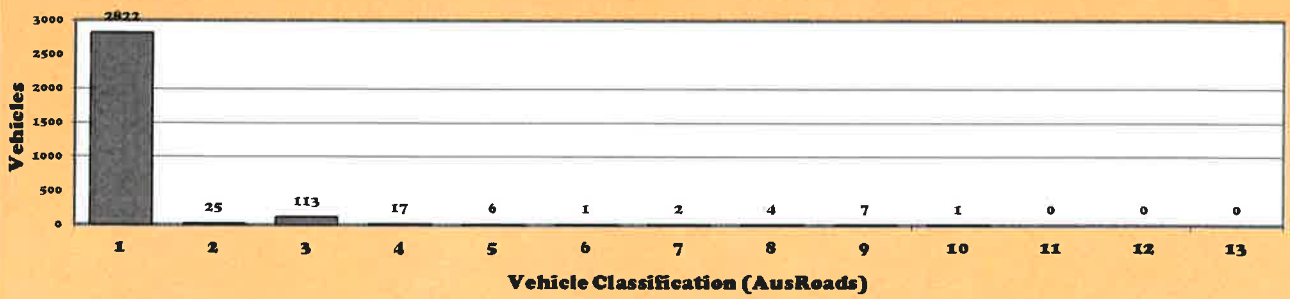


austraffic

Road	Bellambi Ln	**AADT**	2,998				
Location	East of Princes Hwy	**Ave Speed**	58.3		Peak	Time	Vol
Site No.	7812_1	**85%ile**	66		AM	08:00	336
Start Date	Tuesday 02/05/2017	**% Heavy's**	5.0%		PM	15:00	268
Displayed	WeekDay Avg						

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4.0	62.5	69.9
1:00	3	0	0	0	0	0	0	0	0	0	0	0	0	2.6	63.0	67.7
2:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3.2	55.3	62.2
3:00	4	0	0	0	0	0	0	1	0	0	0	0	0	6.2	49.6	59.4
4:00	12	0	1	0	0	0	0	0	0	0	0	0	0	12.6	55.2	66.6
5:00	53	0	2	2	1	0	0	0	0	0	0	0	0	58.8	58.8	67.2
6:00	128	1	7	1	1	0	0	0	1	0	0	0	0	140.0	57.4	63.9
7:00	191	2	10	1	1	0	0	0	2	0	0	0	0	207.2	57.4	63.7
8:00	317	1	14	2	1	0	0	0	1	0	0	0	0	335.6	57.7	63.5
9:00	215	4	11	1	0	0	0	0	0	0	0	0	0	231.4	58.3	64.5
10:00	178	1	11	3	0	0	0	0	1	0	0	0	0	193.4	58.3	64.4
11:00	174	2	10	2	1	0	0	0	1	0	0	0	0	189.8	57.2	64.5
12:00	158	3	9	1	1	0	0	0	0	0	0	0	0	172.6	58.8	65.2
13:00	166	2	9	1	0	0	0	0	0	0	0	0	0	177.8	58.1	64.7
14:00	189	1	8	1	0	0	0	0	0	0	0	0	0	200.8	58.3	65.2
15:00	253	3	10	1	0	0	0	0	0	0	0	0	0	267.6	58.2	64.4
16:00	223	2	4	0	0	0	0	0	0	0	0	0	0	229.0	58.7	64.1
17:00	198	1	2	0	0	0	0	0	0	0	0	0	0	201.8	58.9	64.8
18:00	130	1	2	0	0	0	0	0	0	0	0	0	0	133.2	59.0	65.4
19:00	88	0	2	0	0	0	0	0	0	0	0	0	0	89.6	59.4	66.8
20:00	56	0	0	0	0	0	0	0	0	0	0	0	0	56.6	60.0	65.6
21:00	43	0	0	0	0	0	0	0	0	0	0	0	0	42.8	59.4	66.7
22:00	28	0	1	0	0	0	0	0	0	0	0	0	0	28.4	60.6	67.4
23:00	12	0	0	0	0	0	0	0	0	0	0	0	0	12.8	60.2	65.7
Total	2822	25	113	17	6	1	2	4	7	1	0	0	0	2998	58.3	65.9
	94.1%	0.8%	3.8%	0.6%	0.2%	0.0%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

Daily Vehicle Classification

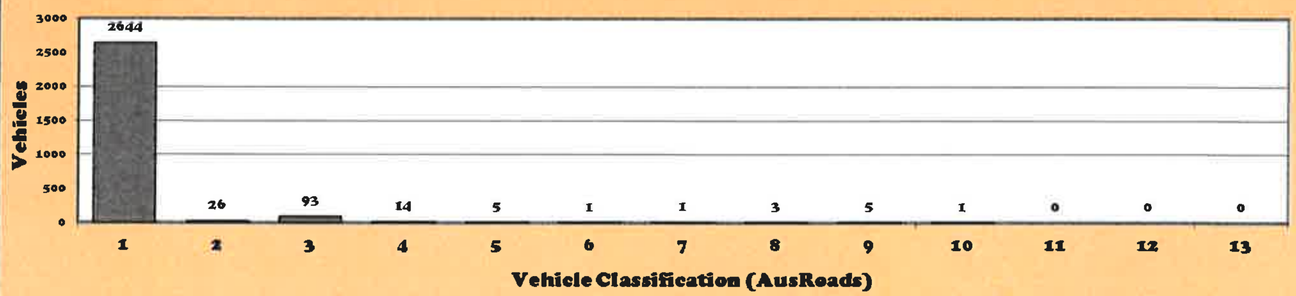


austraffic

Road	Bellambi Ln	**AADT**	2,791				
Location	East of Princes Hwy	**Ave Speed**	58.6		**Peak**	**Time**	**Vol**
Site No.	7812_1	**85%ile**	66		**AM**	08:00	278
Start Date	Tuesday 02/05/2017	**% Heavy's**	4.4%		**PM**	15:00	237
Displayed	Total Avg						

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	8	0	0	0	0	0	0	0	0	0	0	0	0	8.6	61.9	69.1
1:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4.1	63.5	71.5
2:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3.6	57.8	64.4
3:00	3	0	0	0	0	0	0	1	0	0	0	0	0	4.9	51.0	60.2
4:00	10	0	1	0	0	0	0	0	0	0	0	0	0	11.0	57.0	68.2
5:00	43	0	2	2	1	0	0	0	0	0	0	0	0	46.9	58.7	66.8
6:00	103	2	5	1	1	0	0	0	1	0	0	0	0	113.6	57.7	64.3
7:00	155	2	8	1	1	0	0	0	1	0	0	0	0	168.3	57.6	63.9
8:00	262	1	11	2	0	0	0	0	1	0	0	0	0	277.7	57.9	63.8
9:00	210	3	8	1	0	0	0	0	0	0	0	0	0	223.6	58.7	64.9
10:00	195	2	9	2	0	0	0	0	0	0	0	0	0	208.9	58.6	64.6
11:00	194	3	8	1	1	0	0	0	1	0	0	0	0	208.0	58.1	65.2
12:00	167	2	8	1	0	0	0	0	0	0	0	0	0	179.4	59.0	64.9
13:00	171	2	7	1	0	0	0	0	0	0	0	0	0	181.4	58.5	65.0
14:00	176	1	7	1	0	0	0	0	0	0	0	0	0	186.0	58.7	65.5
15:00	225	3	7	1	0	0	0	0	0	0	0	0	0	236.9	58.5	64.9
16:00	202	1	3	0	0	0	0	0	0	0	0	0	0	207.0	59.1	64.5
17:00	174	1	2	0	0	0	0	0	0	0	0	0	0	178.4	58.9	64.9
18:00	120	1	2	0	0	0	0	0	0	0	0	0	0	122.7	59.2	65.4
19:00	78	0	1	0	0	0	0	0	0	0	0	0	0	78.7	59.6	66.6
20:00	53	0	0	0	0	0	0	0	0	0	0	0	0	53.4	59.7	65.6
21:00	43	0	0	0	0	0	0	0	0	0	0	0	0	43.0	59.8	66.5
22:00	30	0	0	0	0	0	0	0	0	0	0	0	0	30.4	60.8	66.8
23:00	15	0	0	0	0	0	0	0	0	0	0	0	0	14.9	61.0	66.4
Total	2644	26	93	14	5	1	1	3	5	1	0	0	0	2791	58.6	65.6
	94.7%	0.9%	3.3%	0.5%	0.2%	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

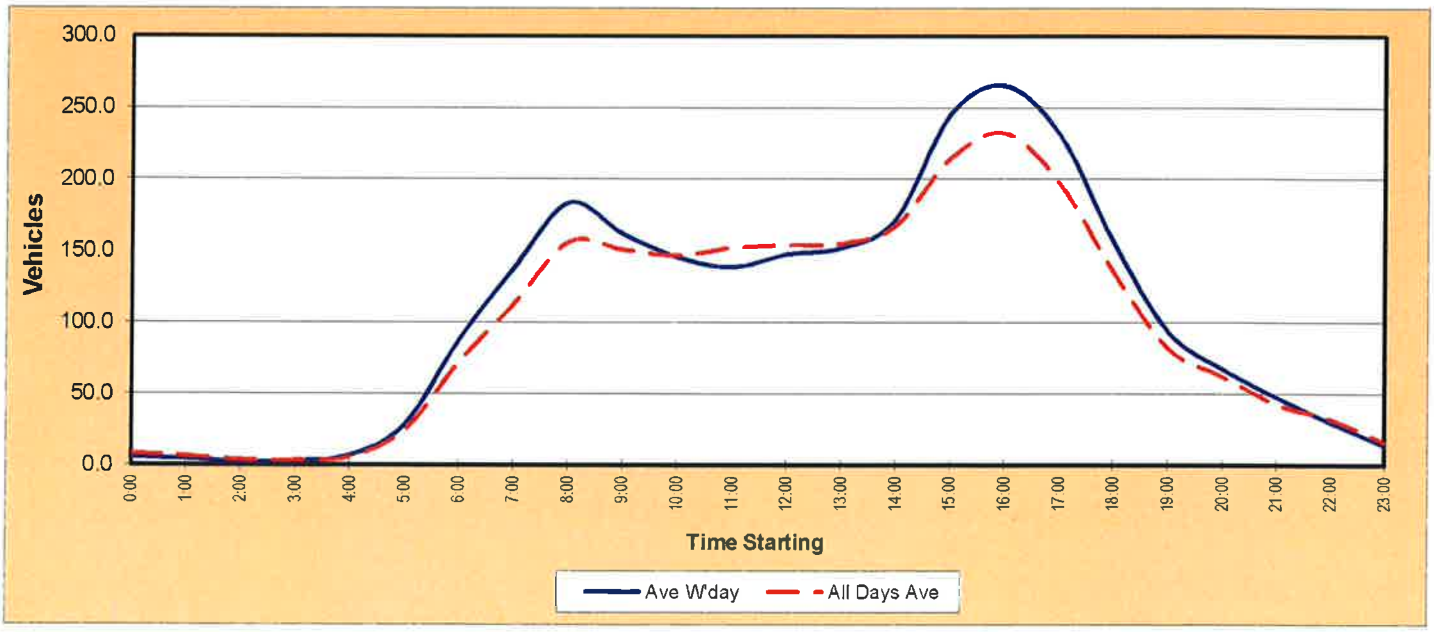
Daily Vehicle Classification



Road	Bellambi Ln
Location	East of Princes Hwy
Site No.	7812_1
Start Date	Tuesday 02/05/2017
Direction	West Bound

Average Weekday	2527
All Day Average	2333
Weekday Heavy's	5.7%
All Day Heavy's	4.9%

Starting Time	Day of Week							Ave W'day	All Days Ave
	Mon 8-May	Tue 2-May	Wed 3-May	Thu 4-May	Fri 5-May	Sat 6-May	Sun 7-May		
AM Peak	**179**	**167**	**181**	**204**	**186**	**203**	**170**		
PM Peak	**267**	**281**	**277**	**274**	**266**	**192**	**153**		
0:00	6	0	8	6	9	15	12	6	8
1:00	3	2	4	6	7	11	12	4	6
2:00	4	1	0	2	4	5	9	2	4
3:00	1	2	1	2	8	3	5	3	3
4:00	7	8	6	4	9	3	3	7	6
5:00	21	27	39	23	30	16	14	28	24
6:00	86	91	78	88	96	38	29	88	72
7:00	131	148	127	143	140	66	33	138	113
8:00	179	167	181	204	186	112	63	183	156
9:00	152	153	167	160	177	150	97	162	151
10:00	152	145	143	135	152	172	128	145	147
11:00	118	119	147	137	172	203	170	139	152
12:00	151	129	152	148	158	192	149	148	154
13:00	151	140	158	137	174	175	151	152	155
14:00	156	154	164	177	210	159	153	172	168
15:00	223	228	263	247	266	135	140	245	215
16:00	267	281	277	274	227	155	144	265	232
17:00	215	236	236	228	242	140	86	231	198
18:00	138	172	137	173	160	80	85	156	135
19:00	81	85	102	98	102	60	45	94	82
20:00	62	72	57	82	63	52	47	67	62
21:00	38	54	39	49	58	39	22	48	43
22:00	29	23	28	29	41	51	25	30	32
23:00	10	10	12	14	22	33	11	14	16
Total	**2381**	**2447**	**2526**	**2566**	**2713**	**2065**	**1633**	**2527**	**2333**
% Heavies	**6.3%**	**5.9%**	**6.2%**	**5.3%**	**4.9%**	**2.8%**	**1.3%**	**5.7%**	**4.9%**

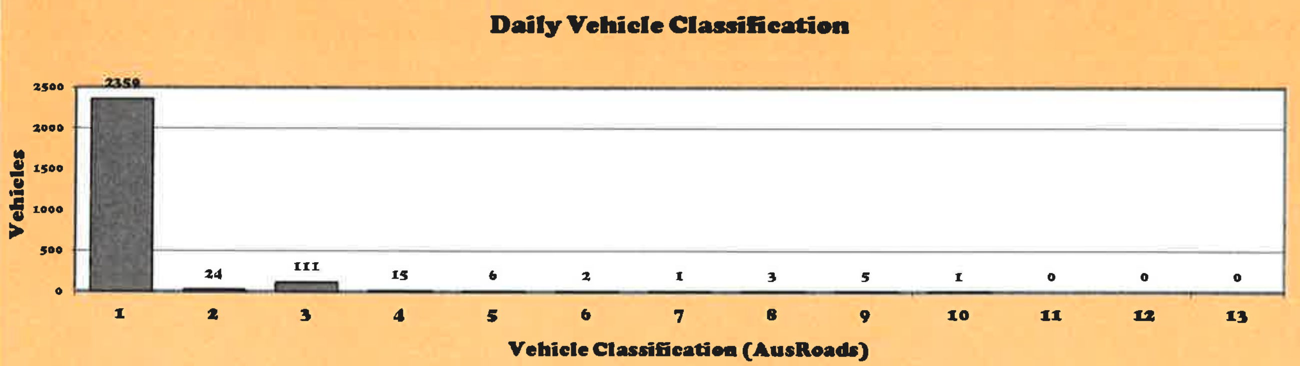


austraffic

Road	Bellambi Ln	**AADT**	2,527
Location	East of Princes Hwy	**Ave Speed**	55.2
Site No.	7812_1	**85%ile**	61
Start Date	Tuesday 02/05/2017	**% Heavy's**	5.7%
Displayed	WeekDay Avg		

Peak	Time	Vol
AM	08:00	183
PM	16:00	265

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	6	0	0	0	0	0	0	0	0	0	0	0	0	5.8	56.9	60.8
1:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4.4	59.6	65.9
2:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2.2	57.6	61.9
3:00	3	0	0	0	0	0	0	0	0	0	0	0	0	2.8	51.0	58.7
4:00	5	0	0	1	0	0	0	0	0	0	0	0	0	6.8	59.0	65.1
5:00	26	0	1	1	0	0	0	0	0	0	0	0	0	28.0	54.5	61.1
6:00	81	1	4	1	1	0	0	0	0	0	0	0	0	87.8	55.6	62.0
7:00	126	2	7	1	1	0	0	0	0	0	0	0	0	137.8	55.2	61.1
8:00	169	2	10	1	0	0	0	0	1	0	0	0	0	183.4	54.2	60.1
9:00	149	2	9	1	0	0	0	0	0	0	0	0	0	161.8	55.4	61.6
10:00	133	2	9	1	0	0	0	0	0	0	0	0	0	145.4	54.5	60.9
11:00	126	1	8	1	1	0	0	0	0	0	0	0	0	138.6	54.5	60.7
12:00	134	2	8	1	0	0	0	0	1	0	0	0	0	147.6	55.0	61.6
13:00	138	2	10	1	0	0	0	0	0	0	0	0	0	152.0	54.5	60.8
14:00	158	2	9	1	0	0	0	1	0	0	0	0	0	172.2	55.5	61.9
15:00	230	2	10	1	0	1	0	0	1	0	0	0	0	245.4	55.1	61.0
16:00	250	2	10	1	1	0	0	1	0	0	0	0	0	265.2	55.5	61.5
17:00	222	1	7	1	0	0	0	0	1	0	0	0	0	231.4	55.5	60.7
18:00	152	2	2	0	0	0	0	0	0	0	0	0	0	156.0	55.7	61.2
19:00	92	0	1	0	0	0	0	0	0	0	0	0	0	93.6	55.6	60.7
20:00	64	1	2	0	0	0	0	0	0	0	0	0	0	67.2	56.5	61.6
21:00	47	0	1	0	0	0	0	0	0	0	0	0	0	47.6	56.7	62.6
22:00	30	0	0	0	0	0	0	0	0	0	0	0	0	30.0	56.4	61.5
23:00	13	0	0	0	0	0	0	0	0	0	0	0	0	13.6	57.4	63.1
Total	2359	24	111	15	6	2	1	3	5	1	0	0	0	2527	55.2	61.4
	93.4%	0.9%	4.4%	0.6%	0.2%	0.1%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			



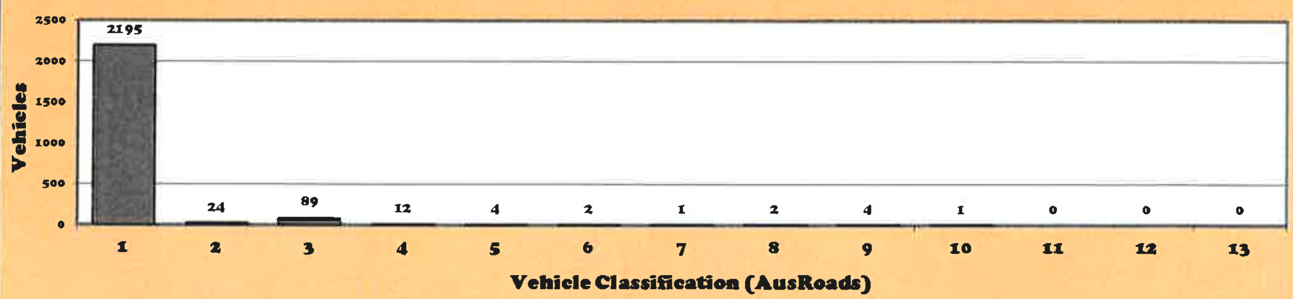
austraffic

Road	Bellambi Ln	**AADT**	2,333		
Location	East of Princes Hwy	**Ave Speed**	55.5		
Site No.	7812_1	**85%ile**	61		
Start Date	Tuesday 02/05/2017	**% Heavy's**	4.9%		
Displayed	Total Avg				

Peak	Time	Vol
AM	08:00	156
PM	16:00	232

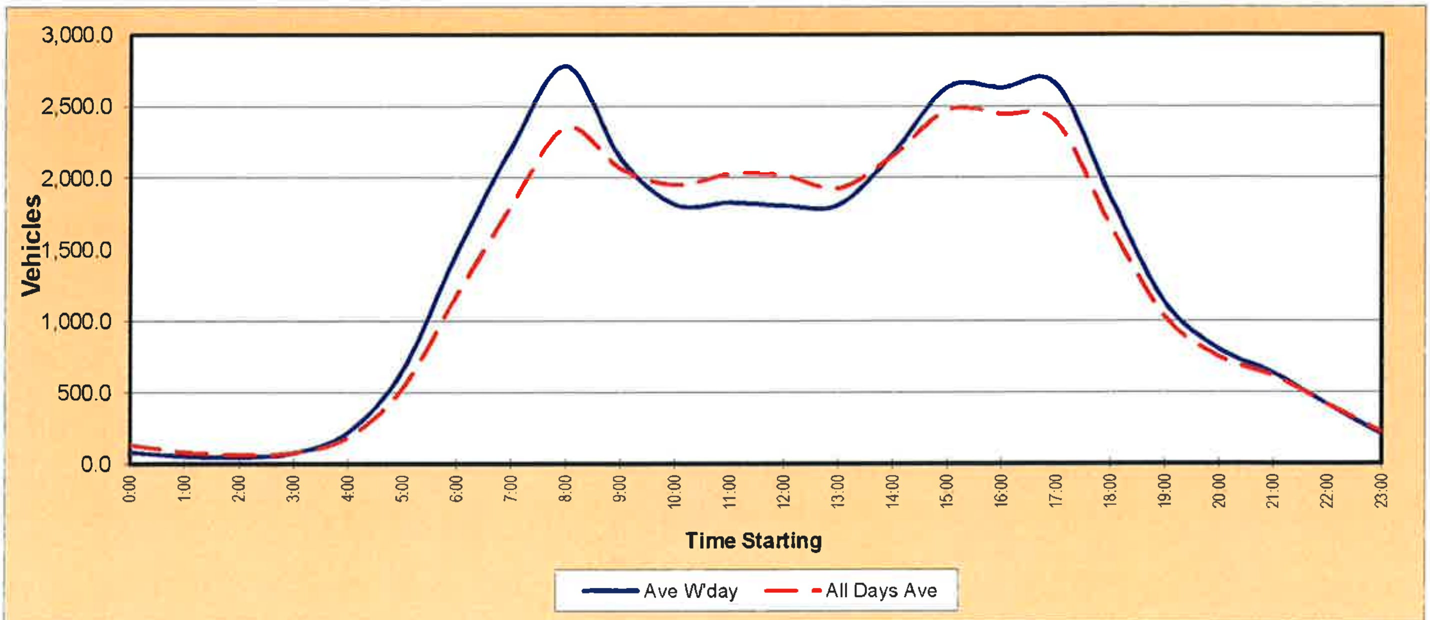
Time Starting	Vehicle Classification													Total	Speed	
	1	2	3	4	5	6	7	8	9	10	11	12	13		Ave.	85%ile
0:00	8	0	0	0	0	0	0	0	0	0	0	0	0	8.0	57.9	62.0
1:00	6	0	0	0	0	0	0	0	0	0	0	0	0	6.4	59.6	65.4
2:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3.6	59.2	66.6
3:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3.1	53.6	62.4
4:00	5	0	0	1	0	0	0	0	0	0	0	0	0	5.7	58.1	63.9
5:00	23	0	1	1	0	0	0	0	0	0	0	0	0	24.3	55.1	61.1
6:00	67	1	3	1	1	0	0	0	0	0	0	0	0	72.3	55.8	62.2
7:00	103	2	6	1	0	0	0	0	0	0	0	0	0	112.6	55.4	61.3
8:00	144	2	8	1	0	0	0	0	0	0	0	0	0	156.0	54.6	60.8
9:00	140	2	7	1	0	0	0	0	0	0	0	0	0	150.9	55.6	61.7
10:00	136	2	7	1	0	0	0	0	0	0	0	0	0	146.7	54.9	61.5
11:00	140	3	7	1	1	0	0	0	0	0	0	0	0	152.3	54.5	60.8
12:00	143	2	7	1	0	0	0	0	1	0	0	0	0	154.1	55.1	61.3
13:00	144	1	8	1	0	0	0	0	0	0	0	0	0	155.1	55.0	61.5
14:00	156	2	7	1	0	0	0	0	0	0	0	0	0	167.6	56.1	62.2
15:00	202	2	8	1	0	0	0	0	0	0	0	0	0	214.6	55.6	61.5
16:00	220	2	8	1	1	0	0	0	0	0	0	0	0	232.1	55.7	61.6
17:00	190	1	6	0	0	0	0	0	1	0	0	0	0	197.6	55.7	61.0
18:00	132	2	2	0	0	0	0	0	0	0	0	0	0	135.0	55.8	61.4
19:00	81	0	1	0	0	0	0	0	0	0	0	0	0	81.9	55.4	60.7
20:00	60	0	2	0	0	0	0	0	0	0	0	0	0	62.1	56.4	61.6
21:00	42	0	1	0	0	0	0	0	0	0	0	0	0	42.7	56.6	62.2
22:00	32	0	0	0	0	0	0	0	0	0	0	0	0	32.3	56.4	61.2
23:00	16	0	0	0	0	0	0	0	0	0	0	0	0	16.0	58.0	63.9
Total	2195	24	89	12	4	2	1	2	4	1	0	0	0	2333	55.5	61.2
	94.1%	1.0%	3.8%	0.5%	0.2%	0.1%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

Daily Vehicle Classification



Road	Memorial Dr	Average Weekday	32127
Location	South of Bellambi Ln	All Day Average	30562
Site No.	7812_2	Weekday Heavy's	4.0%
Start Date	Monday 15/05/2017	All Day Heavy's	3.4%
Direction	Two ways		

Starting Time	Day of Week Mon 15-May	Tue 16-May	Wed 17-May	Thu 18-May	Fri 19-May	Sat 20-May	Sun 21-May	Ave W'day	All Days Ave
AM Peak	**2803**	**2829**	**2747**	**2817**	**2713**	**2650**	**2411**		
PM Peak	**2624**	**2667**	**2764**	**2702**	**2650**	**2685**	**2403**		
0:00	0	93	87	101	129	212	309	82	133
1:00	51	53	49	53	60	136	178	53	83
2:00	38	46	49	54	47	102	108	47	63
3:00	62	66	79	89	84	84	91	76	79
4:00	204	225	232	212	233	117	85	221	187
5:00	679	653	667	663	609	255	172	654	528
6:00	1479	1505	1522	1490	1409	487	399	1481	1184
7:00	2180	2273	2286	2260	2085	945	630	2217	1808
8:00	2803	2829	2747	2817	2713	1584	964	2782	2351
9:00	2019	2180	2071	2159	2238	2121	1670	2133	2065
10:00	1786	1735	1818	1786	1939	2557	2041	1813	1952
11:00	1765	1768	1845	1786	1974	2650	2411	1828	2028
12:00	1689	1704	1856	1859	1925	2685	2403	1807	2017
13:00	1713	1734	1827	1898	1884	2314	2127	1811	1928
14:00	2070	2110	2253	2134	2298	2122	2115	2173	2157
15:00	2574	2667	2670	2626	2634	2092	2055	2634	2474
16:00	2624	2646	2581	2648	2650	2183	1788	2630	2446
17:00	2578	2593	2764	2702	2620	1912	1559	2651	2390
18:00	1781	1920	1890	1933	1753	1292	1062	1855	1662
19:00	1052	1134	1094	1236	1111	882	689	1125	1028
20:00	700	815	899	888	701	677	544	801	746
21:00	537	563	684	718	666	699	437	634	615
22:00	306	317	362	493	593	569	266	414	415
23:00	139	132	198	215	342	401	117	205	221
Total	**30829**	**31761**	**32530**	**32820**	**32697**	**29078**	**24220**	**32127**	**30562**
% Heavies	**4.0%**	**4.0%**	**4.2%**	**4.1%**	**3.6%**	**1.7%**	**1.2%**	**4.0%**	**3.4%**

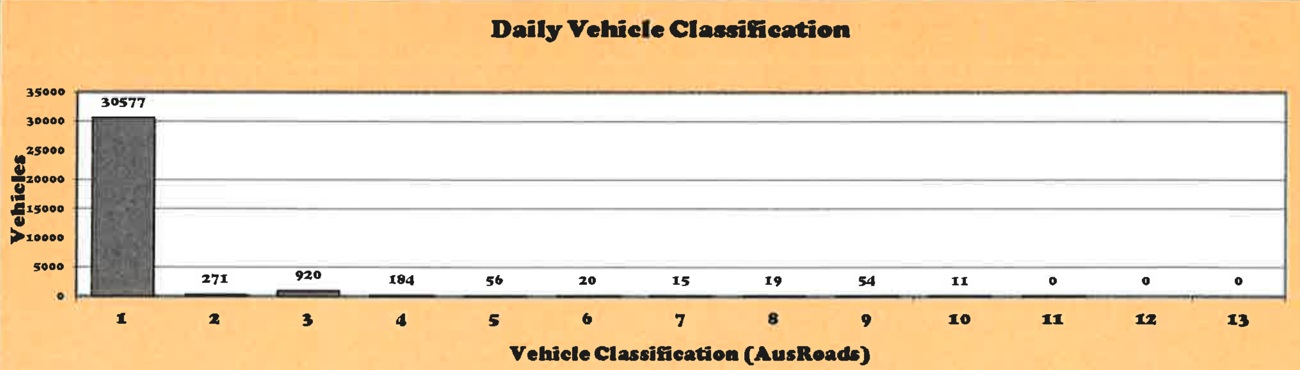


austraffic

Road	Memorial Dr	AADT	####
Location	South of Bellambi Ln	Ave Speed	68.6
Site No.	7812_2	85%ile	77
Start Date	Monday 15/05/2017	% Heavy's	4.0%
Displayed	WeekDay Avg		

Peak	Time	Vol
AM	08:00	2,782
PM	17:00	2,651

Time	Vehicle Classification														Speed	
Starting	1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Ave.	85%ile
0:00	79	0	2	0	0	0	0	0	0	0	0	0	0	82.0	77.3	85.6
1:00	48	0	4	0	0	0	0	0	0	0	0	0	0	53.2	78.3	85.4
2:00	43	0	3	0	0	0	0	0	0	0	0	0	0	46.8	77.7	85.2
3:00	64	0	8	1	0	0	0	1	1	0	0	0	0	76.0	78.3	86.8
4:00	207	0	10	2	0	0	0	0	1	0	0	0	0	221.2	77.9	85.9
5:00	628	2	14	6	1	0	0	0	2	0	0	0	0	654.2	76.3	84.0
6:00	1377	21	58	12	2	2	2	2	4	0	0	0	0	1481.0	72.3	79.8
7:00	2069	24	84	20	7	3	2	2	5	1	0	0	0	2216.8	67.1	77.1
8:00	2662	18	69	17	9	1	2	0	3	1	0	0	0	2781.8	60.3	73.6
9:00	1999	20	79	18	7	1	0	2	6	0	0	0	0	2133.4	67.3	75.4
10:00	1676	23	77	22	7	1	1	1	3	0	0	0	0	1812.8	68.9	76.0
11:00	1701	21	75	16	5	2	1	1	3	1	0	0	0	1827.6	69.6	76.8
12:00	1687	18	69	20	4	2	1	2	4	1	0	0	0	1806.6	70.1	78.0
13:00	1676	18	83	19	5	1	1	3	4	1	0	0	0	1811.2	70.0	77.2
14:00	2044	22	80	15	3	1	1	1	5	0	0	0	0	2173.0	69.2	76.8
15:00	2510	32	70	9	3	3	1	1	4	3	0	0	0	2634.2	66.6	75.3
16:00	2544	21	52	4	1	1	1	1	3	2	0	0	0	2629.8	67.1	75.7
17:00	2601	15	32	2	0	0	1	1	1	0	0	0	0	2651.4	66.5	74.9
18:00	1828	5	20	1	0	0	0	0	1	0	0	0	0	1855.4	70.4	77.7
19:00	1110	3	11	0	0	0	0	0	0	0	0	0	0	1125.4	72.6	80.1
20:00	789	3	6	1	0	0	0	0	1	0	0	0	0	800.6	73.8	80.4
21:00	626	2	4	0	0	0	0	0	1	0	0	0	0	633.6	74.4	81.8
22:00	407	0	4	1	0	0	0	0	1	0	0	0	0	414.2	74.8	81.9
23:00	201	0	3	0	0	0	0	0	0	0	0	0	0	205.2	76.2	83.3
Total	30577	271	920	184	56	20	15	19	54	11	0	0	0	32127	68.6	77.4
	95.2%	0.8%	2.9%	0.6%	0.2%	0.1%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			



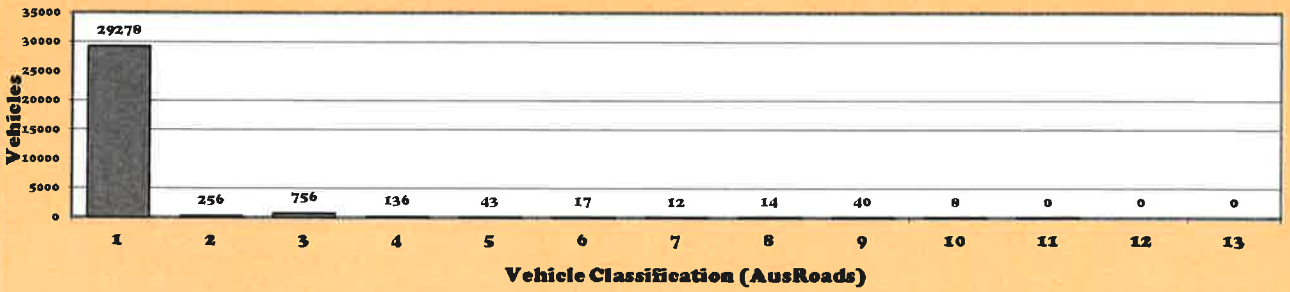
austraffic

Road	Memorial Dr	**AADT**	####		
Location	South of Bellambi Ln	**Ave Speed**	69.2		
Site No.	7812_2	**85%ile**	77		
Start Date	Monday 15/05/2017	**% Heavy's**	3.4%		
Displayed	Total Avg				

Peak	Time	Vol
AM	08:00	2,351
PM	15:00	2,474

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	130	0	2	0	0	0	0	0	0	0	0	0	0	133.0	76.3	83.4
1:00	78	0	4	0	0	0	0	0	0	0	0	0	0	82.9	77.8	84.3
2:00	59	1	3	0	0	0	0	0	0	0	0	0	0	63.4	77.7	85.2
3:00	67	1	9	1	0	0	0	1	1	0	0	0	0	79.3	78.8	86.9
4:00	176	1	8	2	0	0	0	0	1	0	0	0	0	186.9	77.9	85.7
5:00	507	2	12	5	1	0	0	0	2	0	0	0	0	528.3	76.3	84.0
6:00	1103	17	46	9	2	2	2	1	3	0	0	0	0	1184.4	72.6	80.1
7:00	1693	19	65	15	6	2	1	1	4	1	0	0	0	1808.4	68.0	77.7
8:00	2254	16	57	12	6	1	1	0	2	1	0	0	0	2351.0	62.1	74.5
9:00	1957	19	64	13	6	1	0	1	4	0	0	0	0	2065.4	68.0	75.9
10:00	1839	21	64	17	5	2	1	1	3	0	0	0	0	1951.7	69.2	76.2
11:00	1922	20	64	11	4	2	1	1	3	1	0	0	0	2028.4	69.4	76.6
12:00	1916	20	58	14	3	1	0	1	3	0	0	0	0	2017.3	69.9	77.9
13:00	1819	19	65	14	4	1	1	2	3	0	0	0	0	1928.1	69.6	77.2
14:00	2053	22	63	11	2	1	1	1	4	0	0	0	0	2157.4	69.1	76.9
15:00	2374	28	55	7	2	2	1	1	3	2	0	0	0	2474.0	67.2	76.0
16:00	2370	21	46	3	1	1	0	1	2	1	0	0	0	2445.7	68.2	76.4
17:00	2345	15	26	1	0	0	1	1	1	0	0	0	0	2389.7	67.5	75.7
18:00	1636	5	18	1	0	0	0	0	0	0	0	0	0	1661.6	70.9	78.3
19:00	1012	4	11	1	0	0	0	0	0	0	0	0	0	1028.3	72.8	80.3
20:00	735	3	7	0	0	0	0	0	1	0	0	0	0	746.3	73.9	80.5
21:00	607	1	5	0	0	0	0	0	1	0	0	0	0	614.9	74.5	81.8
22:00	409	0	4	0	0	0	0	0	1	0	0	0	0	415.1	74.8	82.0
23:00	217	0	3	0	0	0	0	0	0	0	0	0	0	220.6	76.0	83.6
Total	29278	256	756	136	43	17	12	14	40	8	0	0	0	30562	69.2	77.1
	95.8%	0.8%	2.5%	0.4%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%			

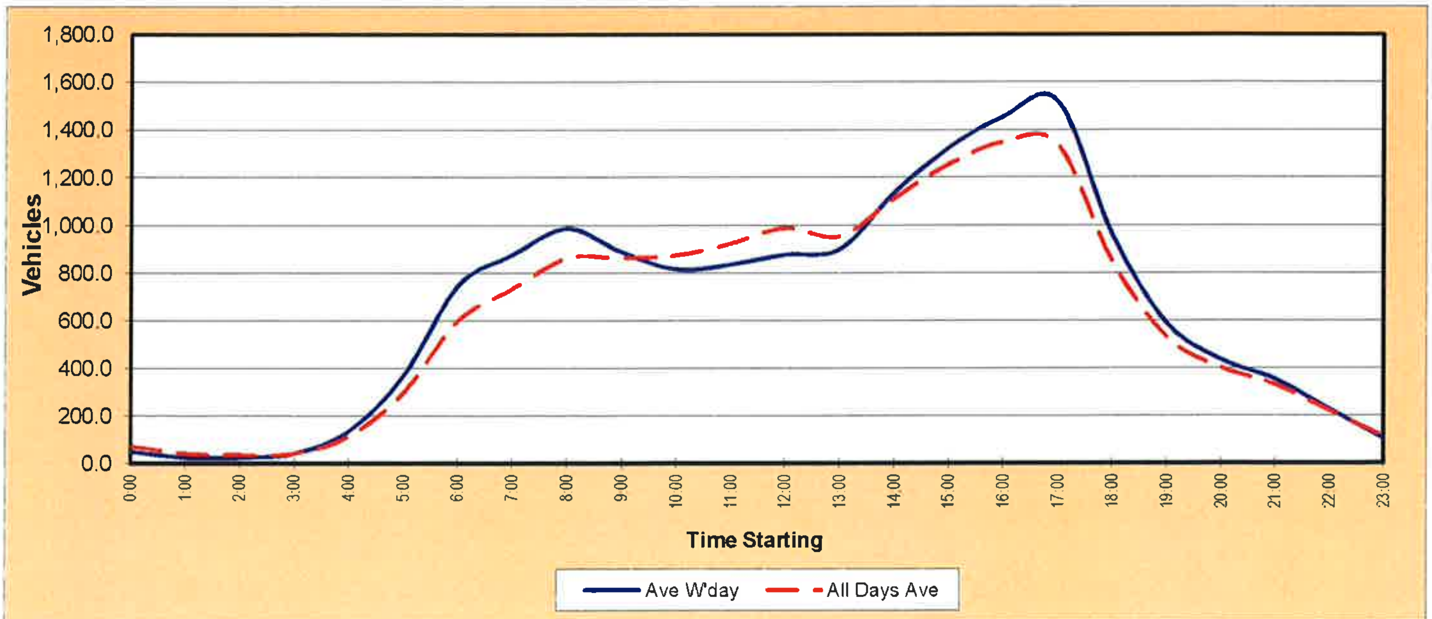
Daily Vehicle Classification



Road	Memorial Dr
Location	South of Bellambi Ln
Site No.	7812_2
Start Date	Monday 15/05/2017
Direction	North Bound

Average Weekday	15678
All Day Average	14909
Weekday Heavy's	4.1%
All Day Heavy's	3.5%

Starting Time	Day of Week Mon 15-May	Tue 16-May	Wed 17-May	Thu 18-May	Fri 19-May	Sat 20-May	Sun 21-May	Ave W'day	All Days Ave
AM Peak	**1025**	**1009**	**951**	**1002**	**944**	**1212**	**1072**		
PM Peak	**1533**	**1528**	**1586**	**1501**	**1492**	**1328**	**1216**		
0:00	0	53	58	57	80	111	147	50	72
1:00	24	18	27	22	30	75	93	24	41
2:00	20	22	26	32	21	58	65	24	35
3:00	36	31	48	48	45	36	52	42	42
4:00	128	139	151	126	132	72	51	135	114
5:00	384	363	360	378	353	153	87	368	297
6:00	774	747	767	746	696	250	214	746	599
7:00	856	900	879	902	842	466	282	876	732
8:00	1025	1009	951	1002	944	634	470	986	862
9:00	819	943	861	913	897	892	715	887	863
10:00	812	814	850	789	811	1150	896	815	875
11:00	804	837	821	806	912	1212	1072	836	923
12:00	812	816	917	892	945	1328	1216	876	989
13:00	873	809	928	942	949	1171	1000	900	953
14:00	1084	1104	1149	1103	1252	1092	1016	1138	1114
15:00	1304	1361	1313	1276	1374	1095	1074	1326	1257
16:00	1458	1448	1449	1442	1492	1145	1019	1458	1350
17:00	1533	1528	1586	1501	1450	931	838	1520	1338
18:00	933	1016	960	1007	875	611	540	958	849
19:00	577	570	543	685	571	419	350	589	531
20:00	384	451	486	513	346	341	298	436	403
21:00	282	337	400	421	330	348	206	354	332
22:00	167	173	207	291	307	287	124	229	222
23:00	63	61	102	114	185	219	56	105	114
Total	**15152**	**15550**	**15839**	**16008**	**15839**	**14096**	**11881**	**15678**	**14909**
% Heavies	**4.0%**	**4.1%**	**4.3%**	**4.3%**	**3.8%**	**2.0%**	**1.2%**	**4.1%**	**3.5%**

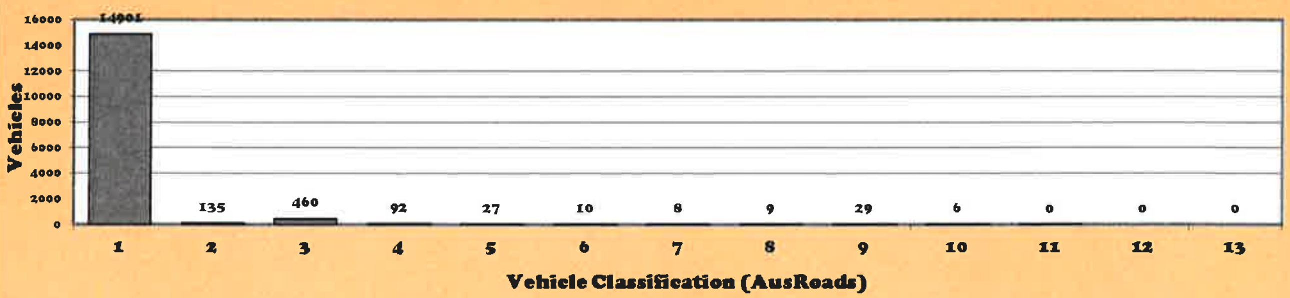


austraffic

Road	Memorial Dr	AADT	####			
Location	South of Bellambi Ln	Ave Speed	69.4	Peak	Time	Vol
Site No.	7812_2	85%ile	79	AM	08:00	986
Start Date	Monday 15/05/2017	% Heavy's	4.1%	PM	17:00	1,520
Displayed	WeekDay Avg					

Time Starting	Vehicle Classification													Total	Speed	
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Ave.	85%ile
0:00	49	0	1	0	0	0	0	0	0	0	0	0	0	49.6	78.7	85.7
1:00	22	0	2	0	0	0	0	0	0	0	0	0	0	24.2	79.7	88.5
2:00	22	0	2	0	0	0	0	0	0	0	0	0	0	24.2	78.4	84.5
3:00	36	0	4	1	0	0	0	0	0	0	0	0	0	41.6	79.3	87.0
4:00	127	0	6	1	0	0	0	0	0	0	0	0	0	135.2	78.5	85.7
5:00	354	1	8	3	0	0	0	0	0	0	0	0	0	367.6	76.9	84.2
6:00	688	13	34	6	1	1	1	0	2	0	0	0	0	746.0	71.8	79.5
7:00	792	13	47	11	4	2	2	1	3	1	0	0	0	875.8	71.1	79.2
8:00	924	10	35	7	5	1	2	0	2	1	0	0	0	986.2	70.0	77.3
9:00	822	8	38	10	3	0	0	1	3	0	0	0	0	886.6	69.4	77.0
10:00	752	11	36	9	3	1	1	1	2	0	0	0	0	815.2	69.2	77.2
11:00	778	10	35	7	2	0	0	1	2	1	0	0	0	836.0	69.6	76.9
12:00	819	10	31	10	2	0	0	1	2	0	0	0	0	876.4	70.1	78.0
13:00	832	8	42	10	3	1	1	1	2	0	0	0	0	900.2	69.7	77.3
14:00	1076	11	39	6	1	1	1	0	3	0	0	0	0	1138.4	68.2	76.1
15:00	1272	14	28	4	1	2	0	1	3	1	0	0	0	1325.6	66.2	75.8
16:00	1414	11	25	3	1	0	0	1	2	1	0	0	0	1457.8	65.5	75.7
17:00	1492	6	18	1	0	0	1	1	1	0	0	0	0	1519.6	64.8	73.3
18:00	944	3	10	1	0	0	0	0	1	0	0	0	0	958.2	70.2	77.7
19:00	580	2	7	0	0	0	0	0	0	0	0	0	0	589.2	72.1	79.0
20:00	430	2	4	0	0	0	0	0	1	0	0	0	0	436.0	73.8	80.9
21:00	348	1	4	0	0	0	0	0	1	0	0	0	0	354.0	74.7	81.8
22:00	225	0	3	0	0	0	0	0	0	0	0	0	0	229.0	75.0	82.2
23:00	103	0	2	0	0	0	0	0	0	0	0	0	0	105.0	76.7	84.3
Total	14901	135	460	92	27	10	8	9	29	6	0	0	0	15678	69.4	79.0
	95.0%	0.9%	2.9%	0.6%	0.2%	0.1%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%			

Daily Vehicle Classification

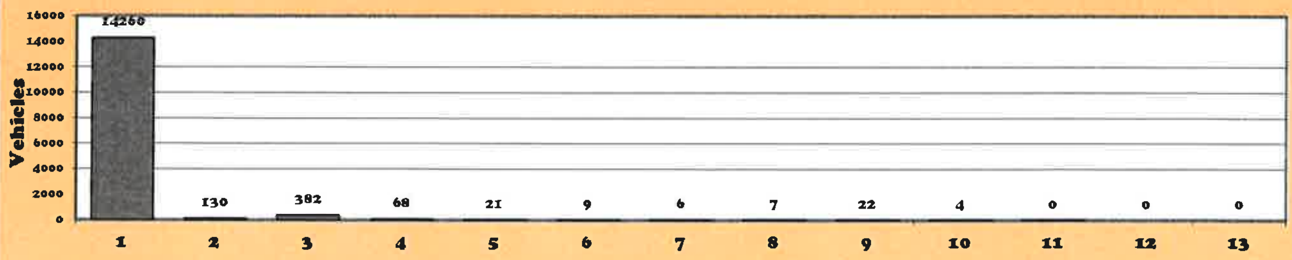


austraffic

Road	Memorial Dr	**AADT**	####				
Location	South of Bellambi Ln	**Ave Speed**	69.8		**Peak**	**Time**	**Vol**
Site No.	7812_2	**85%ile**	79		**AM**	11:00	923
Start Date	Monday 15/05/2017	**% Heavy's**	3.5%		**PM**	16:00	1,350
Displayed	Total Avg						

Time Starting	Vehicle Classification													Total	Speed	
	1	2	3	4	5	6	7	8	9	10	11	12	13		Ave.	85%ile
0:00	71	0	1	0	0	0	0	0	0	0	0	0	0	72.3	77.5	84.3
1:00	39	0	2	0	0	0	0	0	0	0	0	0	0	41.3	78.7	85.7
2:00	33	0	2	0	0	0	0	0	0	0	0	0	0	34.9	78.4	84.8
3:00	37	0	4	1	0	0	0	0	0	0	0	0	0	42.3	80.2	87.7
4:00	107	1	5	1	0	0	0	0	0	0	0	0	0	114.1	78.4	85.5
5:00	286	1	7	2	0	0	0	0	0	0	0	0	0	296.9	76.8	84.0
6:00	555	9	26	4	1	1	1	0	1	0	0	0	0	599.1	72.3	80.0
7:00	668	10	36	9	3	2	1	1	2	0	0	0	0	732.4	71.6	79.6
8:00	811	8	30	5	4	1	1	0	1	0	0	0	0	862.1	70.6	77.8
9:00	810	8	31	8	2	0	0	1	3	0	0	0	0	862.9	69.5	77.2
10:00	821	10	30	7	2	1	0	0	1	0	0	0	0	874.6	69.5	77.3
11:00	874	10	30	5	2	0	0	0	1	1	0	0	0	923.4	69.6	76.8
12:00	941	10	27	7	2	0	0	0	2	0	0	0	0	989.4	69.7	77.6
13:00	897	9	34	7	2	1	1	1	2	0	0	0	0	953.1	68.8	76.7
14:00	1063	11	31	5	1	0	0	0	2	0	0	0	0	1114.3	67.9	75.9
15:00	1211	14	22	3	1	1	0	1	2	1	0	0	0	1256.7	66.7	76.1
16:00	1311	12	22	2	1	0	0	1	1	1	0	0	0	1350.4	66.8	76.4
17:00	1314	7	15	0	0	0	0	1	1	0	0	0	0	1338.1	66.2	74.3
18:00	834	3	10	0	0	0	0	0	0	0	0	0	0	848.9	70.8	78.3
19:00	521	3	6	0	0	0	0	0	0	0	0	0	0	530.7	72.4	79.4
20:00	396	2	4	0	0	0	0	0	0	0	0	0	0	402.7	74.0	81.0
21:00	327	0	4	0	0	0	0	0	1	0	0	0	0	332.0	74.8	81.9
22:00	219	0	3	0	0	0	0	0	0	0	0	0	0	222.3	75.3	82.4
23:00	112	0	2	0	0	0	0	0	0	0	0	0	0	114.3	76.6	84.2
Total	14260	130	382	68	21	9	6	7	22	4	0	0	0	14909	69.8	78.6
	95.6%	0.9%	2.6%	0.5%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%			

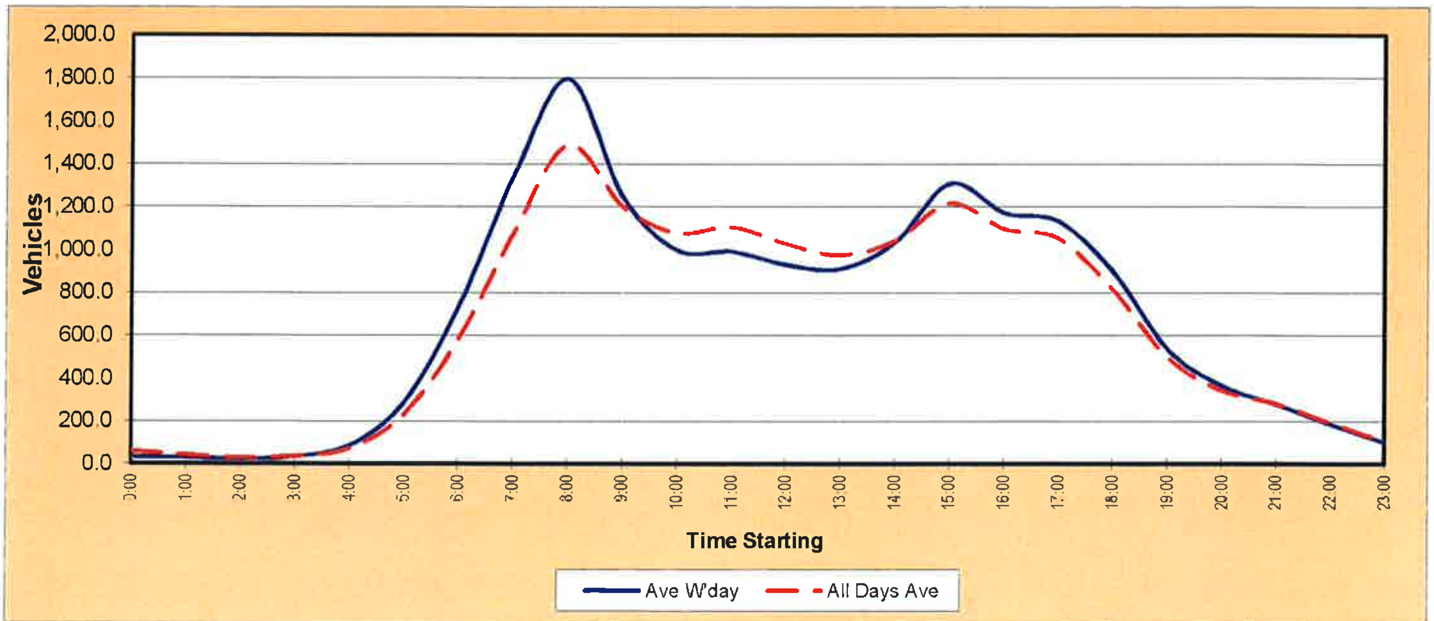
Daily Vehicle Classification



Road	Memorial Dr
Location	South of Bellambi Ln
Site No.	7812_2
Start Date	Monday 15/05/2017
Direction	South Bound

Average Weekday	16450
All Day Average	15653
Weekday Heavy's	3.9%
All Day Heavy's	3.2%

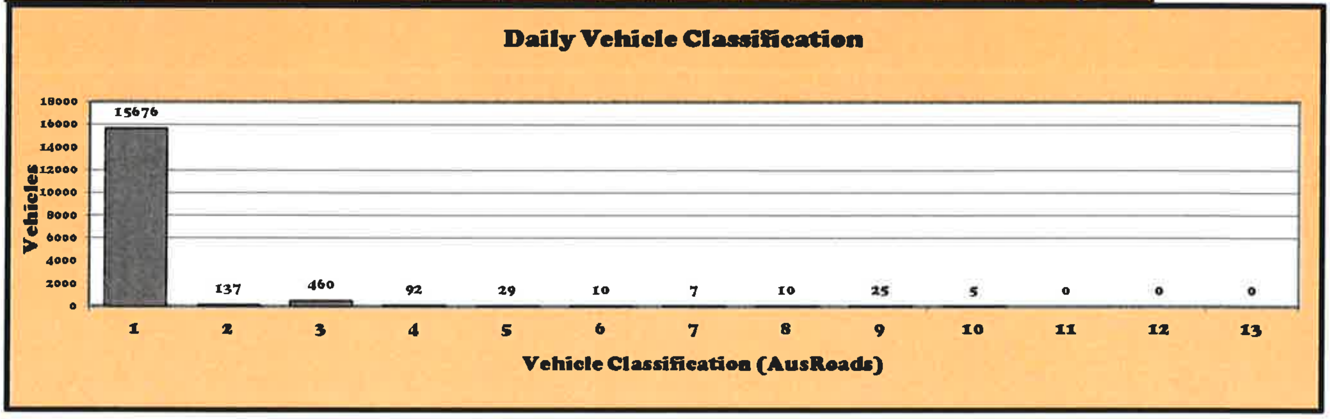
Starting Time	Day of Week							Ave W'day	All Days Ave
	Mon 15-May	Tue 16-May	Wed 17-May	Thu 18-May	Fri 19-May	Sat 20-May	Sun 21-May		
AM Peak	1778	1820	1796	1815	1769	1438	1339		
PM Peak	1270	1306	1357	1350	1260	1357	1187		
0:00	0	40	29	44	49	101	162	32	61
1:00	27	35	22	31	30	61	85	29	42
2:00	18	24	23	22	26	44	43	23	29
3:00	26	35	31	41	39	48	39	34	37
4:00	76	86	81	86	101	45	34	86	73
5:00	295	290	307	285	256	102	85	287	231
6:00	705	758	755	744	713	237	185	735	585
7:00	1324	1373	1407	1358	1243	479	348	1341	1076
8:00	1778	1820	1796	1815	1769	950	494	1796	1489
9:00	1200	1237	1210	1246	1341	1229	955	1247	1203
10:00	974	921	968	997	1128	1407	1145	998	1077
11:00	961	931	1024	980	1062	1438	1339	992	1105
12:00	877	888	939	967	980	1357	1187	930	1028
13:00	840	925	899	956	935	1143	1127	911	975
14:00	986	1006	1104	1031	1046	1030	1099	1035	1043
15:00	1270	1306	1357	1350	1260	997	981	1309	1217
16:00	1166	1198	1132	1206	1158	1038	769	1172	1095
17:00	1045	1065	1178	1201	1170	981	721	1132	1052
18:00	848	904	930	926	878	681	522	897	813
19:00	475	564	551	551	540	463	339	536	498
20:00	316	364	413	375	355	336	246	365	344
21:00	255	226	284	297	336	351	231	280	283
22:00	139	144	155	202	286	282	142	185	193
23:00	76	71	96	101	157	182	61	100	106
Total	15677	16211	16691	16812	16858	14982	12339	16450	15653
% Heavies	3.9%	4.0%	4.1%	4.0%	3.4%	1.5%	1.2%	3.9%	3.2%



Road	Memorial Dr	AADT	####
Location	South of Bellambi Ln	Ave Speed	67.8
Site No.	7812_2	85%ile	78
Start Date	Monday 15/05/2017	% Heavy's	3.9%
Displayed	WeekDay Avg		

Peak	Time	Vol
AM	08:00	1,796
PM	15:00	1,309

Time Starting	Vehicle Classification													Total	Speed	
	1	2	3	4	5	6	7	8	9	10	11	12	13		Ave.	85%ile
0:00	31	0	1	0	0	0	0	0	0	0	0	0	0	32.4	75.2	83.0
1:00	26	0	2	0	0	0	0	0	0	0	0	0	0	29.0	77.2	83.0
2:00	21	0	1	0	0	0	0	0	0	0	0	0	0	22.6	77.0	85.2
3:00	28	0	4	1	0	0	0	1	1	0	0	0	0	34.4	77.2	86.2
4:00	80	0	4	1	0	0	0	0	0	0	0	0	0	86.0	77.1	85.9
5:00	274	1	6	3	1	0	0	0	2	0	0	0	0	286.6	75.6	83.6
6:00	689	9	25	6	1	1	1	2	2	0	0	0	0	735.0	72.8	80.8
7:00	1277	11	37	9	3	0	0	0	3	1	0	0	0	1341.0	64.5	75.3
8:00	1738	9	34	10	4	0	0	0	1	0	0	0	0	1795.6	55.0	69.3
9:00	1177	12	41	7	5	1	0	1	3	0	0	0	0	1246.8	65.8	74.5
10:00	925	12	41	12	4	0	1	1	2	0	0	0	0	997.6	68.7	76.2
11:00	923	11	41	8	3	2	1	1	2	0	0	0	0	991.6	69.7	77.0
12:00	867	9	38	10	1	2	0	1	2	0	0	0	0	930.2	70.1	77.3
13:00	844	10	40	9	3	1	0	2	1	0	0	0	0	911.0	70.4	77.2
14:00	968	11	40	8	2	1	1	1	2	0	0	0	0	1034.6	70.2	77.6
15:00	1238	18	42	5	2	1	1	0	1	1	0	0	0	1308.6	66.9	75.3
16:00	1130	10	28	1	1	1	1	0	1	1	0	0	0	1172.0	69.2	76.6
17:00	1109	8	14	1	0	0	0	0	0	0	0	0	0	1131.8	68.7	76.3
18:00	884	2	11	0	0	0	0	0	0	0	0	0	0	897.2	70.6	78.0
19:00	530	1	4	0	0	0	0	0	0	0	0	0	0	536.2	73.1	79.2
20:00	359	2	2	0	0	0	0	0	0	0	0	0	0	364.6	73.8	80.6
21:00	278	1	1	0	0	0	0	0	0	0	0	0	0	279.6	74.1	80.8
22:00	182	0	1	1	0	0	0	0	1	0	0	0	0	185.2	74.5	81.4
23:00	99	0	1	0	0	0	0	0	0	0	0	0	0	100.2	75.6	81.1
Total	15676	137	460	92	29	10	7	10	25	5	0	0	0	16450	67.8	77.9
	95.3%	0.8%	2.8%	0.6%	0.2%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%			

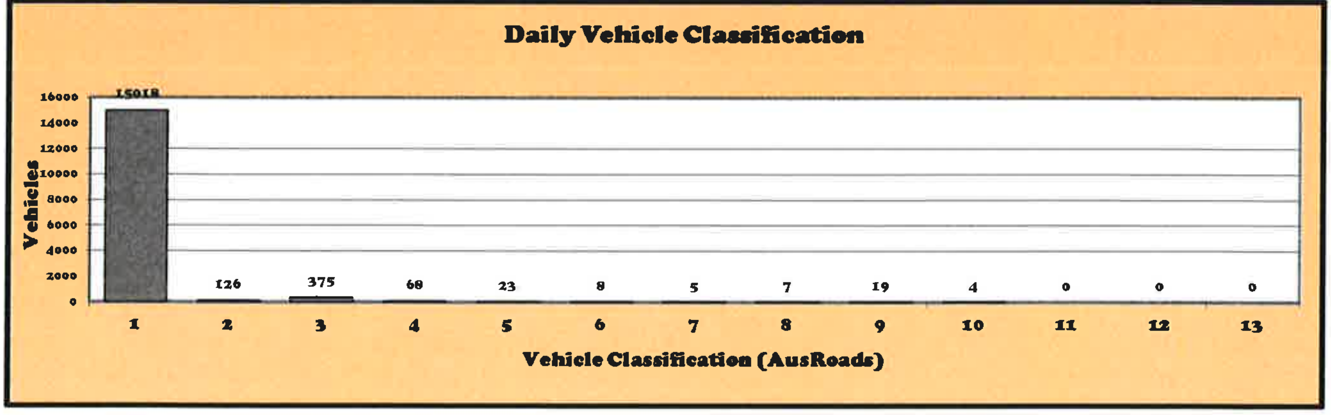


austraffic

Road	Memorial Dr	**AADT**	####
Location	South of Bellambi Ln	**Ave Speed**	68.6
Site No.	7812_2	**85%ile**	78
Start Date	Monday 15/05/2017	**% Heavy's**	3.2%
Displayed	Total Avg		

Peak	Time	Vol
AM	08:00	1,489
PM	15:00	1,217

Time Starting	Vehicle Classification 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Speed Ave.	85%ile
0:00	59	0	1	0	0	0	0	0	0	0	0	0	0	60.7	75.0	82.0
1:00	39	0	3	0	0	0	0	0	0	0	0	0	0	41.6	76.9	83.4
2:00	27	0	1	0	0	0	0	0	0	0	0	0	0	28.6	76.8	84.6
3:00	30	0	5	1	0	0	0	1	0	0	0	0	0	37.0	77.2	85.3
4:00	68	0	3	1	0	0	0	0	0	0	0	0	0	72.7	77.1	85.7
5:00	221	2	5	2	1	0	0	0	1	0	0	0	0	231.4	75.6	83.6
6:00	548	8	20	4	1	1	1	1	2	0	0	0	0	585.3	72.9	80.8
7:00	1025	10	29	7	2	1	0	0	2	0	0	0	0	1076.0	65.6	76.0
8:00	1443	8	27	7	3	0	0	0	1	0	0	0	0	1488.9	57.3	70.6
9:00	1147	11	33	5	4	1	0	1	2	0	0	0	0	1202.6	66.8	75.4
10:00	1018	11	34	9	3	0	0	0	1	0	0	0	0	1077.1	69.0	76.4
11:00	1048	10	34	6	3	1	1	1	1	0	0	0	0	1105.0	69.2	76.9
12:00	975	10	31	7	1	1	0	1	1	0	0	0	0	1027.9	70.0	77.1
13:00	921	10	32	6	2	1	0	1	1	0	0	0	0	975.0	70.4	77.4
14:00	990	11	31	6	2	1	1	0	2	0	0	0	0	1043.1	70.3	77.7
15:00	1162	15	32	3	1	1	0	0	1	1	0	0	0	1217.3	67.7	75.7
16:00	1059	9	24	1	0	1	0	0	1	0	0	0	0	1095.3	69.9	77.2
17:00	1032	8	11	1	0	0	0	0	0	0	0	0	0	1051.6	69.2	76.6
18:00	801	2	9	0	0	0	0	0	0	0	0	0	0	812.7	71.0	78.0
19:00	491	1	5	1	0	0	0	0	0	0	0	0	0	497.6	73.3	79.5
20:00	338	2	3	0	0	0	0	0	0	0	0	0	0	343.6	73.7	80.4
21:00	280	1	1	0	0	0	0	0	0	0	0	0	0	282.9	74.1	81.2
22:00	190	0	1	0	0	0	0	0	1	0	0	0	0	192.9	74.3	80.8
23:00	105	0	1	0	0	0	0	0	0	0	0	0	0	106.3	75.3	81.7
Total	15018	126	375	68	23	8	5	7	19	4	0	0	0	15653	68.6	77.6
	95.9%	0.8%	2.4%	0.4%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%			



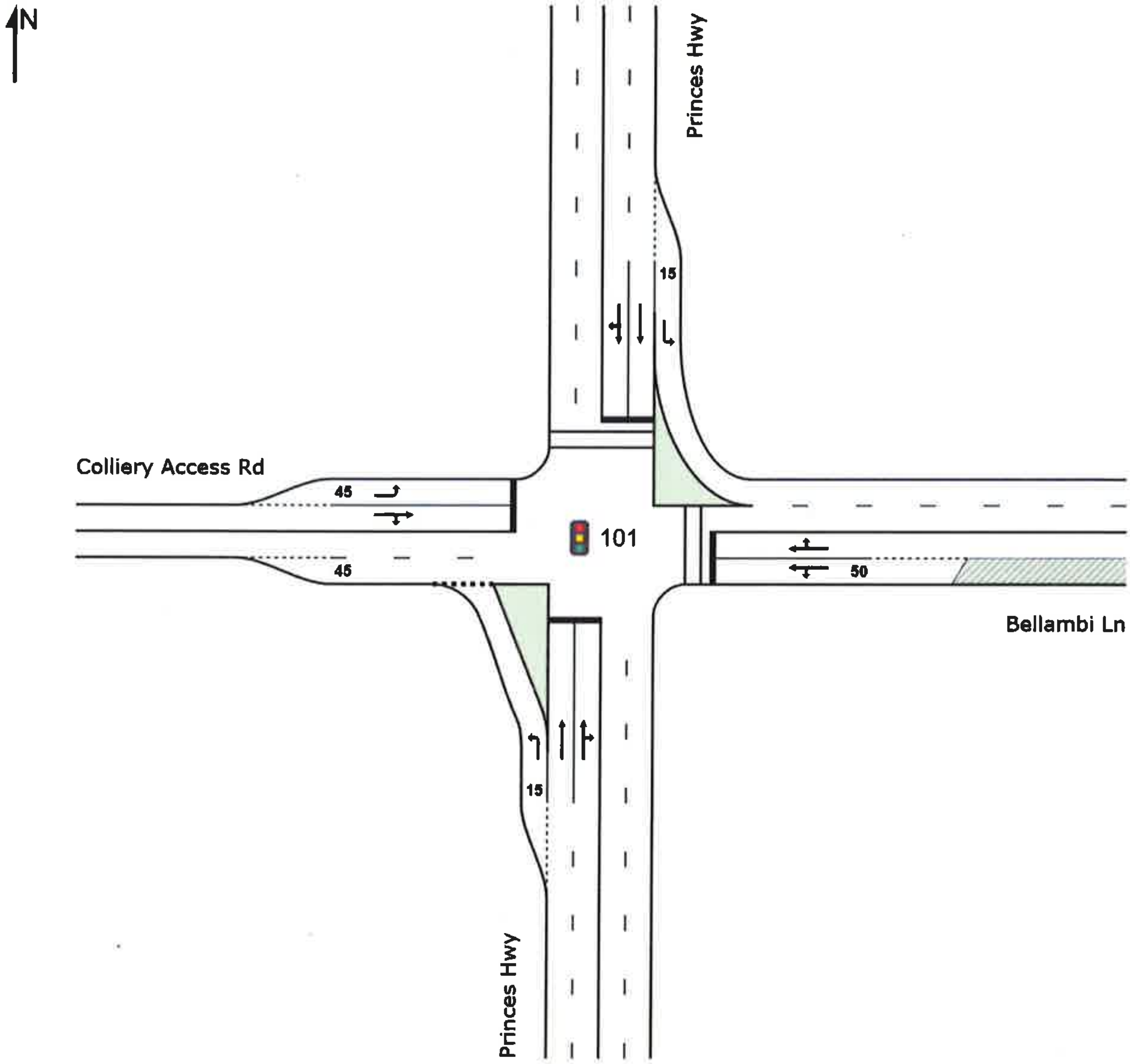
APPENDIX 2

SIDRA MODELLING OUTPUTS

SITE LAYOUT

Site: 101 [Princes Hwy & Bellambi Lane - Ex AM]

Ex AM & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated



MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - Ex AM]

Ex AM & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	365	3.3	0.234	10.0	LOS A	4.3	31.2	0.58	0.51	0.58	51.2
3	R2	45	4.4	0.234	16.3	LOS B	3.4	24.4	0.60	0.56	0.60	48.7
Approach		411	3.4	0.234	10.7	LOS A	4.3	31.2	0.58	0.52	0.58	50.9
East: Bellambi Ln												
4	L2	36	2.8	0.072	24.6	LOS B	1.0	7.2	0.74	0.69	0.74	42.0
5	T1	3	33.3	0.072	19.0	LOS B	1.0	7.2	0.74	0.69	0.74	42.9
6	R2	122	7.4	0.270	26.3	LOS B	3.3	24.2	0.80	0.76	0.80	41.2
Approach		161	6.8	0.270	25.8	LOS B	3.3	24.2	0.79	0.74	0.79	41.4
North: Princes Hwy												
7	L2	295	5.4	0.165	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	54.7
8	T1	503	2.4	0.277	9.6	LOS A	5.3	37.7	0.58	0.49	0.58	51.8
9	R2	1	0.0	0.277	15.3	LOS B	5.3	37.7	0.59	0.50	0.59	50.5
Approach		799	3.5	0.277	8.2	LOS A	5.3	37.7	0.36	0.50	0.36	52.9
West: Colliery Access Rd												
10	L2	1	0.0	0.002	23.7	LOS B	0.0	0.2	0.71	0.59	0.71	42.4
11	T1	2	0.0	0.006	18.3	LOS B	0.1	0.5	0.72	0.52	0.72	45.1
12	R2	1	0.0	0.006	23.9	LOS B	0.1	0.5	0.72	0.52	0.72	44.3
Approach		4	0.0	0.006	21.1	LOS B	0.1	0.5	0.72	0.54	0.72	44.2
All Vehicles		1375	3.9	0.277	11.0	LOS A	5.3	37.7	0.48	0.53	0.48	50.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	22	11.4	LOS B	0.0	0.0	0.57	0.57
P3	North Full Crossing	18	24.0	LOS C	0.0	0.0	0.83	0.83
All Pedestrians		40	17.1	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - Ex PM]

Ex PM with Bunnings
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	541	1.8	0.388	13.8	LOS A	7.7	55.0	0.71	0.62	0.71	48.6
3	R2	68	2.9	0.388	19.9	LOS B	6.2	44.5	0.72	0.65	0.72	46.6
Approach		610	2.0	0.388	14.5	LOS B	7.7	55.0	0.71	0.63	0.71	48.3
East: Bellambi Ln												
4	L2	73	1.4	0.108	21.1	LOS B	1.7	11.8	0.69	0.71	0.69	43.7
5	T1	1	0.0	0.108	15.6	LOS B	1.7	11.8	0.69	0.71	0.69	44.6
6	R2	221	5.4	0.401	23.5	LOS B	5.7	41.8	0.78	0.78	0.78	42.5
Approach		295	4.4	0.401	22.9	LOS B	5.7	41.8	0.76	0.76	0.76	42.8
North: Princes Hwy												
7	L2	204	0.5	0.110	5.6	LOS A	0.0	0.0	0.00	0.53	0.00	54.9
8	T1	394	1.8	0.237	12.4	LOS A	4.3	30.6	0.64	0.53	0.64	49.9
9	R2	1	0.0	0.237	18.0	LOS B	4.3	30.6	0.65	0.54	0.65	48.7
Approach		599	1.3	0.237	10.1	LOS A	4.3	30.6	0.42	0.53	0.42	51.5
West: Colliery Access Rd												
10	L2	2	0.0	0.003	20.1	LOS B	0.0	0.3	0.64	0.61	0.64	44.2
11	T1	2	0.0	0.005	14.7	LOS B	0.1	0.4	0.65	0.49	0.65	47.2
12	R2	1	0.0	0.005	20.3	LOS B	0.1	0.4	0.65	0.49	0.65	46.4
Approach		5	0.0	0.005	18.0	LOS B	0.1	0.4	0.64	0.54	0.64	45.8
All Vehicles		1509	2.2	0.401	14.4	LOS A	7.7	55.0	0.60	0.62	0.60	48.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	8	14.5	LOS B	0.0	0.0	0.64	0.64
P3	North Full Crossing	5	20.1	LOS C	0.0	0.0	0.76	0.76
All Pedestrians		13	16.6	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - AM with Proposal]

AM with Mine Proposal & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	365	3.3	0.241	10.6	LOS A	4.5	32.2	0.60	0.52	0.60	50.8
3	R2	45	4.4	0.241	17.0	LOS B	3.5	25.1	0.62	0.57	0.62	48.3
Approach		411	3.4	0.241	11.3	LOS A	4.5	32.2	0.60	0.53	0.60	50.5
East: Bellambi Ln												
4	L2	36	2.8	0.092	24.0	LOS B	1.2	11.8	0.74	0.68	0.74	42.3
5	T1	20	85.0	0.288	19.1	LOS B	3.5	28.5	0.76	0.71	0.76	42.8
6	R2	122	7.4	0.288	25.7	LOS B	3.5	28.5	0.79	0.76	0.79	41.5
Approach		178	15.2	0.288	24.6	LOS B	3.5	28.5	0.78	0.73	0.78	41.8
North: Princes Hwy												
7	L2	295	5.4	0.165	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	54.7
8	T1	503	2.4	0.289	10.2	LOS A	5.5	39.6	0.60	0.50	0.60	51.4
9	R2	1	0.0	0.289	16.0	LOS B	5.5	39.6	0.61	0.52	0.61	50.0
Approach		799	3.5	0.289	8.6	LOS A	5.5	39.6	0.38	0.51	0.38	52.6
West: Colliery Access Rd												
10	L2	1	0.0	0.002	22.9	LOS B	0.0	0.2	0.70	0.59	0.70	42.7
11	T1	19	89.5	0.052	18.3	LOS B	0.5	9.6	0.72	0.54	0.72	45.1
12	R2	1	0.0	0.052	23.9	LOS B	0.5	9.6	0.72	0.54	0.72	44.3
Approach		21	81.0	0.052	18.8	LOS B	0.5	9.6	0.72	0.54	0.72	44.9
All Vehicles		1409	6.1	0.289	11.5	LOS A	5.5	39.6	0.50	0.55	0.50	50.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	22	12.0	LOS B	0.0	0.0	0.59	0.59
P3	North Full Crossing	18	23.2	LOS C	0.0	0.0	0.81	0.81
All Pedestrians		40	17.1	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - PM with Proposal]

PM with Mine Proposal & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	541	1.8	0.414	15.4	LOS B	8.2	58.0	0.74	0.65	0.74	47.6
3	R2	68	2.9	0.414	21.4	LOS B	6.6	46.8	0.75	0.68	0.75	45.7
Approach		610	2.0	0.414	16.0	LOS B	8.2	58.0	0.74	0.65	0.74	47.4
East: Bellambi Ln												
4	L2	73	1.4	0.134	20.0	LOS B	2.0	19.0	0.67	0.69	0.67	44.3
5	T1	18	94.4	0.420	14.6	LOS B	5.6	41.5	0.67	0.69	0.67	45.2
6	R2	221	5.4	0.420	22.4	LOS B	5.6	41.5	0.77	0.78	0.77	43.1
Approach		312	9.6	0.420	21.3	LOS B	5.6	41.5	0.74	0.75	0.74	43.5
North: Princes Hwy												
7	L2	204	0.5	0.110	5.6	LOS A	0.0	0.0	0.00	0.53	0.00	54.9
8	T1	394	1.8	0.259	13.8	LOS A	4.7	33.2	0.67	0.56	0.67	48.9
9	R2	1	0.0	0.259	19.4	LOS B	4.7	33.2	0.68	0.57	0.68	47.8
Approach		599	1.3	0.259	11.0	LOS A	4.7	33.2	0.45	0.55	0.45	50.8
West: Colliery Access Rd												
10	L2	32	0.0	0.043	19.3	LOS B	0.7	4.6	0.64	0.68	0.64	44.6
11	T1	48	35.4	0.140	14.6	LOS B	1.8	17.9	0.67	0.61	0.67	46.7
12	R2	32	0.0	0.140	20.1	LOS B	1.8	17.9	0.67	0.61	0.67	45.9
Approach		112	15.2	0.140	17.5	LOS B	1.8	17.9	0.66	0.63	0.66	45.9
All Vehicles		1633	4.1	0.420	15.3	LOS B	8.2	58.0	0.63	0.63	0.63	47.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	8	15.8	LOS B	0.0	0.0	0.67	0.67
P3	North Full Crossing	5	18.6	LOS B	0.0	0.0	0.73	0.73
All Pedestrians		13	16.9	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - 2023 AM]

AM Cumulative Imapcts, with Mine Bunnings & Background Growth
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	5	0.0	0.004	6.2	LOS A	0.0	0.1	0.18	0.57	0.18	53.7
2	T1	398	3.3	0.264	10.7	LOS A	4.9	35.5	0.61	0.53	0.61	50.7
3	R2	46	4.3	0.264	17.1	LOS B	3.8	27.4	0.63	0.58	0.63	48.2
Approach		449	3.3	0.264	11.3	LOS A	4.9	35.5	0.60	0.54	0.60	50.5
East: Bellambi Ln												
4	L2	40	2.5	0.103	24.1	LOS B	1.3	13.4	0.74	0.68	0.74	42.2
5	T1	20	85.0	0.323	19.1	LOS B	3.8	30.2	0.76	0.71	0.76	42.8
6	R2	133	7.5	0.323	26.0	LOS B	3.8	30.2	0.81	0.76	0.81	41.3
Approach		193	14.5	0.323	24.9	LOS B	3.8	30.2	0.79	0.74	0.79	41.6
North: Princes Hwy												
7	L2	322	5.3	0.180	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	54.7
8	T1	549	2.4	0.326	10.4	LOS A	6.4	45.7	0.61	0.52	0.61	51.2
9	R2	1	0.0	0.326	16.2	LOS B	6.4	45.7	0.62	0.53	0.62	49.9
Approach		872	3.4	0.326	8.7	LOS A	6.4	45.7	0.38	0.52	0.38	52.5
West: Colliery Access Rd												
10	L2	13	0.0	0.022	23.3	LOS B	0.3	2.1	0.71	0.67	0.71	42.5
11	T1	29	58.6	0.098	18.6	LOS B	1.0	13.5	0.74	0.61	0.74	44.4
12	R2	13	0.0	0.098	24.2	LOS B	1.0	13.5	0.74	0.61	0.74	43.6
Approach		55	30.9	0.098	21.1	LOS B	1.0	13.5	0.73	0.62	0.73	43.8
All Vehicles		1569	5.7	0.326	11.9	LOS A	6.4	45.7	0.51	0.56	0.51	50.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	22	12.0	LOS B	0.0	0.0	0.59	0.59
P3	North Full Crossing	18	23.2	LOS C	0.0	0.0	0.81	0.81
All Pedestrians		40	17.1	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - 2023 PM]

PM Cumulative Impact with Mine, Bunnings & Background Growth
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	590	1.9	0.461	16.0	LOS B	9.3	66.2	0.77	0.67	0.77	47.2
3	R2	75	2.7	0.461	22.5	LOS B	7.3	52.1	0.78	0.70	0.78	45.0
Approach		666	2.0	0.461	16.7	LOS B	9.3	66.2	0.77	0.68	0.77	47.0
East: Bellambi Ln												
4	L2	80	1.2	0.145	20.0	LOS B	2.1	20.6	0.67	0.69	0.67	44.2
5	T1	18	94.4	0.455	14.5	LOS B	6.2	45.5	0.67	0.69	0.67	45.2
6	R2	241	5.4	0.455	22.7	LOS B	6.2	45.5	0.78	0.79	0.78	42.9
Approach		339	9.1	0.455	21.6	LOS B	6.2	45.5	0.75	0.76	0.75	43.3
North: Princes Hwy												
7	L2	223	0.4	0.120	5.6	LOS A	0.0	0.0	0.00	0.53	0.00	54.9
8	T1	430	1.9	0.293	13.9	LOS A	5.4	38.2	0.68	0.57	0.68	48.8
9	R2	1	0.0	0.293	19.7	LOS B	5.4	38.2	0.69	0.58	0.69	47.6
Approach		654	1.4	0.293	11.1	LOS A	5.4	38.2	0.45	0.56	0.45	50.8
West: Colliery Access Rd												
10	L2	32	0.0	0.043	19.3	LOS B	0.7	4.6	0.64	0.68	0.64	44.6
11	T1	48	35.4	0.141	14.6	LOS B	1.8	17.9	0.67	0.61	0.67	46.7
12	R2	32	0.0	0.141	20.1	LOS B	1.8	17.9	0.67	0.61	0.67	45.9
Approach		112	15.2	0.141	17.5	LOS B	1.8	17.9	0.66	0.63	0.66	45.9
All Vehicles		1771	4.0	0.461	15.6	LOS B	9.3	66.2	0.64	0.64	0.64	47.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	8	15.8	LOS B	0.0	0.0	0.67	0.67
P3	North Full Crossing	5	18.6	LOS B	0.0	0.0	0.73	0.73
All Pedestrians		13	16.9	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - AM with Proposal & Higher Traffic Levels]

AM with Mine Proposal & Bunnings & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	365	3.3	0.249	11.2	LOS A	4.6	33.3	0.62	0.54	0.62	50.3
3	R2	45	4.4	0.249	17.6	LOS B	3.6	25.7	0.63	0.59	0.63	47.9
Approach		411	3.4	0.249	11.9	LOS A	4.6	33.3	0.62	0.54	0.62	50.1
East: Bellambi Ln												
4	L2	36	2.8	0.096	23.3	LOS B	1.2	13.4	0.72	0.67	0.72	42.6
5	T1	28	89.3	0.302	18.5	LOS B	3.5	30.9	0.75	0.71	0.75	43.1
6	R2	122	7.4	0.302	25.1	LOS B	3.5	30.9	0.79	0.75	0.79	41.8
Approach		186	18.8	0.302	23.7	LOS B	3.5	30.9	0.77	0.73	0.77	42.1
North: Princes Hwy												
7	L2	295	5.4	0.165	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	54.7
8	T1	503	2.4	0.303	10.9	LOS A	5.8	41.6	0.61	0.52	0.61	50.9
9	R2	1	0.0	0.303	16.6	LOS B	5.8	41.6	0.63	0.53	0.63	49.6
Approach		799	3.5	0.303	9.0	LOS A	5.8	41.6	0.39	0.52	0.39	52.3
West: Colliery Access Rd												
10	L2	1	0.0	0.002	22.2	LOS B	0.0	0.2	0.69	0.59	0.69	43.1
11	T1	27	92.6	0.070	17.7	LOS B	0.7	13.7	0.72	0.54	0.72	45.4
12	R2	1	0.0	0.070	23.3	LOS B	0.7	13.7	0.72	0.54	0.72	44.7
Approach		29	86.2	0.070	18.1	LOS B	0.7	13.7	0.71	0.54	0.71	45.3
All Vehicles		1425	7.2	0.303	11.9	LOS A	5.8	41.6	0.51	0.55	0.51	49.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	22	12.6	LOS B	0.0	0.0	0.60	0.60
P3	North Full Crossing	18	22.4	LOS C	0.0	0.0	0.80	0.80
All Pedestrians		40	17.0	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - PM with Proposal & Higher Traffic Generation]

PM with Mine Proposal & Bunnings & Higher Traffic Generation
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	541	1.8	0.432	16.4	LOS B	8.4	60.1	0.77	0.67	0.77	47.0
3	R2	68	2.9	0.432	23.0	LOS B	6.8	48.4	0.78	0.70	0.78	44.8
Approach		610	2.0	0.432	17.1	LOS B	8.4	60.1	0.77	0.67	0.77	46.7
East: Bellambi Ln												
4	L2	73	1.4	0.136	19.3	LOS B	2.0	20.0	0.65	0.68	0.65	44.6
5	T1	26	96.2	0.425	14.3	LOS A	5.7	43.6	0.68	0.70	0.68	45.3
6	R2	221	5.4	0.425	21.7	LOS B	5.7	43.6	0.76	0.78	0.76	43.4
Approach		320	11.9	0.425	20.6	LOS B	5.7	43.6	0.73	0.75	0.73	43.8
North: Princes Hwy												
7	L2	204	0.5	0.110	5.6	LOS A	0.0	0.0	0.00	0.53	0.00	54.9
8	T1	394	1.8	0.270	14.5	LOS A	4.8	34.3	0.69	0.57	0.69	48.5
9	R2	1	0.0	0.270	20.2	LOS B	4.8	34.3	0.70	0.58	0.70	47.3
Approach		599	1.3	0.270	11.5	LOS A	4.8	34.3	0.46	0.56	0.46	50.5
West: Colliery Access Rd												
10	L2	32	0.0	0.042	18.6	LOS B	0.6	4.5	0.62	0.68	0.62	45.0
11	T1	56	44.6	0.153	14.0	LOS A	1.9	21.4	0.66	0.60	0.66	47.1
12	R2	32	0.0	0.153	19.6	LOS B	1.9	21.4	0.66	0.60	0.66	46.2
Approach		120	20.8	0.153	16.7	LOS B	1.9	21.4	0.65	0.62	0.65	46.3
All Vehicles		1649	5.0	0.432	15.7	LOS B	8.4	60.1	0.64	0.64	0.64	47.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	8	16.5	LOS B	0.0	0.0	0.69	0.69
P3	North Full Crossing	5	17.9	LOS B	0.0	0.0	0.71	0.71
All Pedestrians		13	17.0	LOS B			0.70	0.70

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - 2023 AM With Higher Traffic Levels]

AM Cumulative Imapcts, with Mine Bunnings & Background Growth & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	5	0.0	0.004	6.2	LOS A	0.0	0.1	0.18	0.57	0.18	53.7
2	T1	398	3.3	0.273	11.6	LOS A	5.1	36.7	0.63	0.55	0.63	50.1
3	R2	46	4.3	0.273	18.4	LOS B	4.0	28.7	0.66	0.60	0.66	47.4
Approach		449	3.3	0.273	12.2	LOS A	5.1	36.7	0.63	0.55	0.63	49.9
East: Bellambi Ln												
4	L2	40	2.5	0.106	23.4	LOS B	1.3	14.6	0.73	0.67	0.73	42.6
5	T1	28	89.3	0.331	18.6	LOS B	3.9	32.9	0.76	0.71	0.76	43.1
6	R2	133	7.5	0.331	25.3	LOS B	3.9	32.9	0.80	0.76	0.80	41.6
Approach		201	17.9	0.331	24.0	LOS B	3.9	32.9	0.78	0.74	0.78	42.0
North: Princes Hwy												
7	L2	322	5.3	0.180	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	54.7
8	T1	549	2.4	0.338	11.1	LOS A	6.7	47.5	0.62	0.53	0.62	50.8
9	R2	1	0.0	0.338	16.9	LOS B	6.7	47.5	0.64	0.55	0.64	49.4
Approach		872	3.4	0.338	9.1	LOS A	6.7	47.5	0.39	0.53	0.39	52.2
West: Colliery Access Rd												
10	L2	13	0.0	0.021	22.6	LOS B	0.3	2.1	0.70	0.66	0.70	42.9
11	T1	37	67.6	0.115	18.0	LOS B	1.2	17.6	0.73	0.60	0.73	44.7
12	R2	13	0.0	0.115	23.6	LOS B	1.2	17.6	0.73	0.60	0.73	44.0
Approach		63	39.7	0.115	20.1	LOS B	1.2	17.6	0.72	0.62	0.72	44.2
All Vehicles		1585	6.7	0.338	12.3	LOS A	6.7	47.5	0.52	0.57	0.52	49.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	22	12.6	LOS B	0.0	0.0	0.60	0.60
P3	North Full Crossing	18	22.4	LOS C	0.0	0.0	0.80	0.80
All Pedestrians		40	17.0	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Princes Hwy & Bellambi Lane - 2023 PM with Higher Traffic Levels]

PM Cumulative Impact with Mine, Bunnings & Background Growth & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Princes Hwy												
1	L2	1	0.0	0.001	6.1	LOS A	0.0	0.0	0.18	0.56	0.18	53.7
2	T1	590	1.9	0.461	16.0	LOS B	9.3	66.1	0.77	0.67	0.77	47.2
3	R2	75	2.7	0.461	22.5	LOS B	7.3	52.1	0.78	0.70	0.78	45.0
Approach		666	2.0	0.461	16.7	LOS B	9.3	66.1	0.77	0.68	0.77	47.0
East: Bellambi Ln												
4	L2	80	1.2	0.152	20.1	LOS B	2.2	22.2	0.67	0.69	0.67	44.2
5	T1	26	96.2	0.476	15.1	LOS B	6.4	48.9	0.70	0.71	0.70	44.9
6	R2	241	5.4	0.476	22.9	LOS B	6.4	48.9	0.79	0.79	0.79	42.8
Approach		347	11.2	0.476	21.6	LOS B	6.4	48.9	0.75	0.76	0.75	43.3
North: Princes Hwy												
7	L2	223	0.4	0.120	5.6	LOS A	0.0	0.0	0.00	0.53	0.00	54.9
8	T1	430	1.9	0.293	13.9	LOS A	5.4	38.3	0.68	0.57	0.68	48.8
9	R2	1	0.0	0.293	19.7	LOS B	5.4	38.3	0.69	0.58	0.69	47.6
Approach		654	1.4	0.293	11.1	LOS A	5.4	38.3	0.45	0.56	0.45	50.8
West: Colliery Access Rd												
10	L2	32	0.0	0.043	19.3	LOS B	0.7	4.6	0.64	0.68	0.64	44.6
11	T1	56	44.6	0.159	14.7	LOS B	2.0	22.0	0.67	0.61	0.67	46.6
12	R2	32	0.0	0.159	20.3	LOS B	2.0	22.0	0.67	0.61	0.67	45.8
Approach		120	20.8	0.159	17.4	LOS B	2.0	22.0	0.66	0.63	0.66	45.9
All Vehicles		1787	4.8	0.476	15.7	LOS B	9.3	66.1	0.64	0.65	0.64	47.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

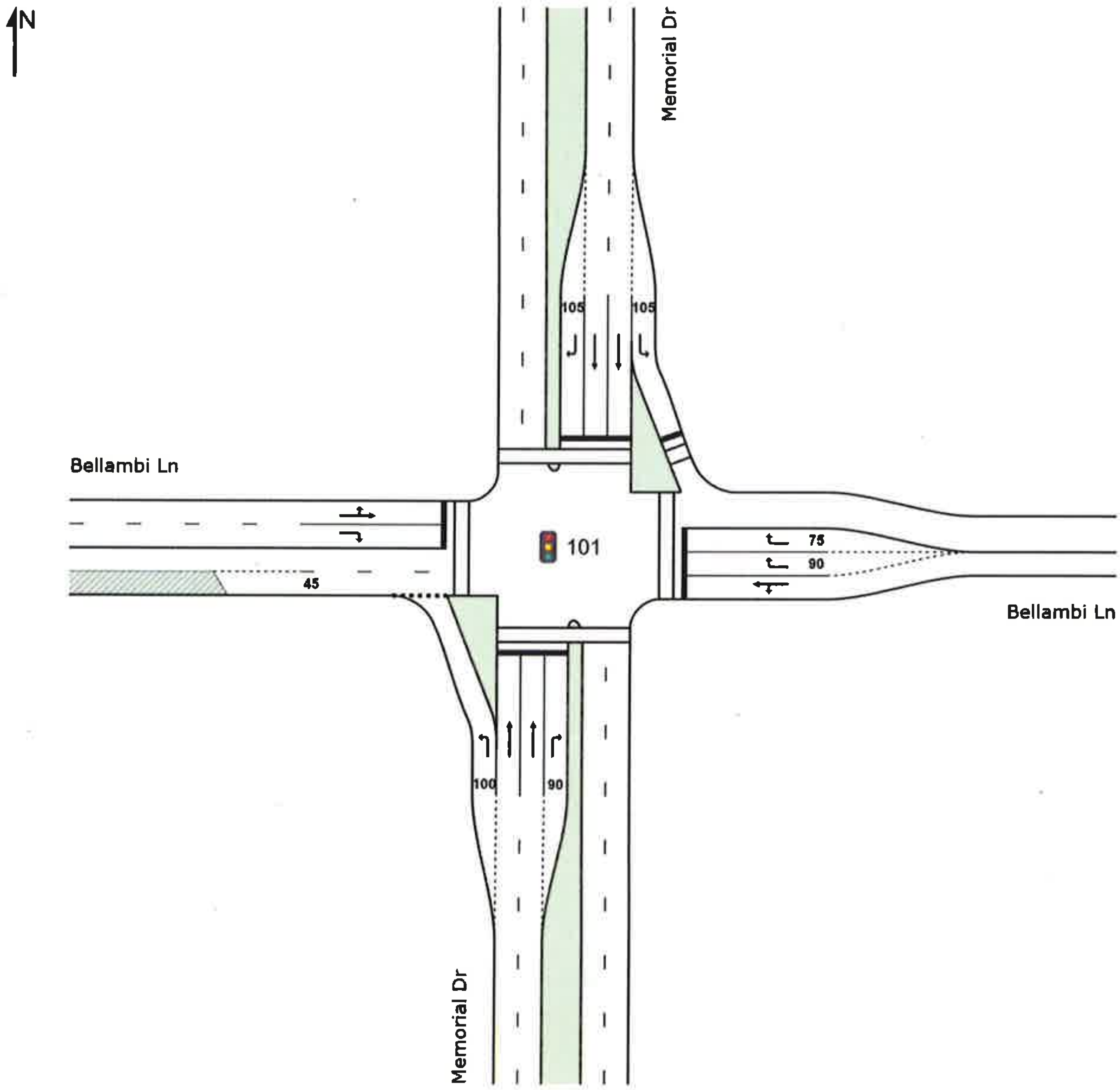
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P2	East Full Crossing	8	15.8	LOS B	0.0	0.0	0.67	0.67
P3	North Full Crossing	5	18.6	LOS B	0.0	0.0	0.73	0.73
All Pedestrians		13	16.9	LOS B			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SITE LAYOUT

Site: 101 [Memorial Dr & Bellambi Lane - Ex AM]

Ex AM & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated



MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - Ex AM]

Ex AM & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles													
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	95	11.6	0.065	6.5	LOS A	0.6	4.9	0.17	0.59	0.17	53.1
2	T1	831	3.4	0.396	19.8	LOS B	14.9	107.3	0.67	0.59	0.67	55.9
3	R2	35	11.4	0.408	69.8	LOS E	2.1	16.5	1.00	0.73	1.00	27.7
Approach		961	4.5	0.408	20.3	LOS B	14.9	107.3	0.63	0.59	0.63	53.6
East: Bellambi Ln												
4	L2	49	8.2	0.751	68.8	LOS E	7.1	52.5	1.00	0.87	1.18	28.5
5	T1	65	6.2	0.751	63.2	LOS E	7.1	52.5	1.00	0.87	1.18	29.0
6	R2	178	4.5	0.270	42.1	LOS C	4.0	29.2	0.91	0.76	0.91	35.1
Approach		292	5.5	0.751	51.3	LOS D	7.1	52.5	0.94	0.80	1.02	32.3
North: Memorial Dr												
7	L2	255	1.2	0.195	11.8	LOS A	4.9	34.9	0.36	0.66	0.36	49.7
8	T1	1599	1.9	0.811	26.0	LOS B	40.2	286.2	0.87	0.80	0.88	51.0
9	R2	24	20.8	0.297	69.5	LOS E	1.5	12.0	1.00	0.71	1.00	27.5
Approach		1878	2.0	0.811	24.7	LOS B	40.2	286.2	0.80	0.78	0.81	50.3
West: Bellambi Ln												
10	L2	22	22.7	0.763	69.5	LOS E	7.1	54.7	1.00	0.88	1.20	28.5
11	T1	92	8.7	0.763	63.7	LOS E	7.1	54.7	1.00	0.88	1.20	29.2
12	R2	228	3.9	0.686	46.2	LOS D	11.4	86.5	0.99	0.84	1.02	33.8
Approach		342	6.4	0.763	52.4	LOS D	11.4	86.5	0.99	0.85	1.08	32.1
All Vehicles		3473	3.4	0.811	28.4	LOS B	40.2	286.2	0.79	0.74	0.80	46.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	14	53.2	LOS E	0.0	0.0	0.94	0.94
P2	East Full Crossing	5	20.4	LOS C	0.0	0.0	0.58	0.58
P3	North Full Crossing	24	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	17	42.5	LOS E	0.0	0.0	0.84	0.84
P4	West Full Crossing	16	20.4	LOS C	0.0	0.0	0.58	0.58
All Pedestrians		76	41.8	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - Ex PM]

Ex PM & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	158	3.8	0.108	6.9	LOS A	1.2	9.2	0.20	0.60	0.20	53.1
2	T1	1260	2.1	0.697	26.6	LOS B	28.8	205.0	0.83	0.74	0.83	50.6
3	R2	85	3.5	0.704	69.8	LOS E	5.3	38.1	1.00	0.83	1.15	27.7
Approach		1503	2.3	0.704	27.0	LOS B	28.8	205.0	0.77	0.74	0.78	48.6
East: Bellambi Ln												
4	L2	84	4.8	0.704	61.1	LOS E	10.9	78.1	1.00	0.86	1.06	30.3
5	T1	102	2.0	0.704	55.5	LOS D	10.9	78.1	1.00	0.86	1.06	30.8
6	R2	193	0.5	0.285	40.2	LOS C	4.3	29.9	0.89	0.76	0.89	35.8
Approach		379	1.8	0.704	49.0	LOS D	10.9	78.1	0.95	0.81	0.98	33.1
North: Memorial Dr												
7	L2	212	1.9	0.183	15.2	LOS B	5.0	35.8	0.44	0.68	0.44	47.5
8	T1	1050	4.4	0.549	25.0	LOS B	21.9	159.4	0.78	0.69	0.78	51.8
9	R2	42	11.9	0.368	66.8	LOS E	2.5	19.3	0.99	0.74	0.99	28.1
Approach		1304	4.2	0.549	24.7	LOS B	21.9	159.4	0.73	0.69	0.73	49.7
West: Bellambi Ln												
10	L2	44	4.5	0.531	58.3	LOS E	8.0	56.4	0.98	0.79	0.98	31.3
11	T1	99	0.0	0.531	52.7	LOS D	8.0	56.4	0.98	0.79	0.98	31.8
12	R2	152	2.0	0.500	42.1	LOS C	7.0	50.8	0.96	0.79	0.96	35.2
Approach		295	1.7	0.531	48.1	LOS D	8.0	56.4	0.97	0.79	0.97	33.4
All Vehicles		3481	2.9	0.704	30.3	LOS C	28.8	205.0	0.79	0.73	0.80	44.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	17	53.2	LOS E	0.1	0.1	0.94	0.94
P2	East Full Crossing	12	23.4	LOS C	0.0	0.0	0.63	0.63
P3	North Full Crossing	31	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	16	35.3	LOS D	0.0	0.0	0.77	0.77
P4	West Full Crossing	14	23.5	LOS C	0.0	0.0	0.63	0.63
All Pedestrians		90	41.5	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - AM with Proposal]

AM with Mine Proposal & Bunnings
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	112	25.0	0.084	6.7	LOS A	0.7	7.2	0.17	0.59	0.17	52.6
2	T1	831	3.4	0.417	21.8	LOS B	15.7	112.8	0.70	0.61	0.70	54.2
3	R2	35	11.4	0.408	69.8	LOS E	2.1	16.5	1.00	0.73	1.00	27.7
Approach		978	6.1	0.417	21.8	LOS B	15.7	112.8	0.65	0.62	0.65	52.2
East: Bellambi Ln												
4	L2	49	8.2	0.751	68.8	LOS E	7.1	52.5	1.00	0.87	1.18	28.5
5	T1	65	6.2	0.751	63.2	LOS E	7.1	52.5	1.00	0.87	1.18	29.0
6	R2	178	4.5	0.283	52.5	LOS D	4.6	33.3	0.91	0.77	0.91	32.0
Approach		292	5.5	0.751	57.6	LOS E	7.1	52.5	0.95	0.81	1.02	30.6
North: Memorial Dr												
7	L2	255	1.2	0.195	11.8	LOS A	4.9	34.9	0.36	0.66	0.36	49.7
8	T1	1599	1.9	0.859	33.4	LOS C	46.0	327.2	0.92	0.88	0.98	46.3
9	R2	25	20.0	0.308	69.6	LOS E	1.5	12.5	1.00	0.71	1.00	27.5
Approach		1879	2.0	0.859	30.9	LOS C	46.0	327.2	0.84	0.85	0.90	46.3
West: Bellambi Ln												
10	L2	26	19.2	0.808	71.1	LOS F	7.7	58.8	1.00	0.92	1.28	28.2
11	T1	95	8.4	0.808	65.4	LOS E	7.7	58.8	1.00	0.92	1.28	28.8
12	R2	249	10.4	0.823	64.0	LOS E	15.5	132.7	1.00	0.93	1.20	29.0
Approach		370	10.5	0.823	64.8	LOS E	15.5	132.7	1.00	0.93	1.22	28.9
All Vehicles		3519	4.3	0.859	34.2	LOS C	46.0	327.2	0.81	0.79	0.87	43.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	14	53.2	LOS E	0.0	0.0	0.94	0.94
P2	East Full Crossing	5	22.2	LOS C	0.0	0.0	0.61	0.61
P3	North Full Crossing	24	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	17	42.5	LOS E	0.0	0.0	0.84	0.84
P4	West Full Crossing	16	22.2	LOS C	0.0	0.0	0.61	0.61
All Pedestrians		76	42.3	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - PM with Proposal]

PM with Bunnings & Mine Proposal
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	175	13.1	0.127	7.0	LOS A	1.4	12.4	0.21	0.60	0.21	52.8
2	T1	1260	2.1	0.729	28.3	LOS B	29.2	208.4	0.86	0.77	0.86	49.4
3	R2	85	3.5	0.704	69.8	LOS E	5.3	38.1	1.00	0.83	1.15	27.7
Approach		1520	3.4	0.729	28.2	LOS B	29.2	208.4	0.79	0.75	0.80	47.7
East: Bellambi Ln												
4	L2	84	4.8	0.748	63.3	LOS E	11.1	80.1	1.00	0.88	1.12	29.8
5	T1	102	2.0	0.748	57.7	LOS E	11.1	80.1	1.00	0.88	1.12	30.3
6	R2	193	0.5	0.368	56.9	LOS E	5.2	36.8	0.95	0.78	0.95	30.8
Approach		379	1.8	0.748	58.5	LOS E	11.1	80.1	0.97	0.83	1.03	30.4
North: Memorial Dr												
7	L2	212	1.9	0.180	14.8	LOS B	4.9	35.0	0.43	0.68	0.43	47.8
8	T1	1050	4.4	0.570	26.6	LOS B	22.6	164.5	0.80	0.71	0.80	50.6
9	R2	42	11.9	0.368	66.8	LOS E	2.5	19.3	0.99	0.74	0.99	28.1
Approach		1304	4.2	0.570	26.0	LOS B	22.6	164.5	0.75	0.71	0.75	48.9
West: Bellambi Ln												
10	L2	56	3.6	0.640	60.4	LOS E	9.3	65.7	1.00	0.82	1.02	30.7
11	T1	106	0.0	0.640	54.8	LOS D	9.3	65.7	1.00	0.82	1.02	31.2
12	R2	179	11.2	0.735	62.5	LOS E	10.7	92.5	1.00	0.87	1.11	29.3
Approach		341	6.5	0.735	59.8	LOS E	10.7	92.5	1.00	0.84	1.06	30.1
All Vehicles		3544	3.8	0.748	33.6	LOS C	29.2	208.4	0.81	0.75	0.83	43.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	17	53.2	LOS E	0.1	0.1	0.94	0.94
P2	East Full Crossing	12	24.7	LOS C	0.0	0.0	0.64	0.64
P3	North Full Crossing	31	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	16	36.1	LOS D	0.0	0.0	0.78	0.78
P4	West Full Crossing	14	24.7	LOS C	0.0	0.0	0.64	0.64
All Pedestrians		90	42.0	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - 2023 AM]

AM Cumulative Impacts with Mine, Bunnings & Background Growth
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 130 seconds (Site Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	123	23.6	0.091	6.9	LOS A	0.9	9.2	0.18	0.59	0.18	52.6
2	T1	906	3.4	0.439	22.6	LOS B	18.3	131.5	0.70	0.61	0.70	53.6
3	R2	39	10.3	0.488	76.0	LOS F	2.6	19.8	1.00	0.73	1.00	26.5
Approach		1068	6.0	0.488	22.7	LOS B	18.3	131.5	0.65	0.62	0.65	51.5
East: Bellambi Ln												
4	L2	53	7.5	0.801	75.3	LOS F	8.4	62.4	1.00	0.91	1.24	27.1
5	T1	71	5.6	0.801	69.7	LOS E	8.4	62.4	1.00	0.91	1.24	27.6
6	R2	194	4.6	0.305	56.3	LOS D	5.4	39.4	0.91	0.77	0.91	30.9
Approach		318	5.3	0.801	62.5	LOS E	8.4	62.4	0.95	0.83	1.04	29.4
North: Memorial Dr												
7	L2	278	1.1	0.209	11.8	LOS A	5.6	39.5	0.35	0.66	0.35	49.8
8	T1	1743	1.7	0.924	48.3	LOS D	65.5	465.0	0.94	1.00	1.12	38.9
9	R2	33	15.2	0.427	75.8	LOS F	2.2	17.4	1.00	0.73	1.00	26.3
Approach		2054	1.9	0.924	43.8	LOS D	65.5	465.0	0.86	0.95	1.01	39.8
West: Bellambi Ln												
10	L2	27	18.5	0.854	78.8	LOS F	9.1	69.8	1.00	0.97	1.36	26.6
11	T1	103	8.7	0.854	73.0	LOS F	9.1	69.8	1.00	0.97	1.36	27.2
12	R2	271	10.0	0.883	74.9	LOS F	19.4	165.0	1.00	0.98	1.31	26.7
Approach		401	10.2	0.883	74.6	LOS F	19.4	165.0	1.00	0.98	1.33	26.8
All Vehicles		3841	4.2	0.924	42.7	LOS D	65.5	465.0	0.82	0.85	0.95	39.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	14	58.2	LOS E	0.0	0.0	0.95	0.95
P2	East Full Crossing	5	22.2	LOS C	0.0	0.0	0.58	0.58
P3	North Full Crossing	24	58.2	LOS E	0.1	0.1	0.95	0.95
P3S	North Slip/Bypass Lane Crossing	17	46.6	LOS E	0.1	0.1	0.85	0.85
P4	West Full Crossing	16	22.2	LOS C	0.0	0.0	0.59	0.59
All Pedestrians		76	45.7	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - 2023 PM]

PM Cumulative Impacts with Mine, Bunnings & Background Growth
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	190	12.6	0.139	7.2	LOS A	1.6	14.4	0.22	0.61	0.22	52.6
2	T1	1374	2.1	0.808	30.9	LOS C	34.3	244.1	0.89	0.82	0.91	47.8
3	R2	93	3.2	0.768	71.3	LOS F	5.9	42.3	1.00	0.88	1.24	27.4
Approach		1657	3.4	0.808	30.4	LOS C	34.3	244.1	0.82	0.80	0.85	46.3
East: Bellambi Ln												
4	L2	92	4.3	0.815	66.4	LOS E	12.6	90.7	1.00	0.94	1.21	29.0
5	T1	111	1.8	0.815	60.8	LOS E	12.6	90.7	1.00	0.94	1.21	29.5
6	R2	211	0.5	0.402	57.2	LOS E	5.8	40.4	0.95	0.78	0.95	30.7
Approach		414	1.7	0.815	60.2	LOS E	12.6	90.7	0.98	0.86	1.08	30.0
North: Memorial Dr												
7	L2	232	1.7	0.197	14.9	LOS B	5.4	38.7	0.44	0.68	0.44	47.7
8	T1	1145	4.5	0.637	27.4	LOS B	26.3	191.4	0.83	0.74	0.83	50.0
9	R2	46	10.9	0.400	67.0	LOS E	2.7	21.0	1.00	0.74	1.00	28.1
Approach		1423	4.2	0.637	26.7	LOS B	26.3	191.4	0.77	0.73	0.77	48.4
West: Bellambi Ln												
10	L2	60	3.3	0.690	61.5	LOS E	10.2	72.2	1.00	0.85	1.06	30.4
11	T1	115	0.0	0.690	55.9	LOS D	10.2	72.2	1.00	0.85	1.06	30.9
12	R2	195	10.3	0.795	65.1	LOS E	12.0	102.6	1.00	0.91	1.18	28.8
Approach		370	5.9	0.795	61.7	LOS E	12.0	102.6	1.00	0.88	1.12	29.6
All Vehicles		3864	3.8	0.815	35.2	LOS C	34.3	244.1	0.84	0.79	0.87	42.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	17	53.2	LOS E	0.1	0.1	0.94	0.94
P2	East Full Crossing	12	24.7	LOS C	0.0	0.0	0.64	0.64
P3	North Full Crossing	31	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	16	36.1	LOS D	0.0	0.0	0.78	0.78
P4	West Full Crossing	14	24.7	LOS C	0.0	0.0	0.64	0.64
All Pedestrians		90	42.0	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - AM with Proposal & Higher Traffic Levels]

AM with Mine Proposal & Bunnings & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	120	30.0	0.092	6.8	LOS A	0.7	8.3	0.17	0.58	0.17	52.4
2	T1	831	3.4	0.417	21.8	LOS B	15.7	112.8	0.70	0.61	0.70	54.2
3	R2	35	11.4	0.408	69.8	LOS E	2.1	16.5	1.00	0.73	1.00	27.7
Approach		986	6.9	0.417	21.7	LOS B	15.7	112.8	0.65	0.61	0.65	52.2
East: Bellambi Ln												
4	L2	49	8.2	0.751	68.8	LOS E	7.1	52.5	1.00	0.87	1.18	28.5
5	T1	65	6.2	0.751	63.2	LOS E	7.1	52.5	1.00	0.87	1.18	29.0
6	R2	178	4.5	0.283	52.5	LOS D	4.6	33.3	0.91	0.77	0.91	32.0
Approach		292	5.5	0.751	57.6	LOS E	7.1	52.5	0.95	0.81	1.02	30.6
North: Memorial Dr												
7	L2	255	1.2	0.195	11.8	LOS A	4.9	34.9	0.36	0.66	0.36	49.7
8	T1	1599	1.9	0.859	33.4	LOS C	46.0	327.2	0.92	0.88	0.98	46.3
9	R2	25	20.0	0.308	69.6	LOS E	1.5	12.5	1.00	0.71	1.00	27.5
Approach		1879	2.0	0.859	30.9	LOS C	46.0	327.2	0.84	0.85	0.90	46.3
West: Bellambi Ln												
10	L2	26	19.2	0.808	71.1	LOS F	7.7	58.8	1.00	0.92	1.28	28.2
11	T1	95	8.4	0.808	65.4	LOS E	7.7	58.8	1.00	0.92	1.28	28.8
12	R2	257	13.2	0.865	68.3	LOS E	16.8	150.7	1.00	0.97	1.29	28.0
Approach		378	12.4	0.865	67.8	LOS E	16.8	150.7	1.00	0.96	1.29	28.2
All Vehicles		3535	4.8	0.865	34.5	LOS C	46.0	327.2	0.81	0.79	0.88	42.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	14	53.2	LOS E	0.0	0.0	0.94	0.94
P2	East Full Crossing	5	22.2	LOS C	0.0	0.0	0.61	0.61
P3	North Full Crossing	24	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	17	42.5	LOS E	0.0	0.0	0.84	0.84
P4	West Full Crossing	16	22.2	LOS C	0.0	0.0	0.61	0.61
All Pedestrians		76	42.3	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - PM with Proposal & Higher Traffic Levels]

PM with Bunnings & Mine Proposal & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	184	16.8	0.137	7.1	LOS A	1.5	14.0	0.21	0.60	0.21	52.6
2	T1	1260	2.1	0.746	29.2	LOS C	29.5	209.9	0.87	0.78	0.87	48.9
3	R2	85	3.5	0.704	69.8	LOS E	5.3	38.1	1.00	0.83	1.15	27.7
Approach		1529	3.9	0.746	28.8	LOS C	29.5	209.9	0.80	0.76	0.81	47.3
East: Bellambi Ln												
4	L2	84	4.8	0.748	63.3	LOS E	11.1	80.1	1.00	0.88	1.12	29.8
5	T1	102	2.0	0.748	57.7	LOS E	11.1	80.1	1.00	0.88	1.12	30.3
6	R2	193	0.5	0.348	55.8	LOS D	5.2	36.3	0.94	0.77	0.94	31.1
Approach		379	1.8	0.748	58.0	LOS E	11.1	80.1	0.97	0.83	1.03	30.6
North: Memorial Dr												
7	L2	212	1.9	0.180	14.8	LOS B	4.9	35.0	0.43	0.68	0.43	47.8
8	T1	1050	4.4	0.581	27.4	LOS B	23.0	167.1	0.81	0.72	0.81	50.1
9	R2	42	11.9	0.368	66.8	LOS E	2.5	19.3	0.99	0.74	0.99	28.1
Approach		1304	4.2	0.581	26.6	LOS B	23.0	167.1	0.76	0.72	0.76	48.5
West: Bellambi Ln												
10	L2	56	3.6	0.640	60.4	LOS E	9.3	65.7	1.00	0.82	1.02	30.7
11	T1	106	0.0	0.640	54.8	LOS D	9.3	65.7	1.00	0.82	1.02	31.2
12	R2	187	15.0	0.743	62.1	LOS E	11.2	103.1	1.00	0.87	1.11	29.4
Approach		349	8.6	0.743	59.6	LOS E	11.2	103.1	1.00	0.85	1.07	30.1
All Vehicles		3561	4.3	0.748	34.1	LOS C	29.5	209.9	0.82	0.76	0.84	42.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	17	53.2	LOS E	0.1	0.1	0.94	0.94
P2	East Full Crossing	12	25.4	LOS C	0.0	0.0	0.65	0.65
P3	North Full Crossing	31	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	16	36.1	LOS D	0.0	0.0	0.78	0.78
P4	West Full Crossing	14	25.4	LOS C	0.0	0.0	0.65	0.65
All Pedestrians		90	42.1	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - 2023 AM with Higher Traffic Levels]

AM Cumulative Impacts with Mine, Bunnings & Background Growth & Higher Traffic Levels
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 130 seconds (Site Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	131	28.2	0.100	6.9	LOS A	0.9	10.5	0.18	0.59	0.18	52.4
2	T1	906	3.4	0.439	22.6	LOS B	18.3	131.5	0.70	0.61	0.70	53.6
3	R2	39	10.3	0.488	76.0	LOS F	2.6	19.8	1.00	0.73	1.00	26.5
Approach		1076	6.7	0.488	22.6	LOS B	18.3	131.5	0.64	0.61	0.64	51.5
East: Bellambi Ln												
4	L2	53	7.5	0.801	75.3	LOS F	8.4	62.4	1.00	0.91	1.24	27.1
5	T1	71	5.6	0.801	69.7	LOS E	8.4	62.4	1.00	0.91	1.24	27.6
6	R2	194	4.6	0.305	56.3	LOS D	5.4	39.4	0.91	0.77	0.91	30.9
Approach		318	5.3	0.801	62.5	LOS E	8.4	62.4	0.95	0.83	1.04	29.4
North: Memorial Dr												
7	L2	278	1.1	0.209	11.8	LOS A	5.6	39.5	0.35	0.66	0.35	49.8
8	T1	1743	1.7	0.924	48.2	LOS D	65.4	464.4	0.94	1.00	1.12	39.0
9	R2	33	15.2	0.427	75.8	LOS F	2.2	17.4	1.00	0.73	1.00	26.3
Approach		2054	1.9	0.924	43.7	LOS D	65.4	464.4	0.86	0.95	1.01	39.9
West: Bellambi Ln												
10	L2	27	18.5	0.854	78.8	LOS F	9.1	69.8	1.00	0.97	1.36	26.6
11	T1	103	8.7	0.854	73.0	LOS F	9.1	69.8	1.00	0.97	1.36	27.2
12	R2	279	12.5	0.925	84.6	LOS F	21.7	192.8	1.00	1.05	1.46	24.9
Approach		409	12.0	0.925	81.3	LOS F	21.7	192.8	1.00	1.03	1.43	25.6
All Vehicles		3857	4.6	0.925	43.3	LOS D	65.4	464.4	0.82	0.85	0.96	38.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	14	58.2	LOS E	0.0	0.0	0.95	0.95
P2	East Full Crossing	5	22.2	LOS C	0.0	0.0	0.58	0.58
P3	North Full Crossing	24	58.2	LOS E	0.1	0.1	0.95	0.95
P3S	North Slip/Bypass Lane Crossing	17	46.6	LOS E	0.1	0.1	0.85	0.85
P4	West Full Crossing	16	22.2	LOS C	0.0	0.0	0.59	0.59
All Pedestrians		76	45.7	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 101 [Memorial Dr & Bellambi Lane - 2023 PM Higher Traffic Levels]

PM Cumulative Impacts with Mine & Higher Traffic Levels, Bunnings & Background Growth
Site Category: (None)
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Memorial Dr												
1	L2	190	21.6	0.145	7.3	LOS A	1.6	16.6	0.22	0.61	0.22	52.3
2	T1	1336	2.4	0.827	34.1	LOS C	34.8	248.5	0.91	0.85	0.96	45.9
3	R2	111	2.7	0.812	71.9	LOS F	7.1	50.8	1.00	0.92	1.30	27.3
Approach		1637	4.6	0.827	33.5	LOS C	34.8	248.5	0.83	0.83	0.89	44.5
East: Bellambi Ln												
4	L2	100	5.0	0.810	66.2	LOS E	12.4	89.9	1.00	0.94	1.20	29.0
5	T1	100	3.0	0.810	60.6	LOS E	12.4	89.9	1.00	0.94	1.20	29.5
6	R2	223	1.3	0.404	56.4	LOS D	6.0	42.7	0.95	0.78	0.95	31.0
Approach		423	2.6	0.810	59.7	LOS E	12.4	89.9	0.97	0.86	1.07	30.1
North: Memorial Dr												
7	L2	230	0.4	0.196	15.3	LOS B	5.5	38.7	0.45	0.69	0.45	47.5
8	T1	1213	3.6	0.716	29.7	LOS C	28.8	207.7	0.87	0.78	0.87	48.5
9	R2	45	8.9	0.344	65.3	LOS E	2.6	19.8	0.99	0.74	0.99	28.5
Approach		1488	3.3	0.716	28.6	LOS C	28.8	207.7	0.81	0.76	0.81	47.4
West: Bellambi Ln												
10	L2	51	3.9	0.665	61.0	LOS E	9.7	69.4	1.00	0.83	1.04	30.6
11	T1	116	2.6	0.665	55.4	LOS D	9.7	69.4	1.00	0.83	1.04	31.1
12	R2	211	14.2	0.834	67.2	LOS E	13.4	122.3	1.00	0.94	1.25	28.3
Approach		378	9.3	0.834	62.7	LOS E	13.4	122.3	1.00	0.89	1.16	29.4
All Vehicles		3926	4.4	0.834	37.3	LOS C	34.8	248.5	0.86	0.81	0.91	41.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate
P1	South Full Crossing	17	53.2	LOS E	0.1	0.1	0.94	0.94
P2	East Full Crossing	12	26.0	LOS C	0.0	0.0	0.66	0.66
P3	North Full Crossing	31	53.3	LOS E	0.1	0.1	0.94	0.94
P3S	North Slip/Bypass Lane Crossing	16	35.3	LOS D	0.0	0.0	0.77	0.77
P4	West Full Crossing	14	26.0	LOS C	0.0	0.0	0.66	0.66
All Pedestrians		90	42.2	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

APPENDIX 8

Greenhouse Gas Assessment

Inspired people | Dedicated team
Quality outcomes

GREENHOUSE GAS AND ENERGY ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

July 2019

GREENHOUSE GAS AND ENERGY ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
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Report No.	3687/R08
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Appendices

Appendix A Life of Mine Calculations

1.0 Introduction

Wollongong Coal Limited (WCL) is proposing amendments to the Russell Vale Underground Expansion Project (UEP) in response to concern raised by government agencies, the Planning Assessment Commission (PAC) and the community. WCL has revised the UEP to address potential subsidence, biodiversity and water impacts within the Cataract Reservoir catchment and noise and traffic impacts associated with surface operations (Revised Preferred Project). The following Greenhouse Gas and Energy Assessment (GHGEA) quantifies the potential greenhouse gas (GHG) and energy impacts of the Revised Preferred Project (referred to herein as the Revised Project).

2.0 Assessment Framework

2.1 Objectives

The objective of this assessment is to evaluate the GHG and energy use implications of the Revised Project, as part of WCL's response to issues raised in the PAC Second Review Report.

2.2 Scope

The scope of the GHGEA includes:

- estimating direct and indirect (Scope 1, 2 and 3) GHG emissions associated with the Revised Project
- estimating energy use directly associated with the Revised Project.

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 GHG covered by the Kyoto Protocol and referred to in this GHGEA include: • Carbon dioxide; • Methane; • Nitrous oxide; • Hydrofluorocarbons; • Perfluorocarbons; and • Sulphur hexafluoride.
Scope 1 emissions	Direct emissions occur from sources that are owned or controlled by the Revised Project (in this case, the proponent, WCL) (e.g. fuel use, fugitive emissions). Scope 1 emissions are emissions over which the Revised Project has a high level of control.
Scope 2 emissions	Emissions from the generation of purchased electricity consumed by the Revised Project.
Scope 3 emissions	Indirect emissions that are a consequence of the activities of the Revised Project, but occur at sources owned or controlled by other entities (e.g. outsourced services). Scope 3 emissions can include emissions generated upstream of the Revised Project by providers of energy, materials and transport. Scope 3 emissions can also include emissions generated downstream of the Revised Project 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 2017. The assessment framework also incorporates the principles of The Greenhouse Gas Protocol 2004 (GHG Protocol).

[1] The GHG Protocol 2004

The GHG Protocol provides an internationally accepted approach to GHG accounting. The GHG 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 NGA Factors 2017 (DoEE 2017). Fugitive emissions have been calculated using the Method 1 approach, as described in the National Greenhouse Accounts (NGA) Factors 2017 (DoEE 2017).

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 NGA Factors 2017 (DoEE 2017).

2.5 Data Sources

The calculations in this report are based on activity data developed by WCL 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	WCL - forecast diesel consumption
Electricity consumption	WCL - forecast electricity consumption
Fugitive emissions	WCL – Historical NGER data
Product transport	WCL - 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.

The GHG Protocol requires inventory data and methodologies to be relevant, consistent, complete, transparent and accurate. The relevance principle states that the GHG inventory should appropriately reflect GHG emissions and serve the decision-making needs of users – both internal and external [to the Revised Project] (GHG Protocol 2004).

An underground 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
- waste/reject transport
- product use.

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).

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 Data Exclusions

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.
Materials transport	Scope 3	• Delivery of diesel and other materials to site.
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 Russell Vale site.

3.0 Impact Assessment Results

GHG and energy use estimates have only been calculated for the operational stage of the Revised Preferred Project.

The following information and key assessment assumptions were used to estimate the GHG emissions from the operational stage of the Revised Project:

- Approximately 3.7 million tonne (Mt) of run-of-mine (ROM) coal will be recovered.
- The ventilation system will extract a flat rate of 270,000 t CO_2-e of fugitive emissions per annum (historical average).
- The mine will be classified as a “Gassy Mine” and generate post mining emissions from stockpiled ROM coal.
- Diesel use will average approximately 450 kL per annum.
- Electricity use will average approximately 90,000 GJ per annum (no longwall).
- Onsite ROM coal processing will generate 10% waste materials.
- Up to 80% of waste materials (coarse reject) will be transported off site as fill material.
- Waste materials will be transported an average of 15 kilometres (km).
- All product transport will be outsourced.
- Product transport will average 15 km.
- Product will be transported using road registered 19 metre (m) articulated vehicles such as semi-trailer or truck and dog trailers.
- All product will be exported to either India or China.
- All coal will be used to produce coke for steel production.

3.1 Greenhouse Gas Emissions

The Revised Project’s GHG emissions are summarised in **Table 3.1**. Forecast GHG emissions are based on the Revised Project recovering approximately 3,700,000 ROM tonnes and extending the life of mine by 5 years.

The Revised Project is forecast to generate approximately 1,419,000 t CO_2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. Approximately 284,000 t CO_2-e per annum of Scope 1 emissions are expected to be generated the Revised Project. 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 Revised Project is forecast to be associated with approximately 104,000 t CO_2-e of Scope 2 emissions from consuming electricity. Approximately 21,000 t CO_2-e per annum of Scope 2 emissions are expected to be associated with the Revised Project.

The Revised Project is forecast to be associated with approximately 9,624,000 t CO_2-e of Scope 3 emissions. Scope 3 emissions will be generated by third parties who transport and consume coal products. Approximately 1,925,000 t CO_2-e per annum of Scope 3 emissions are expected to be associated with the Revised Project.

Figure 3.1 demonstrates that the Revised Project's GHG inventory is dominated by Scope 3 emissions. Approximately 86% of the Revised Project's GHG emissions occur downstream of the project. Approximately 14% of the GHG associated with the Revised Project is related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions).

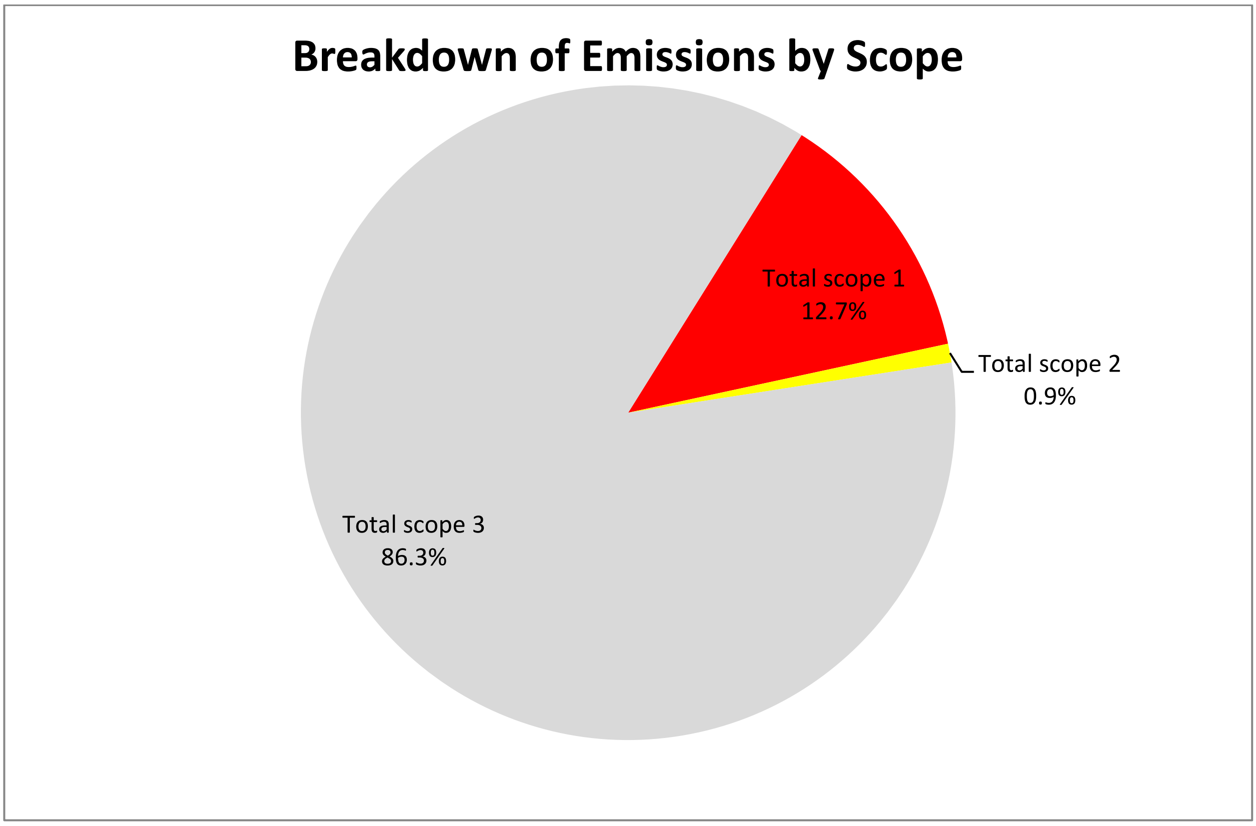

Figure 3.1 Breakdown of Emissions by Scope

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Revised Project. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

3.2 Energy Use

The Revised Project is forecast to require approximately 537,000 GJ of energy from diesel and grid electricity. The Revised Project is expected to use approximately 108,000 GJ per annum.

The industry average energy use for underground coal mines in Australia ranges between 140 and 490 Megajoules (MJ)/Product tonne (Energetics 2009). The Revised Project is forecast to operate with an average energy use intensity of approximately 162 MJ/Product Tonne. The forecast energy use intensity of the Revised Project is within the normal operating range for Australian underground coal mines.

Table 3.1 GHG Emission Summary for the Revised Preferred Project

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Life of Mine	Scope 1 (Direct)	Diesel use	6,097	1,418,997
		Fugitive emissions	1,412,900	
	Scope 2 (Indirect)	Electricity	103,500	103,500
	Scope 3 (Indirect)	Product use	9,192,798	9,623,427
		Associated with energy extraction and distribution	15,163	
		Product transport	415,117	
		Waste transport	349	
			Total GHG Emissions for Operations	**11,145,924**

(refer to **Appendix A** for further detail)

4.0 Impact Assessment Summary

The GHG emissions generated by the Revised Project 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 Revised Project's GHG emissions will be highly mobile and generated across multiple policy jurisdictions along the product value chain. The accumulation of GHG or carbon in 'carbon sinks' is the primary impact of GHG emissions. Anthropogenic GHG 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 GHG 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 GHG in the ocean is also an important driver of ocean acidification (IPCC 2013).

The Revised Project's direct emissions (Scope 1) are forecast to be approximately 284,000 t CO_2 –e per annum.

To put the Revised Project's emissions into perspective, under current policy settings, global GHG emissions are forecast to reach 56,200,000,000 t CO_2-e per annum by 2025 (UNEP 2016). During operation, the Revised Project will contribute approximately 0.0005% to global emissions per annum (based on its projected Scope 1 emissions). The relative environmental impact of the Revised Project is likely to be relative to its proportion of global GHG emissions.

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 GHG 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.

A qualitative assessment of climate change requires a regional reference and future emission trajectory assumptions. The Revised Project, 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 GHG 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 Revised Project 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 GHG 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 GHG 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 GHG 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 GHG 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 2018).

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 GHG 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 5 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 GHG 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 A summary of Australia's NDC

Emissions reduction target	Economy-wide target to reduce greenhouse gas emissions by 26 – 28% 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 GHG mitigation policy framework caps facility level emissions via the Safeguard Mechanism, and funds mitigation projects through the Emissions Reduction Fund. The DoEE forecasts that the current national GHG policy will not be enough to achieve the level of mitigation contribution prescribed in Australia's NDC (DoEE 2018). **Table 4.2** is based on data produced by the DoEE in December 2018 (DoEE 2018). 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 2018)

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 GHG 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 Revised Project). It is difficult to determine whether the Revised Project'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 Revised Project's emissions will inflate 2030 projections.

If as a worst case, it is assumed that the none of the Revised Project's Scope 1 emissions have been included in DoEE's forecast (and all other assumptions hold true), then the Revised Project's cumulative Scope 1 emissions (1,419,000 t CO_2-e) will increase the required national mitigation effort by approximately 0.19%.

The Revised Project may increase the national effort required to reach Australia's 2030 GHG mitigation target, however, the Revised Project 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 Revised Project'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 GHG 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 Revised Project is unlikely to affect the objectives of the NSW Climate Change Policy Framework in a material way.

5.0 Conclusion

The Revised Project is a small scale coal operation that will produce energy commodities over 5 years. The Revised Project's forecast energy use intensity is considered to fall within the normal operating range for an Australian underground coal mine, and expected to generate approximately 1,523,000 t CO_2-e of Scope 1 and 2 emissions.

The Revised Project is also forecast to be associated with approximately 9,624,000 t CO_2-e of Scope 3 emissions. The Revised Project's Scope 3 emissions are beyond the operational control of WCL, and the majority of Scope 3 emissions will be generated downstream of the Revised Project, when coal products are combusted to produce coke.

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APPENDIX A

Life of Mine Calculations

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
2,250	38.6	86,850	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)			6,071	9	17
				Total GHG Emissions (t CO_2-e)	6,097

Fugitive Emissions

Activity Data	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
3,700,000 – VAM	N/A	365	N/A
3,700,000 – Post mining	N/A	17	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	1,412,900	N/A
		Total GHG Emissions (t CO_2-e)	1,412,900

Electricity use

Activity Data	Energy Use	Emission Factors		
		CO_2	CH_4	N_20
GJ	GJ	kg CO_2-e / GJ	kg CO_2-e / GJ	kg CO_2-e / GJ
450,000	450,000	230	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)		103,500	N/A	N/A
			Total GHG Emissions (t CO_2-e)	103,500

Product Use

Activity Data		Energy Production		Emission Factors		
				CO_2	CH_4	N_20
Product	Product (t)	GJ/Product t	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Thermal coal	0	27.0	0	90	0.03	0.2
Coking coal	3,330,000	30.0	99,900,000	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)				9,170,820	1,998	19,980
					Total GHG Emissions (t CO_2-e)	9,192,798

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	86,850	3.6	N/A	N/A
Electricity	450,000	33	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)		15,163	N/A	N/A
			Total GHG Emissions (t CO_2-e)	**15,163**

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**
Ship	3,330,000	9,800	32,634,000,000	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)				411,188	N/A	N/A
					Total GHG Emissions (t CO_2-e)	**411,188**

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	**Product (t)**	**Return Distance (km)**	**Diesel use (kL)**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Truck	3,330,000	30	1,374	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)				3,897	5	27
					Total GHG Emissions (t CO_2-e)	**3,929**

Waste Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	**Product (t)**	**Return Distance (km)**	**Diesel use (kL)**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Truck	296,000	30	122	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)				346	0	3
					Total GHG Emissions (t CO_2-e)	**349**

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APPENDIX 9

Social Impact Assessment

SOCIAL IMPACT ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

July 2019

SOCIAL IMPACT ASSESSMENT

Russell Vale Revised Underground Expansion Project

FINAL

Prepared by
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Appendices

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Appendix B	Strategies identified to meet the objectives of Our Wollongong 2028
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Abbreviations

Abbreviation	Meaning
ABS	Australian Bureau of Statistics
CBD	Central Business District
DPE	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
DfID	Department for International Development
DIDO	Drive in Drive Out
DoEE	Department of Environment and Energy
EA	Environmental Authority
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
IRRM	Illawarra Resident for Responsible Mining
LGA	Local Government Area
Mtpa	Million Tonnes per Annum
NSW	New South Wales
OEH	Office of Environment and Heritage
PAC	Planning Assessment Commission
ROM	Run-of-Mine
SEIFA	Socio-Economic Indexes for Areas
SIA	Social Impact Assessment
SLTO	Social Licence To Operate
SSC	State Suburbs
UEP	Underground Expansion Project
VENM	Virgin Excavated Natural Material
WCC	Wollongong City Council
WCL	Wollongong Coal Limited

1.0 Introduction

1.1 Project background

Wollongong Coal Limited (WCL) owns and operates the Russell Vale Colliery, an existing underground coal mine located in the north of Wollongong in New South Wales (NSW) (**Figure 1.1**). Originally known as South Bulli, Russell Vale Colliery is one of the oldest operating coal mines in Australia, dating back to the 1880's. Russell Vale Colliery has been on 'care and maintenance' since 2015 and the current Project Approval applying to mining operations at Russell Vale Colliery requires that no mining occur after 31 December 2015. WCL is seeking Project Approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act) to expand the mining operations at Russell Vale Colliery.

In 2009 an application to extend operations was lodged with the State Government. This proposal was referred to as the Underground Expansion Project (UEP). Since then, the Project has been through a number of iterations to minimise its potential adverse impacts and has been reviewed by the Planning Assessment Commission (PAC) on two occasions, most recently in 2016.

In response to this most recent review, WCL has developed a revised mine plan for the UEP which if approved, will provide the company with 5 years of mining to facilitate further exploration and planning processes. This revised mine plan is referred as the Revised Preferred Project (hereafter referred to as the Revised Project) and is shown in **Figure 1.2**. The Revised Project is based on a non-caving first workings mining technique that has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity and water impacts within the Cataract Reservoir catchment. In addition, changes to the Russell Vale Pit Top are proposed to address concerns regarding potential amenity impacts to surrounding residential areas.

1.2 Key project and design changes

The key elements of the Revised Project include:

- Mining using first working mining techniques only, with the workings designed to be long-term stable with minimal subsidence impacts. No longwall mining is proposed. All future mine designs will be based on first working mine designs only.
- Current longwall equipment will be retrieved from underground and sold. Extraction of approximately 3.7 Million tonnes (Mt) of Run-of-Mine (ROM) coal over a period of 5 years at a reduced production rate that will be up to 1 Mt of product coal per year.
- Substantial reduction in extraction area, with no mining currently proposed within the Wonga West area or underneath the Cataract Reservoir,
- Construction and use of a coal processing plant to improve the quality of product coal.
- Substantial redesign of the Russell Vale Pit Top layout to relocate infrastructure to more shielded locations to reduce amenity impacts.
- Operation of surface facilities and product transport typically limited to daytime hours (7.00am - 6.00pm Monday to Friday, 8.00am - 6.00pm Saturday, no Sundays and Public Holidays); with provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected port closures or interruptions.

- Reduced product trucking rates and hours relative to the previous Project.
- Additional noise mitigation works surrounding the Russell Vale Pit Top including noise barriers, extension to the height of existing bunds and acoustic treatment of buildings.

A summary of the key components of the Revised Project is provided in **Table 1.1.**

Table 1.1 Project Components

Project Component	Summary of the Revised Preferred Project
Mining Method	Non-caving first workings panels within the Wonga East area only. Longwall mining is no longer included in the proposed mine design.
Resource	Wongawilli Seam.
Annual Production	Up to 1 million tonnes product coal per annum (Mtpa).
Mine Life	5 years.
Total Resource Recovered	Approximately 3.7Mt ROM.
Coal Processing	Construction and use of a new Processing Plant to improve product coal. No washing of coal will occur on site.
Hours of Operation – Mining and Coal Processing	Underground Mining - 24 hours per day, 7 days per week. Operation of surface facilities and product transport typically limited to daytime hours (7.00am - 6.00pm Mondays to Friday, 8.00am - 6.00pm Saturday, no Sundays and Public Holidays); with provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions.
Management of Mining Waste	Coarse rejects from the processing plant will be trucked off site as fill if it meets requirements for Virgin Excavated Natural Material (VENM), stockpiled for emplacement underground or used in the rehabilitation of the site.
Russell Vale Pit Top Facilities Infrastructure	Establishment of new product coal and rejects stockpiles within the Russell Vale Pit Top disturbance area. Construction and use of new Processing Plant to improve coal quality. Enclosed structures (where possible) on the surface to reduce noise and dust impacts on the community. Construction and use of a new Secondary Sizing Plant. Construction and use of new Surge Bin in more shielded location. Construction and use of enclosed conveyors for transfer of ROM coal to Secondary Sizer, Processing Plant and truck loading facility. Construction of new truck loading facility. Construction of noise barriers and extension to height of existing bunds. Establishment of a designated truck parking area.
Coal Transport	Coal will be transported by truck to Port Kembla Coal Terminal via Bellambi Lane and Memorial Drive.

Project Component	Summary of the Revised Preferred Project
Transport Hours and Rates	An average rate of 16 laden outbound trucks per hour leaving the site between 7.00am - 6.00pm Monday to Friday and 8.00am - 6.00pm Saturday. No coal transport Sundays and Public Holidays. If coal transport is required during the evening to cater for unexpected Port closures or interruptions, these movements would be limited to an average of 12 trucks per hour leaving the site between 6.00pm - 10.00pm Mondays to Fridays only. Trucks arriving at the site between 6.00am - 7.00am Monday to Friday or 7.00 am - 8.00am Saturday will be required to proceed to the truck parking area on site and turn off engine until loading commences at 7.00 am Monday to Friday or 8.00 am Saturday.
Operational Workforce	Approximately up to 205.
Construction Workforce	Approximately 22 over 12 to 24 months.

umwelt

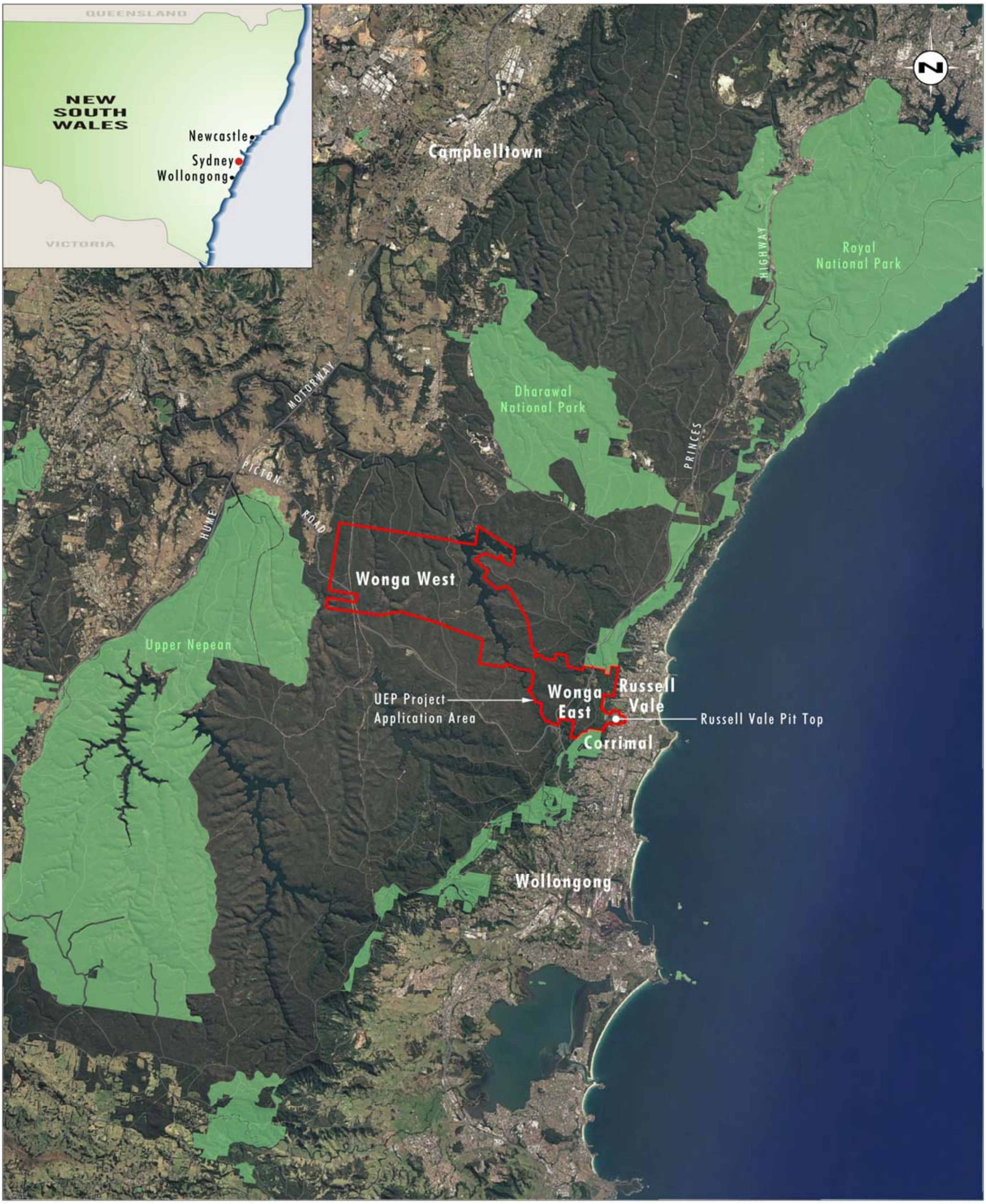

Image Source: Google Maps (2016)
Data Source: OEH (2016)

0 3.0 7.5 15.0km
1:300 000

Legend

UEP Project Application Area

FIGURE 1.1

Locality Plan

File Name (A4): R03/3687_075.dgn
20190711 11.39

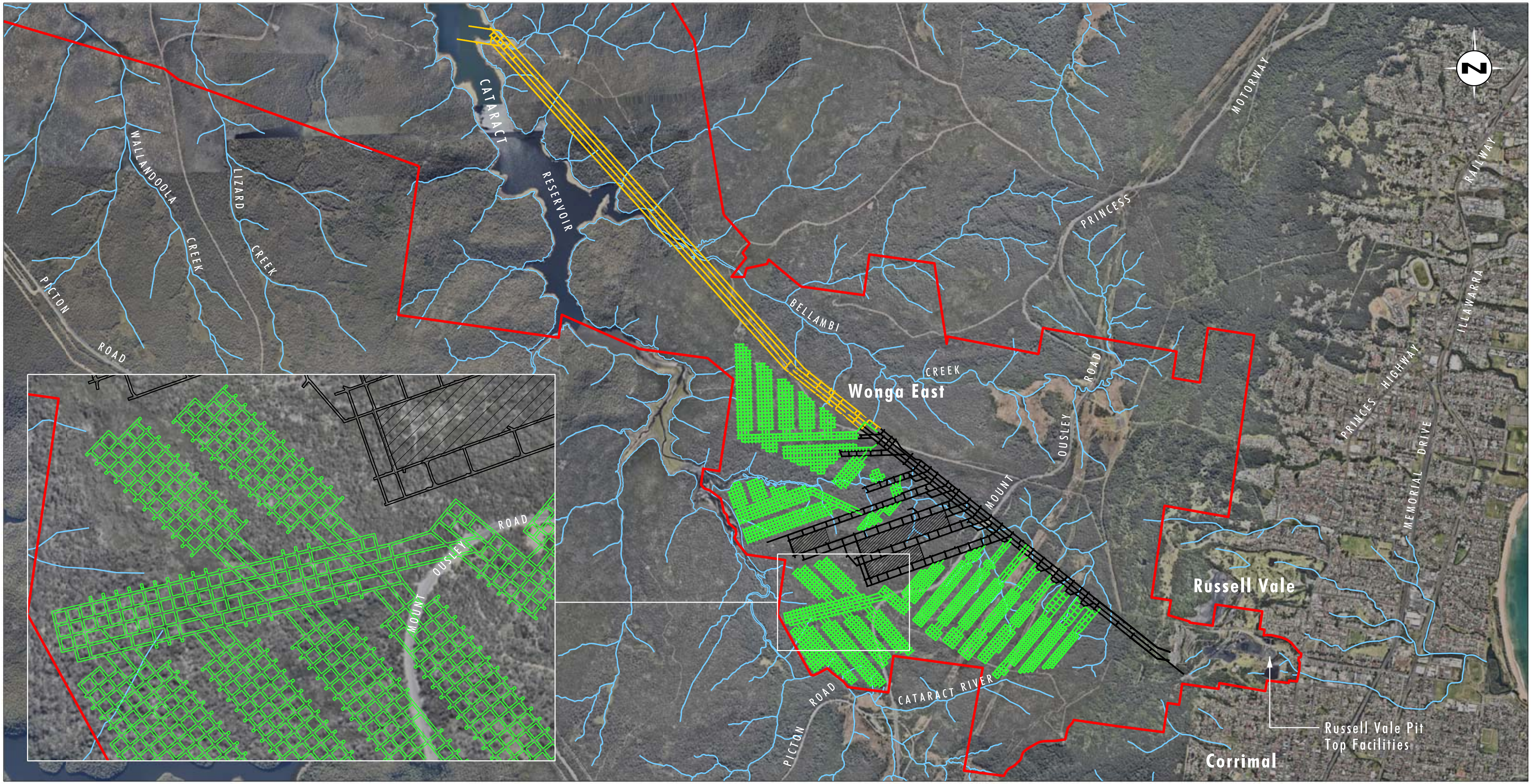

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line

FIGURE 1.2

Revised Preferred Project Mine Plan

File Name (A4): R03/3687_076.dgn
20190711 11.47

1.3 Social Impact Assessment Framework

In September 2017, the Department of Planning and Environment (DPE), now Department of Planning, Industry and Environment (DPIE), released the *Social Impact Assessment: Guidelines for State Significant Mining Petroleum Production and Extractive Industry Development (*the SIA Guideline). While there is no Secretary Environmental Assessment Requirements (SEARs) requiring the Revised Project to be prepared in accordance with the SIA Guidelines, this SIA has been prepared cognisant of these requirements and best SIA practice.

In particular, this SIA program has been designed to:

- Profile key communities in proximity to, and associated with, the Revised Project operations.
- Scope and assess the potential social issues/impacts and opportunities associated with the Revised Project on these communities.
- Develop strategies to address any significant identified impacts and opportunities and monitor and manage social impacts associated with the Revised Project should the project be approved.

Engagement with the community and other stakeholders has been a key component of the SIA program during key stages of the assessment, notably during scoping of project issues and impacts and during the development of appropriate strategies to mitigate and/or enhance impacts.

1.4 Report Structure

Based on the above framework, this report has been structured as detailed below:

- **Section 1.0** Provides an introduction and background to the Revised Project and a summary of its key components.
- **Section 2.0** Details the methodologies employed as part of the SIA, including engagement with key stakeholders.
- **Section 3.0** Comprises a socio-economic profile and community capitals analysis of the Wollongong Local Government Area (LGA) and the suburbs of Russell Vale and Corrimal – proximal suburbs to the colliery.
- **Section 4.0** Reports on analysis from engagement with the community, business and other stakeholders undertaken as part of the Revised Project to scope potential impacts and opportunities for enhancement.
- **Section 5.0** Provides an assessment of impacts and opportunities associated with the Revised Project. Recommended strategies to manage the predicted and perceived socio-economic impacts identified during the assessment process and to enhance potential benefits of the Revised Project are also discussed.
- **Section 7.0** Provides an overview of proposed ongoing monitoring and evaluation activities.

2.0 Study Approach and Methodology

2.1 Introduction

In the context of the Revised Project, a social impact is a consequence experienced by people[1] due to changes associated with a State Significant Resource (SSR) project. 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) and the DPIE SIA guideline (2017) 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.
- The **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 can 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 is also a key component of an SIA process to identify any unanticipated impacts that may arise in the future as a result of the Revised Project.

[1] 'People' includes individuals, households, groups, communities, organisations and the NSW population generally

2.2 Sustainable Livelihoods approach

The study has utilised aspects of the sustainable livelihoods approach (Department for International Development (DfID), 1999), to provide a comprehensive understanding of the relevant communities proximal to the Russell Vale Colliery.[2]

The DfID approach draws on broad categories of community capitals as a fundamental basis to identifying and further enhancing community capacity and resilience. According to DFID[3], 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. A livelihood is considered sustainable "…when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base".

This 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 area.

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 socioeconomic change as a result of disruption.

Social 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, child care. For example, a highly remote community that lacks access to basic infrastructure 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.

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 2.1**.

[2] Coakes, S., Sadler, A., 2011. Utilising a sustainable livelihoods approach to inform social impact assessment practice, in: New Directions in Social Impact Assessment. Edward Elgar Publishing, Cheltenham, pp. 3–20.

[3] Department for International Development, 1999. Sustainable Livelihoods Guidance Sheets.

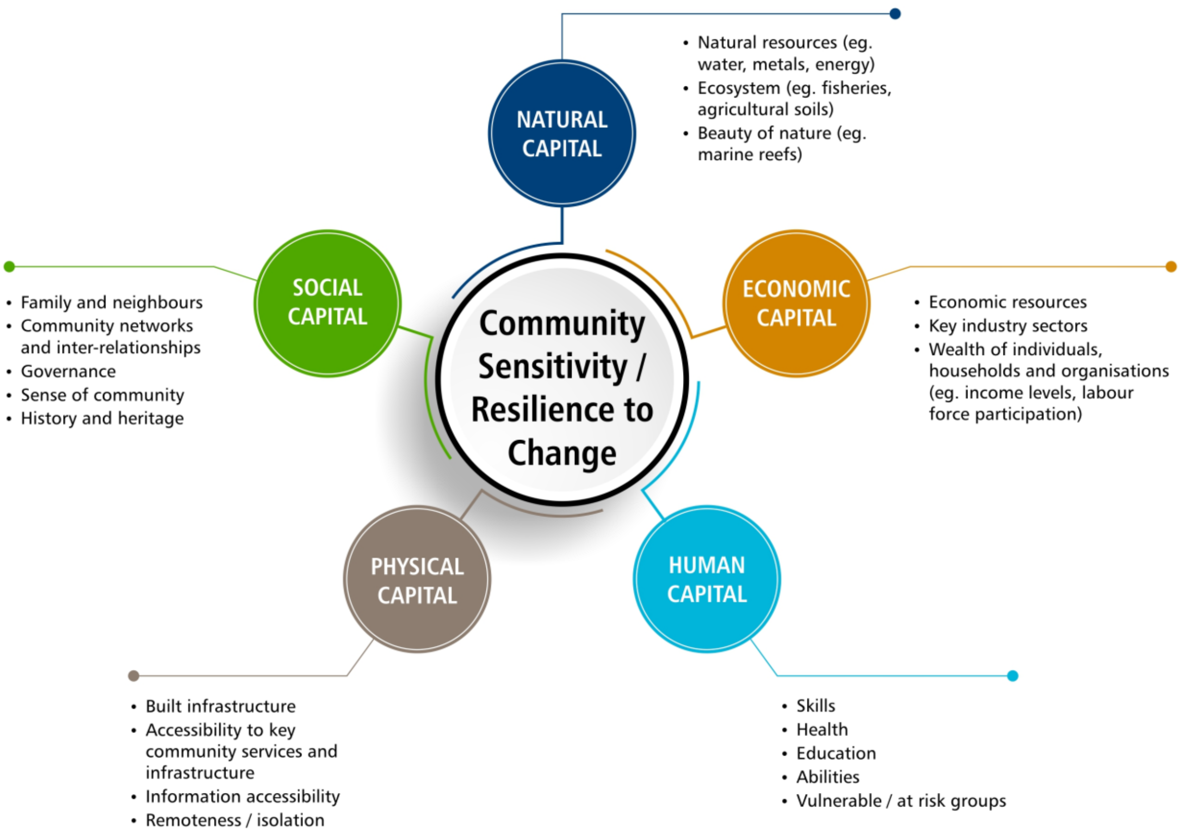

Figure 2.1 Capital Framework

Source: Adapted from Coakes Consulting (2013)

2.3 Assessment Activities

The SIA for the Revised Project has involved a number of key phases:

- Developing a profile of the social and economic context in which the Revised Project is located, at a local and regional scale, and summarising the social and community issues of relevance to the communities of interest (**Section 3.0**).

- Identifying the impacts and opportunities that are most important to the local community in relation to the Revised Project, through both primary sources i.e. engagement with near neighbours and other key stakeholders within the Wollongong LGA and secondary sources, including document and media review (**Section 4.0**).

- Assessing and predicting the significance of impacts associated with the Revised Project through the application of a 'risk-based approach'; integrating both perceived and technical assessments of risk. Where available, relevant data sets have been used to inform the assessment of the social impacts associated with the Revised Project and to explore perceptions raised in engagement with the community. This approach affords greater integration with the broader environmental assessment work so that impacts of relevance to technical specialists and community members are adequately discussed and considered in the impact assessment process (**Section 5.0**).

- Developing strategies that address and manage the predicted social impacts associated with the Revised Project and those which may enhance opportunities in a manner that values existing community aspirations and assets (**Section 6.0**).

- Identifying what will require monitoring should the Revised Project be approved and how any unanticipated social impacts that may result from the Revised Project will be identified (**Section 7.0**).

Table 2.1 summarises the social assessment mechanisms specifically utilised during each phase of the SIA program for the Revised Project.

Table 2.1 Summary of Social Impact and Assessment and Engagement Methods

Phase	Summary
Phase 1 – Program Planning	Development of a constraints analysis and stakeholder engagement strategy for the Revised Project.
Phase 2 – Community Profiling	Review of secondary data sources e.g. census, social and community indicators, historical accounts of the region, local media sources; and collection of primary data through face to face interviews with key stakeholders.
Phase 3 – Scoping of Issues and Opportunities	Review and analysis of previous stakeholder engagement outcomes and complaints data from the Russell Vale operations and other relevant assessment studies to obtain an understanding of perceived issues and opportunities in the locality. Face to face meetings with proximal neighbours of the Revised Project to identify perceived issues and opportunities, followed by ranking of perceived issues and opportunities relative to frequency of response. Briefings with relevant non-government organisations, business and community groups, and other interested stakeholders, to identify perceived Revised Project issues and opportunities.
Phase 4 – Assessment of Impacts and Opportunities	Assessment of the social risks and prediction of social impacts associated with the Revised Project.
Phase 5 – Prediction of Impact and Strategy Development	Identification and development of appropriate strategies to address predicted Project impacts and to monitor change.

2.3.1 Demographic Data

A key component of the baseline profiling for the SIA has been the collation, analysis and interpretation of extensive demographic data. Sources used are outlined in **Table 2.2** below.

Table 2.2 Secondary data sources

Source	Content
Australian Bureau of Statistics (ABS)	2016 General Community, Time Series and Indigenous Profile data.
	Review of 2016 Socioeconomic Indices of disadvantage, education and occupation, and access to economic resources for relevant areas. Population projections (2011 - 2036).
The Public Health Information Development Unit (PHIDU), Torrens University Australia	2018 releases of public health data through the Social Health Atlas (NSW) and Aboriginal and Torres Strait Islander Social Health Atlas. Data within the Social Health Atlas is collated from a range of sources. http://phidu.torrens.edu.au/social-health-atlases.
NSW Bureau of Crime Statistics and Research (BOSCAR)	June 2018 recorded crime reports by LGA. Data Extracted from the Computerised Operational Policing System (COPS) of the NSW Police Force. https://www.bocsar.nsw.gov.au.

Source	Content
MySchool	The My School website is a resource for parents, educators and the community to find important information about each of Australia's schools. My School contains data on a school's student profile, NAPLAN performance, funding levels and sources, other financial information and enrolment numbers and attendance rates. https://www.myschool.edu.au/.

Analysis undertaken using demographic data has included:

- Indicator identification and selection.
- Analysis of data from Greater Sydney and the State of NSW data for comparative purposes.
- Longitudinal/time-series analysis of data, as relevant.

Socio-economic characteristics of the relevant communities are largely based on a State Suburb (SSC) (where data is available) and LGA level of analysis and informed by data available from the latest 2016 Census and other data sources as relevant. The primary communities of interest, for this study include Russell Vale (SSC) and Corrimal (SSC). These suburbs were selected due to their proximity to the Revised Project and the potential to be directly affected.

Indicators have been identified according to each capital area. **Table 2.3** presents the indicators that have been selected for use in the development of the baseline profiles. This data has been collected at the SSC unit of analysis (where possible) and the LGA unit of analysis for all areas and as previously noted has been compared against Greater Sydney and NSW data.

Table 2.3 Examples of indicators collated and reported in profile by capital

Indicator	Data Source
Human Capital	
Indigenous Status	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT Local Government Areas, 2018.
Learning or earning	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT Local Government Areas, 2018.
SEIFA Education occupation	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta.
Highest level of school attained	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro.
Non-school qualifications	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro.
Children Developmentally vulnerable on two or more domains	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT Local Government Areas, 2018.
Social Capital	
Population Mobility	ABS, 2016. General Community Profile, Catalogue 2001.0. Accessed using ABS Community Profiles.
Aged pensioners	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT Local Government Areas, 2018.

Indicator	Data Source
Poor Proficiency in English	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT LGA, 2018.
Population Projections	ABS, 2016. NSW State and LGA Population and Household Projections, and Implied Dwelling Requirements. Accessed through DPIE.
Family composition	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta.
Marriage status	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta.
Proportion who volunteer for an Organisation or Group	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT LGA, 2018.
Economic Capital	
Household income	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro
Employment in mining	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro
Unemployment rate	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta
SEIFA Economic resources	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta
SEIFA IER	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using ABS.Stat beta
Financial stress from mortgage or rent	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT LGA, 2018
Physical Capital	
Home ownership	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro
Rent Assistance from the Government	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT LGA, 2018
Residential Aged Care Places	PHIDU, 2018. Social Health Atlas of Australia: NSW and ACT LGA, 2018
Overcrowding (no. of people per bedroom)	ABS, 2016. Extended Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro
Travel to work	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro
Access to internet	ABS, 2016. Community Profile, Catalogue 2001.0. Accessed using TableBuilder Pro

It should be noted that when collecting data that reflected indicators of Natural Capital, there was insufficient data available that was:

- Related to the adaptive capacity of the chosen communities.
- Valid at the required scale/s of analysis.
- Replicable across identified communities.

2.3.2 Documentary and Media Review

In addition to the quantitative data sources noted above, a review of relevant literature has also been undertaken. This review has included:

- Analysis of relevant local media.
- Review of relevant local and regional planning documents (refer to **Table 2.4**).

Key documents that have been reviewed are listed in **Table 2.4**. Additional information sources have been identified within the reference section at the end of the report.

Table 2.4 Literature Review

Source	Description
Local Government and Regional Strategic Plans	Review of relevant Wollongong City Council (WCC) Strategic Plans and assessments and relevant regional plans including: • Illawarra Shoalhaven Youth Employment Action Plan 2016. • NSW DPE Illawarra Shoalhaven Regional Plan 2015 • WCC Aging Plan 2018-2022 • WCC Economic strategy 2013-2023 • WCC Our Wollongong 2028 Community Strategic Plan 2018
Local Media	Media review of relevant local media sources (including Illawarra Mercury) to identify: • General issues, needs and priorities of relevant communities • Salient stakeholder issues in each of the relevant communities • Historical response of local communities to change
Other Sources	Referenced as relevant.

2.4 Program Participants

SIA involves the cooperation and coordination of a number of 'social partners' or 'stakeholders'. As Burdge[4] outlines, stakeholders 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
- Are forced to relocate.

As part of the SIA program for the Revised Project, stakeholders have been identified and involved in the program. These stakeholders have been grouped as follows, with further details included in the sections below.

[4] Burdge, Rabel J. (2004). A Community Guide to Social Impact Assessment: 3rd Edition, Social Ecology Press, ISBN 0-941042-17-0. www.dog-eared.com/socialecologypress/

- Local landholders and residents residing in proximity to the Revised Project operations.
- Local community groups and organisations.
- Regional environment and recreational groups.
- State and Commonwealth government agencies.
- Local government representatives.
- State and Federal Elected Representatives.
- Local business and business chambers/groups, and
- Service providers, including education and emergency services.

There were two phases of stakeholder engagement conducted as a part of the consultation process.

2.4.1 Engagement Activities

Engagement has been undertaken at two key phases of the assessment, namely in the scoping of the issues and impacts development of appropriate strategies to address and/or mitigate impacts.

A number of mechanisms have been utilised to obtain the input of the differing stakeholder groups. **Table 2.5**outlines the mechanisms used to engage with local landholders, key stakeholders and the wider community.

Table 2.5 Engagement Methods

Method	Description
Engagement	
Near neighbour and landholder interviews	Personal interviews with near neighbours and landholders to outline Project aspects and document project issues and opportunities.
Regional stakeholder engagement	Personal meetings with key regional stakeholders drawn from across key community service sectors (including education, local business and community groups) in Russell Vale and Corrimal.
Regional and State Environment/Interest Groups	Project briefings provided to group members of the Illawarra Residents for Responsible Mining (IRRM) 26 June 2017 (10 in attendance). Additional meetings were held with the IRRM and Illawarra branch of the Knitting Nannas Against Greed (KNAG) on 23 May 2019 and the
Government briefings and consultation	Briefings and personal meetings with relevant government representatives (local, state and federal) to present the Project and obtain feedback on project aspects.
Community Information Session	Facilitation of a community information session at the Thirroul Community Centre held on 25 May 2019, to present the key project changes for the Revised Project, key outcomes of the updated environmental assessment and technical studies as well as document perceived community issues and opportunities. A total of 67 individuals attended.
Community Consultative Committee (CCC) presentations	Presentations on the revised mine plan to the CCC on 6 June 2017 with a presentation on the key project changes for the Revised Project, key outcomes of the updated environmental assessment and technical studies on 21 May 2019. An update on the progress of the UEP was provided at the regular CCC meetings held on 21 March 2018, 18 June 2018, 27 August 2018 and 26 November 2018.

Method	Description
Information Provision	
Project Information Sheets	Development of a Project information Sheet No. 1 summarising key aspects of the Project and progress/outcomes of the environmental and social assessment program – approximately 1200 information sheets distributed to neighbouring community residents and relevant stakeholders. Development of a Project Information Sheet No. 2 providing a summary of the key project changes for the Revised Project, key outcomes of the updated environmental assessment and technical studies – approximately 1,500 distributed to neighbouring community residents and relevant stakeholders.

2.4.2 Phase 1 – Community Engagement

Phase 1 was conducted between May and June of 2017. The purpose of this first phase was to:

- Understand community perceptions of WCL.
- Measure community knowledge regarding the Revised Project specifically.
- Seek feedback regarding potential impacts on the community (both positive and negative) and suggested mitigations.

During this phase of engagement, a total of 158 stakeholders were contacted, including proximal landholders, community groups and service providers. This was undertaken via phone calls, personal letters, interviews, and project briefings and was in addition to broader project briefings delivered to relevant local and State government agencies (as outlined in **Table 2.8**).

Table 2.6 Phase 1 - Engagement Status by stakeholder group

Stakeholder group	Direct contact made	Contact attempted with no response	Total
Landholders	63	57	120
Local Businesses	16	5	21
Community Groups	4	1	5
Education	3	5	8
Environmental Groups	1	1	2
Recreational Groups	2	0	2
Total	**89**	**69**	**158**

Doorknocking of approximately 50 households and landholders in the area proximal to the Russell Vale Colliery (noting more than one person may have been consulted per household) was undertaken to provide these residents with project information and to offer the opportunity for a personal meeting. Twelve individuals (24%) agreed to a meeting and these have been included in the landholder count (n=63) in **Table 2.5** above.

Of the 158 stakeholders where contact was attempted, direct contact was made with 89 stakeholders (56%). Note that those contacted has been categorised in three groups in **Figure 2.2** below. These categories are completed interview (n=34); information provided yet did not respond (n=12); and declined (n=43). The remainder could not be contacted for a number of reasons including disconnected phone numbers or no reply to phone calls or messages.

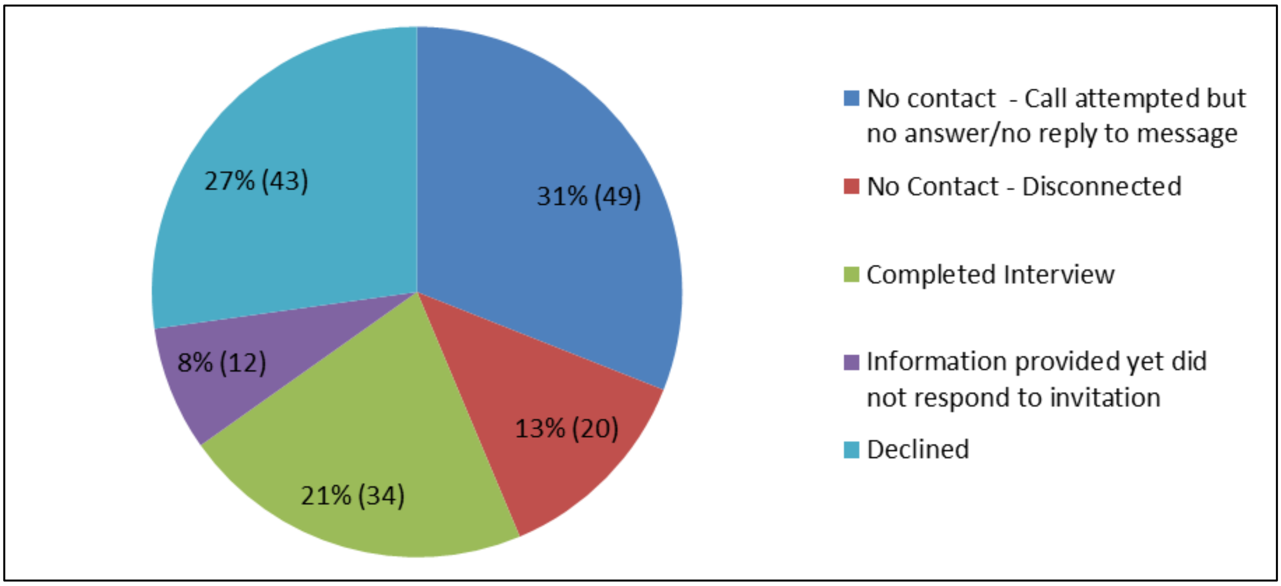

Figure 2.2 Engagement Status, n=158

Figure 2.3 outlines the reasons that were given for people declining to be part of the engagement process.

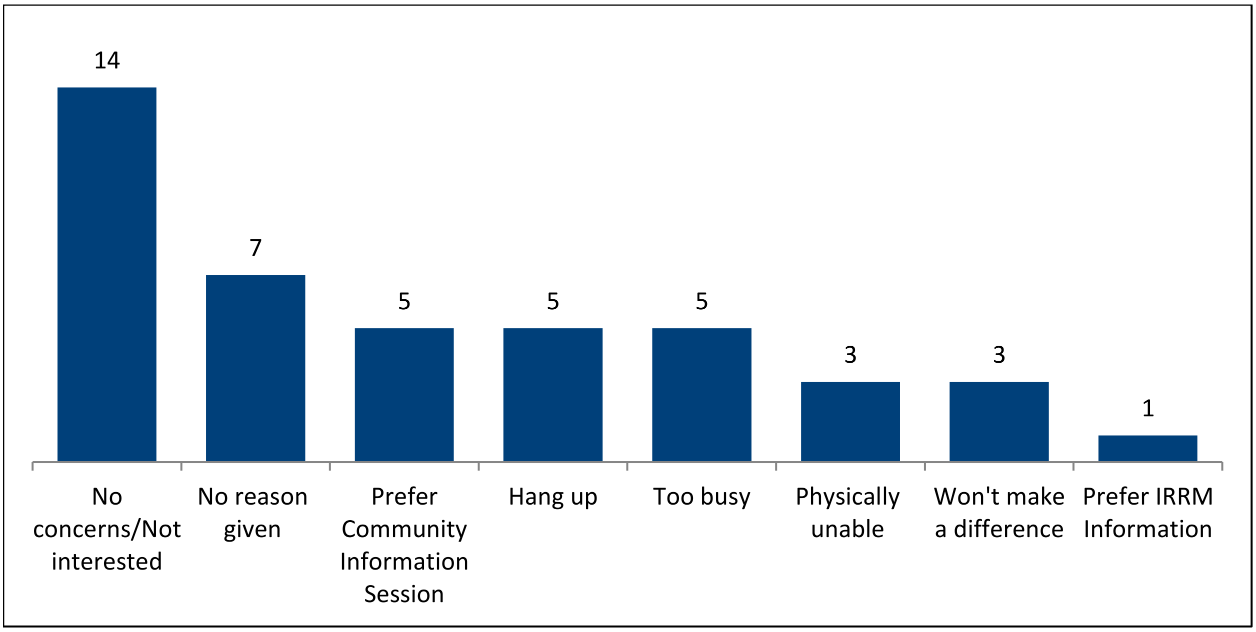

Figure 2.3 Declined Interview Reasons, n=43

Table 2.7 provides an overview of the number of stakeholders that participated in an interview, across each stakeholder group category. Outcomes of the 34 interviews with local landholders, local business, community groups, service providers and recreational groups form the basis of the analysis of impacts and opportunities undertaken in **Section 4.0**.

Table 2.7 Phase 1 - Meeting Summary

Stakeholder Category	Meetings	Participants
Local Landholders and Residents	27	37
Local Businesses	4	4
Community Groups	1	1
Education	1	1
Recreation Groups	1	1
Total	**34**	**44**

Community issues and feedback from the Phase 1 of engagement are documented in **Section 4.0**

2.4.3 Phase 2 – Community Engagement

Phase 2 community engagement activities were undertaken during June 2019. The focus of the engagement was to:

- provide previously engaged stakeholders with feedback from the first phase of consultation
- consult with potential new and additional stakeholders that had not yet had an opportunity to be engaged.

In addition, this phase also aimed to:

- provide the community with information regarding changes to the Revised Project
- provide the community with information regarding the outcomes of the updated environmental and social studies as a result of the project changes.

Mechanisms utilised during phase 2 included:

- Targeted meetings with key community groups such as the Illawarra Residents for Responsible Mining (IRRM) and the Knitting Nannas Against Greed (KNAG) on 22 May 2019. Three additional organisations were contacted by email and phone between 6 and 11 June. They were contacted to participate due to their proximity to the Russell Vale Colliery. The organisations included the Russell Vale Pre-School, Aspect School South Coast and Russell Vale Golf Course; with only the Russell Vale Pre-School taking up the offer of a discussion.
- Letter box drop to approximately 1,500 residential properties in Russell Vale and Corrimal, to inform residences of the Community Information Session and to provide them with an opportunity for a personal meeting if they were not able to attend the information session. This letter box drop included residential properties along Rixons Pass Road who weren't included in the Phase 1 information sheet distribution (Note that the information sheet could not be delivered to those with 'no junk mail' stickers).
- A drop-in style Community Information Session held at Thirroul Community Centre on Saturday 25 May 2019. The session was attended by 67 individuals who included employees and contractors of WCL, residents from surrounding suburbs (including Russell Vale, Corrimal, Bellambi and Woonona), members of the KNAG, members of the CCC, and other interested Illawarra residents. **Table 2.8** provides an overview of attendees.

- Newspaper advertisement in the Illawarra Mercury on 16 May 2019 to inform the broader community of the session.

- Letterbox drop of Project Information Sheet No. 2 delivered to 1500 households including residents of Russell Vale (including Rixons Pass Road) and Corrimal (note that the information sheet could not be delivered to those with 'no junk mail' stickers).

Table 2.8 outlines those attended the Community Information Session held in Phase 2.

Table 2.8 Community Information Session Attendees

Stakeholder Category	Participants
Residents (Russell Vale, Corrimal, Bellambi and Woonona)	22
Illawarra Residents	16
Wollongong Coal employees and contractors (and family members)	17
Members of the CCC	2
Members of the KNAG	3
Anonymous	7
Total	**67**

All attendees to the Information Session were provided with a copy of the Project Information Sheet No.2 which they were able to take with them as a reference (refer to **Appendix D**). This was in addition to the letter box drop to 1,500 residences of Russell Vale and Corrimal referred to above. The information sheet contained contact details to obtain further information on the Revised Project. No additional calls were received as a result.

2.5 Government Agency Participation

WCL has undertaken ongoing consultation with government agencies in regard to the site's ongoing compliance program for the 'care and maintenance' regime and consultation with Umwelt during the preparation of the updated environmental assessment. A summary of ongoing government consultation undertaken is provided in **Table 2.9**.

Table 2.9 Summary of Ongoing Government Agency Consultation

Agency name	Date	Purpose
Department of Planning, Industry and Environment (DPIE)	6 December 2016	A meeting was held with the DPIE to document outcomes from Meeting with DPIE on 5 December 2016 regarding approach to UEP application following Court Decision.
	21 May 2017	Presentation to DPIE regarding the proposed revised mine plan.
	22 August 2018	A meeting was held with the DPIE to discuss the approach and progress of the Mod 4 Response to Submissions (RTS) Report and the UEP Revised Project and Response to PAC Second Review Report.
	17 December 2018	Briefing meeting and presentation to provide an update on the progress of the Mod 4 RTS and UEP Revised Project RTS Reports and discuss indicative lodgement dates.

Agency name	Date	Purpose
	21 December 2018	Working draft document of the UEP Revised Project and Response to PAC Second Review Report was submitted to the DPIE for preliminary feedback. This version was still awaiting final technical study outcomes and the final round of consultation to be completed.
	31 January 2019	Preliminary feedback was received from DPIE on the working draft document.
	12 April 2019	A meeting was held with the DPIE to provide a further update on the progress of the UEP and Mod 4 applications.
Department of Resources and Geosciences (DRG)	May 2017	Background briefing and presentation on the proposed revised mine plan.
	5 June 2017	Conceptual Project Development Plans (CDPD) Presentation regarding the proposed revised mine plan.
	5 June 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Project and to request a meeting with DRG.
Department of Environment and Energy (DoEE)	27 June 2017	Presentation to DoEE regarding the Revised Mine Plan.
Environment Protection Authority (EPA)	2 May 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Project and to request a meeting with EPA.
	22 May 2019	Briefing meeting and presentation with regards to the Revised Project and outcomes of the updated environmental assessment and associated technical studies.
Wollongong City Council (WCC)	20 June 2017	Briefing meeting and presentation regarding the Revised Mine Plan.
	March 2018	WCL met with EPA and WCC to discuss variation of the EPL to satisfy further requirements from EPA.
	July 2018	WCL met with EPA and WCC's flood plain manager regarding the overall storm water management plan for the entire Bellambi Gully Creek and to discuss the Mod 4 application and proposed revised water management system at the site.
	2 May 2019	Letter to provide brief overview of the progress and status of the UEP and to request a meeting with WCC.
	21 May 2019	Briefing meeting and presentation regarding the Revised Project and outcomes of the updated environmental assessment and associated technical studies.

Agency name	Date	Purpose
WaterNSW	21 April 2017	Presentation to WaterNSW regarding the Revised Mine Plan.
	20 May 2019	Executive Steering Group Meeting was held and brief update on the Mod 4 and UEP applications was provided.
	5 July 2019	Briefing meeting and presentation regarding the Revised Project and outcomes of the updated environmental assessment and associated technical studies.
Office of Environment and Heritage (OEH)	2 May 2019	Letter to provide an overview of the progress, status and key assessment outcomes for the Revised Project and to request a meeting with OEH.
	22 May 2019	Briefing meeting and presentation with regards to the Revised Project and outcomes of the updated environmental assessment and associated technical studies.

3.0 Community Context and Socio-Economic Profile

An understanding of the local context has been developed through review of relevant history, geography, governance and demography and to provide a ‘baseline’ understanding of the surrounding communities and other stakeholder groups that are likely to be impacted by and/or have an interest in the Revised Project. The approach to profile development and data sources used is detailed at **Section 2.3**.

The Russell Vale operation lies in the Wollongong LGA, approximately 9 kilometres (km) north of Wollongong CBD. Wollongong is Australia’s ninth largest city with a population of 203,629 (ABS 2016) and is located 80 km south of Sydney. The Wollongong LGA occupies the coastal strip from Sydney to the north South Coast and is bordered by the Royal National Park to the north, Lake Illawarra to the south, the Tasman Sea to the east and the Illawarra Escarpment to the west.

The name Wollongong originated from the Aboriginal word ‘woolyungah’ meaning five islands. Wadi Wadi is the tribe name of the Aboriginal people of the Illawarra with evidence indicating that Aboriginal communities have lived in the area for at least 30,000 years (Destination Wollongong 2018).

In 1815, Dr Charles Throsby established a settlement in the area, bringing his cattle from the Southern Highlands to a lagoon of fresh water located near South Beach. The earliest reference to Wollongong was in 1826, in a report written by John Oxley about the local cedar industry. The area's first school was established in 1833, and just one year later the Surveyor-General arrived from Sydney to lay out the township of Wollongong on property owned by Charles Throsby-Smith (WCC 2018).

In 1927 the local steel industry emerged with Charles Hoskins entering into an agreement with the NSW Government to build a steelworks at Port Kembla, the beginning of a long history of steel production that continues to this day. Operations commenced in 1930 with one blast furnace of 800 tonnes capacity. The steel industry has been a catalyst for growth in the region for many decades, and has laid the foundations for the city's economy, lifestyle and culture.

The relevant geographic regions for the assessment, are those that include the populations of the suburbs of Russell Vale and Corrimal, as immediate neighbours to the mine infrastructure and facilities (refer to **Figure 3.1**). They also include the wider Wollongong LGA, as the host LGA for the Revised Project, and the likely location of residence of many employees. It is also acknowledged that employees may live in other LGAs and people and groups outside the Wollongong LGA may also have interests in the Revised Project. Assessment of locations of employee residence is undertaken in **Section 5.2.1**.

The following sections of this report present information about the key social and economic characteristics of the communities of relevance to the Russell Vale Colliery, highlighting the strengths and weaknesses that define its socio-economic resilience. As noted in **Section 2.2**, these characteristics are described in terms of five community capitals or assets: human, social, physical, economic and natural (Coakes and Sadler 2011; Beckley et al. 2008; Emery and Flora 2006; DFID 1999; Ellis 2000; Hart 1999).

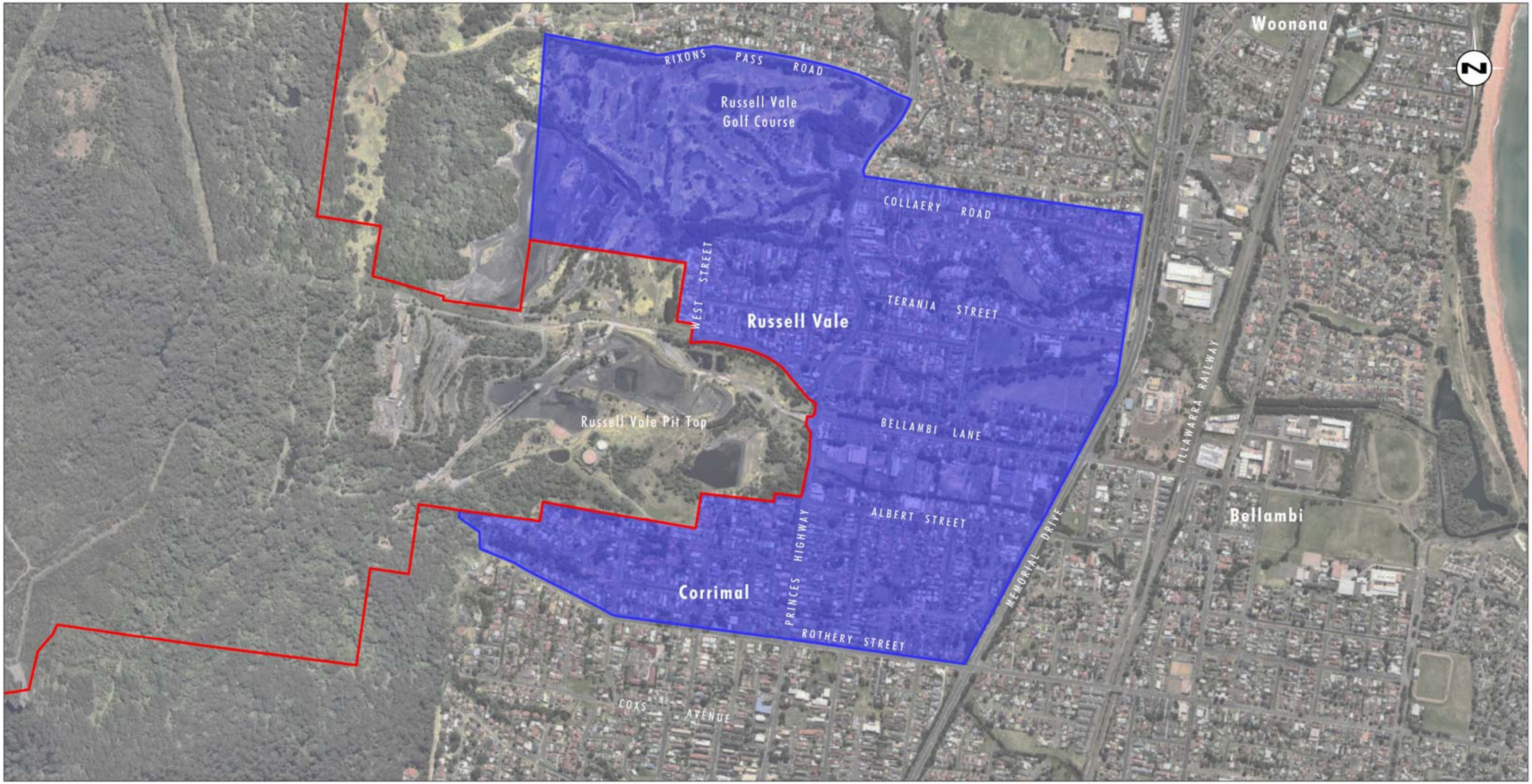

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

0 250 500 750m
1:15 000

Legend

UEP Project Application Area
Area of Interest

FIGURE 3.1

Area of Interest

3.1 Human Capital

The status of a community's human capital has been assessed by considering population size, age distribution, education and skills, general population health and the prevalence of at-risk groups within the community.

Table 3.1 provides a summary of the key human capital indicators for the study communities relevant to the Revised Project. This data is compared with Greater Sydney and Wollongong LGA, where relevant, with further discussion of these indicators and key issues of significance provided in the subsequent sections.

Table 3.1 Summary of Human Capital Indicators

Indicator	Russell Vale	Corrimal	Wollongong	Greater Sydney	NSW
Population	1,546	6,518	203,629	4,823,991	7,480,231
Indigenous (%)	4	3	3	1	3
Males (%)	50	48	49	49	49
Median Age (years)	39	42	39	36	38
Proportion born overseas (%)	11	20	23	39	30
Year 12 or equivalent (%)	44	46	52	67	59
Equivalent Post-Secondary Education (%)	51	48	49	52	49
Bachelor degree level (%)	18	20	22	31	26
Living with a profound or severe disability (%)	-	-	6.7	5.1	5.6
Earning or learning (%)	-	-	86.7	86.9	85.0
Children developmentally vulnerable in two or more domains (2015) (%)	-	-	9.0	9.3	9.6

Source: ABS (2016) Census – Community Profiles

3.1.1 Key Population Characteristics and Trends

The communities of Russell Vale and Corrimal have a combined population of 8,064, comprising 4% of the population of Wollongong LGA.

The proportion of Indigenous population in Wollongong is consistent with the NSW average, and has experienced an increase since the 2006 Census (refer to **Figure 3.2**). The Indigenous population in Russell Vale (4%) and Corrimal (3%) are also comparable to Wollongong (3%) (ABS, 2016).

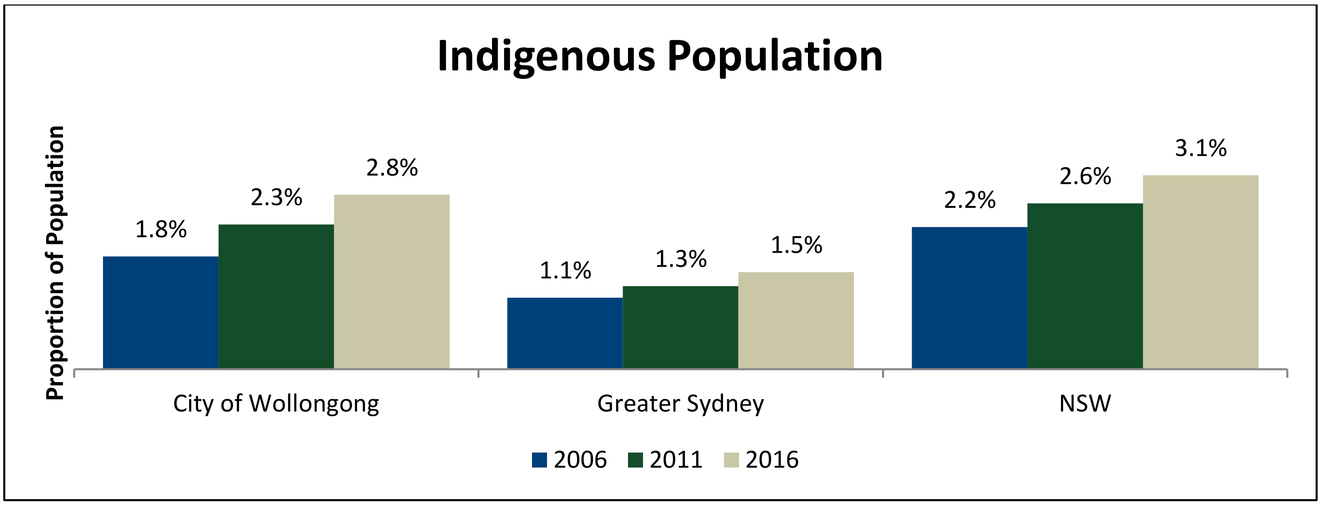

Figure 3.2 Indigenous Population Proportions (2006-2016)

Source: ABS Census (2016) – Community Profile

3.1.2 Age Structure

Compared with Greater Sydney and NSW state average, the City of Wollongong (LGA) has a slightly older median age, 39 years, compared with 36 and 38 years respectively (refer to **Figure 3.3**). The median age in Russell Vale is comparable to Wollongong, however Corrimal has an older population (refer to **Figure 3.3**).

Across all study communities there is an aging population, with the median age in the City of Wollongong and Russell Vale increasing from 37 - 39 years from 2006 - 2016; while Corrimal increased from 39 - 42 years.

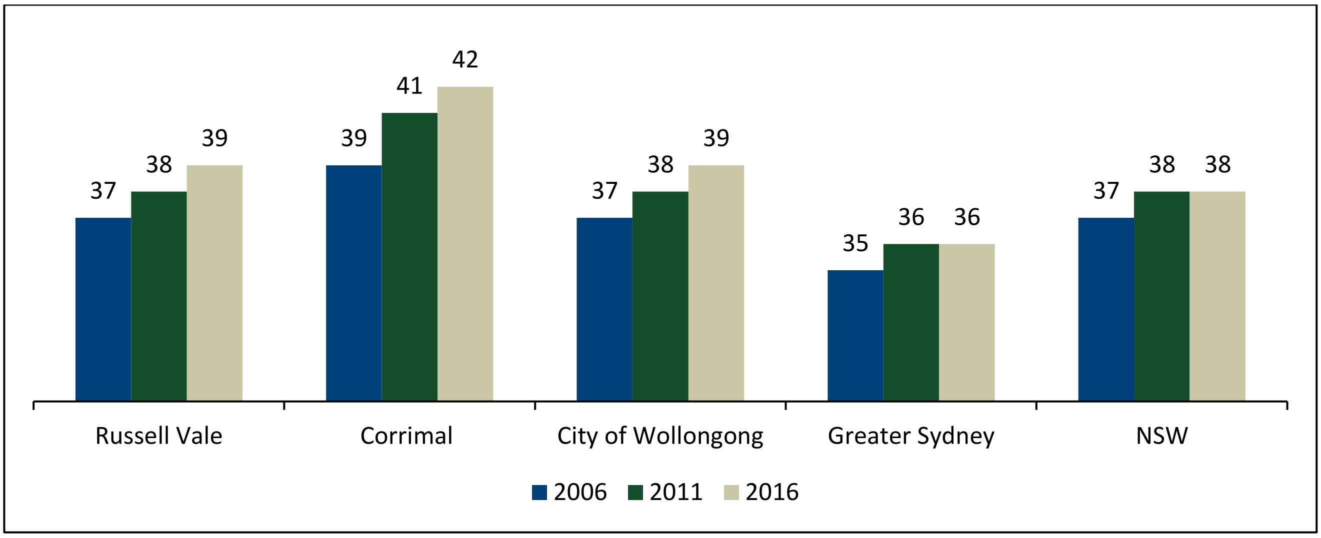

Figure 3.3 Median Age - Years (Change over Time)

Source: ABS Census (2016) – Community Profiles

Figure 3.4 to **Figure 3.6** illustrates the age structure by gender in each of the communities of interest and change in the age structure over time since 2006. These figures indicate that:

- Russell Vale has seen a decrease in the 15 - 24 year age cohort between 2006 and 2016, and an increase in 45 - 74 year cohort. In addition, there has been a notable increase in boys 5 - 14 years.
- Corrimal has seen an increase in the number of persons aged 45 - 74 years and those aged 85 years and over.
- The City of Wollongong has seen the most population growth in the 55 - 74 years age cohorts.

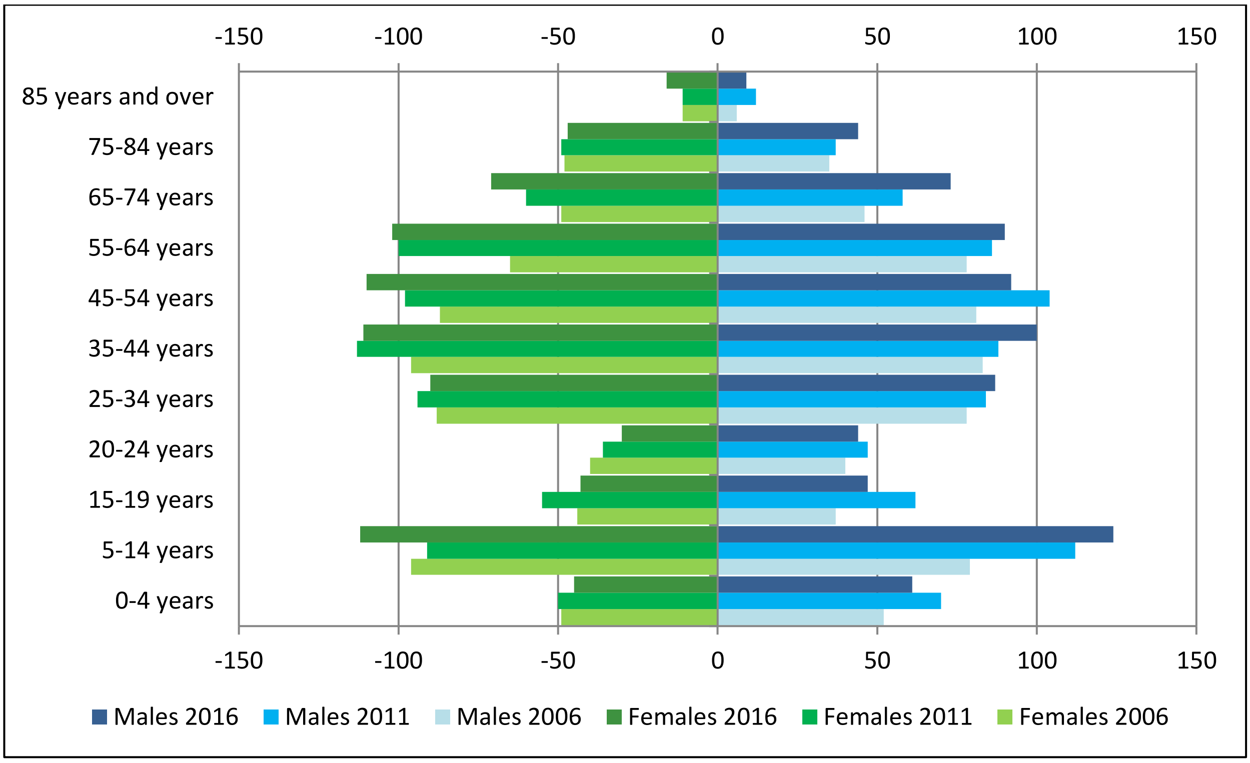

Figure 3.4 Age/Gender pyramid – Russell Vale

Source: ABS Census (2016) – Community Profiles

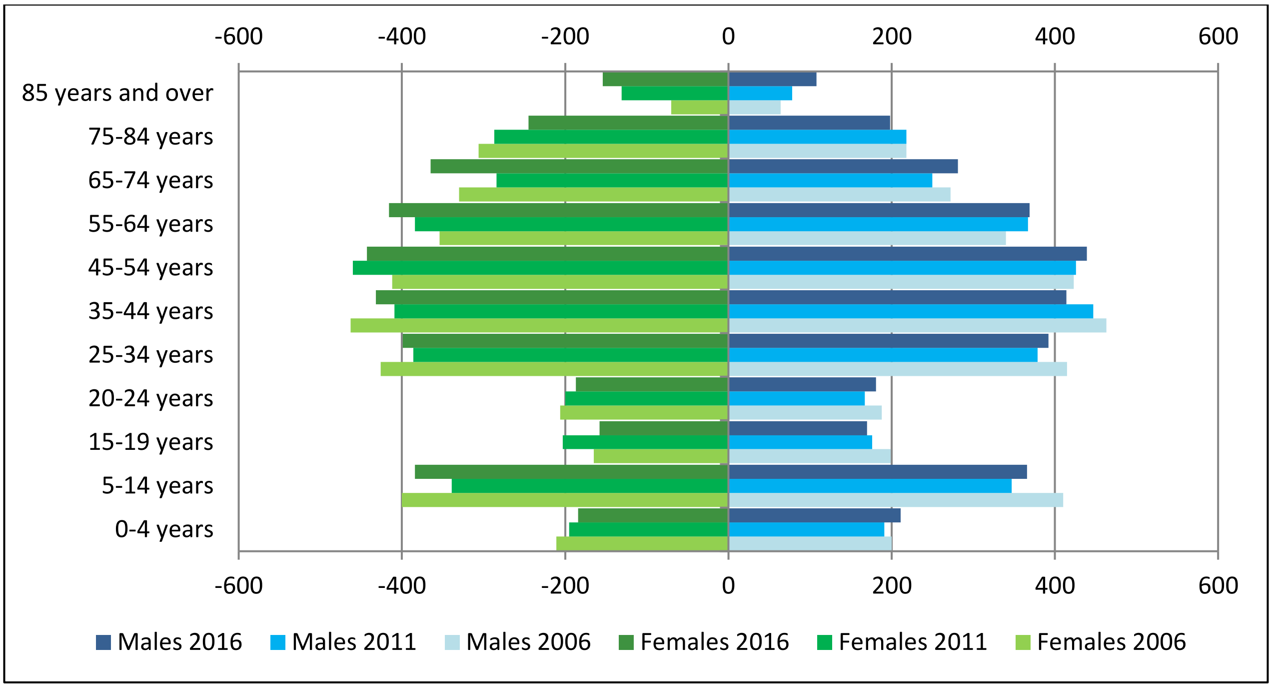

Figure 3.5 Age/Gender pyramid – Corrimal

Source: ABS Census (2016) – Community Profiles

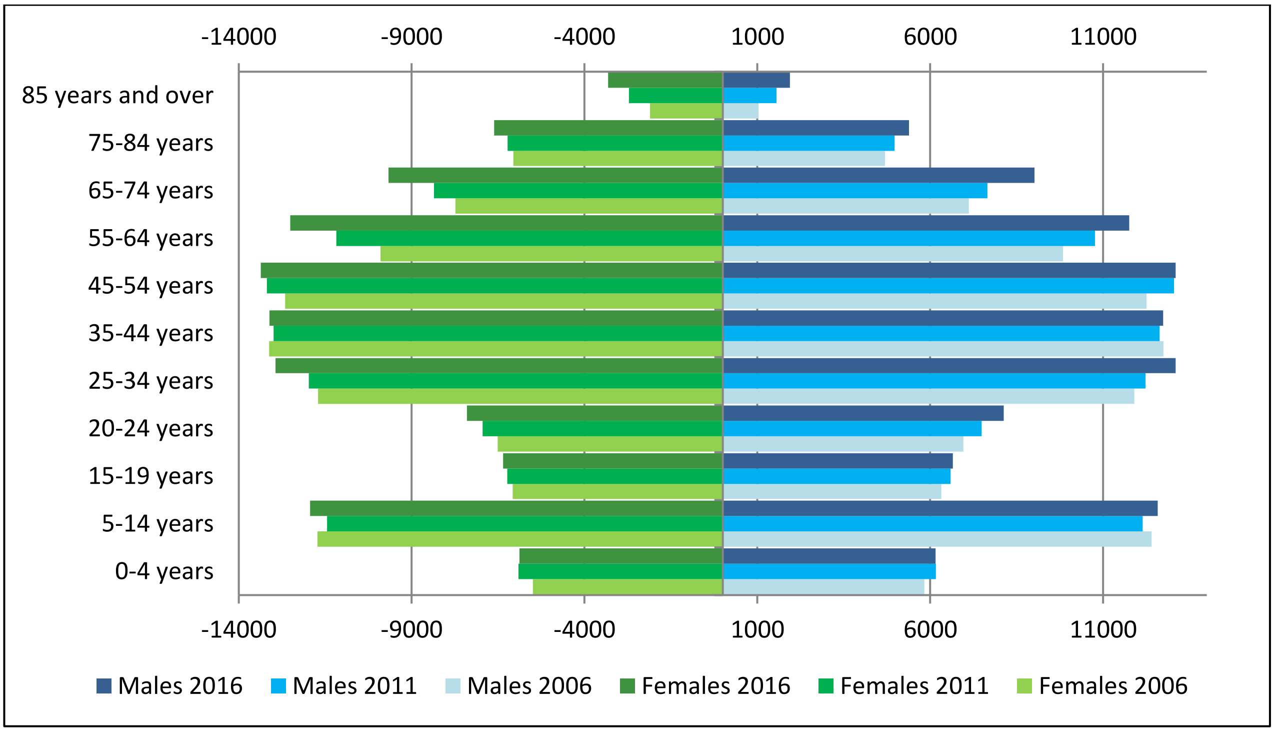

Figure 3.6 Age/Gender pyramid – Wollongong

Source: ABS Census (2016) – Community Profiles

3.1.3 Population growth

As shown in **Table 3.2**, population numbers across the WCC have increased over the past few Census years, however this increase has not been as dramatic as the increase in growth within Greater Sydney, or across NSW more widely.

- The population of Corrimal has remained fairly stable since 2006, with a decrease of 211 people to 6,324 from 2006 - 2011, and then an increase of 194 from 2011 - 2016.
- Between 2006 and 2011 the population of Russell Vale increased by 289 people to 1,517 and has remained stable to 2016**.**

To respond and capitalise on this growth since 2006, WCC has adopted a range of strategies designed to support the development of an innovative and sustainable economy. These include:

- Growing the national competitiveness of Metro Wollongong to drive economic growth, employment and diversification of the region's economy.
- Coordinate and implement cross-sector initiatives to increase and attract business investment, supporting small businesses and encouraging jobs growth.
- Effectively manage urban growth in West Dapto to balance employment and population growth.

Table 3.2 Changes in Population Over Time

Indicator	2006	2011	2016	Change (2006-2016)	Change (2011-2016)
Russell Vale	1,288	1,517	1,546	↑20%	↑2%
Corrimal	6,535	6,324	6,518	↓0.3%	↑3%
Wollongong	184,210	192,418	203,629	↑11%	↑6%
Greater Sydney	4,119,190	4,391,674	4,823,987	↑17%	↑10%
NSW	6,549,174	6,917,662	7,480,231	↑14%	↑8%

Source: ABS Census (2016) – Community Profiles

Population projections prepared by the DPIE from 2011 - 2036 (2016 edition) and presented in **Figure 3.7** and **Figure 3.8** indicate that:

- The City of Wollongong is expected to reach a population of 244,400 by 2036.
- On average WCC is expected to experience a 0.8% annual growth rate from 2011 - 2036 (total of 21% over the 25 year period).
- The City of Wollogong is excepted to experience higher rates of growth between 2011 and 2016 (4.8%) and between 2016 - 2021 (4.3%), after which timegrowth is expected to slow to only 3% between 2031 - 2036. However, actual growth rates between 2011 - 2016 exceeded projections (6%, as noted in **Table 3.2**).

- The largest proportion of the population will remain between 30 - 44 years of age, with a projected increase in those aged 65 years and over.

Consultation undertaken to inform the development of the *Our Wollongong 2028* strategic plan idenfied that the Wollongong community sees an aging population as a key challenge for the LGA in the next 10 years. Strategies to support an aging popoulation identified by WCC include:

- Promotion and availaibility of community transport options for frail older people with disabilities and transport for disadvantaged groups.

- Promotion of Healthy, active aging programs in partnership with government agencies and community organisations.

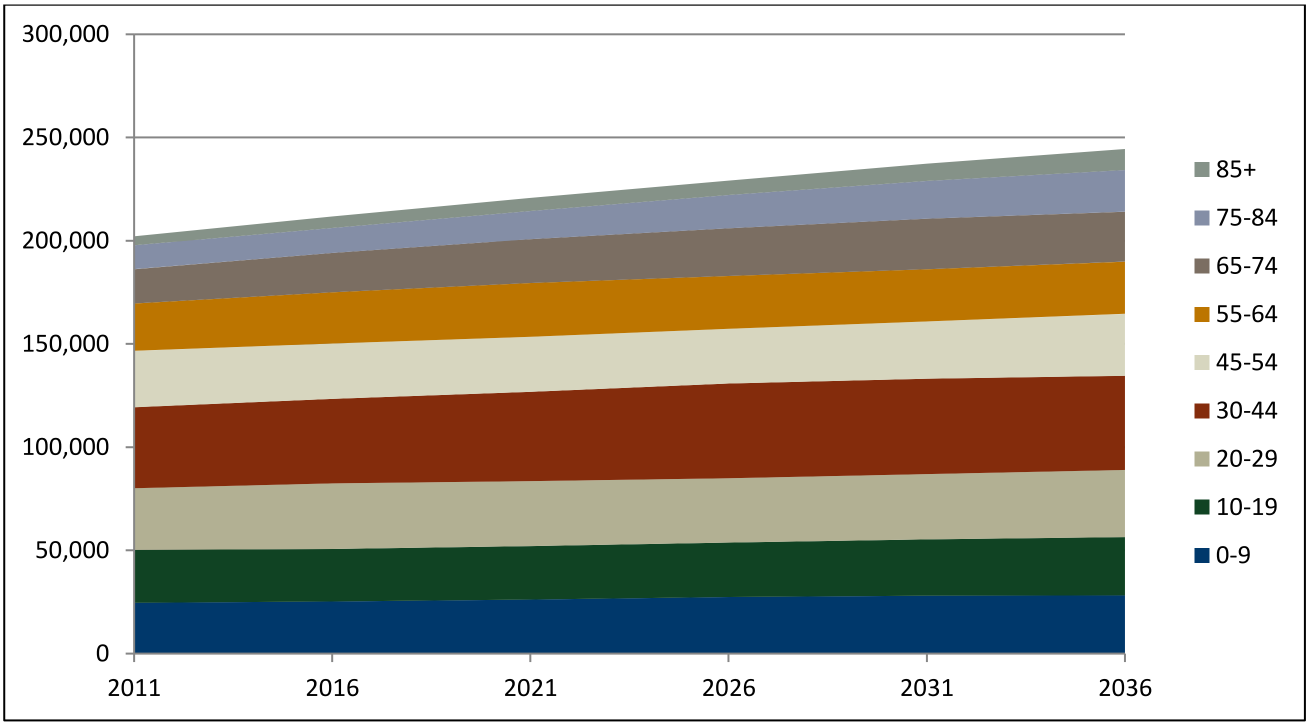

Figure 3.7 Population Projections - Wollongong

Source: 2016 New South Wales State and Local Government Area Population and Household Projections, and Implied Dwelling Requirements

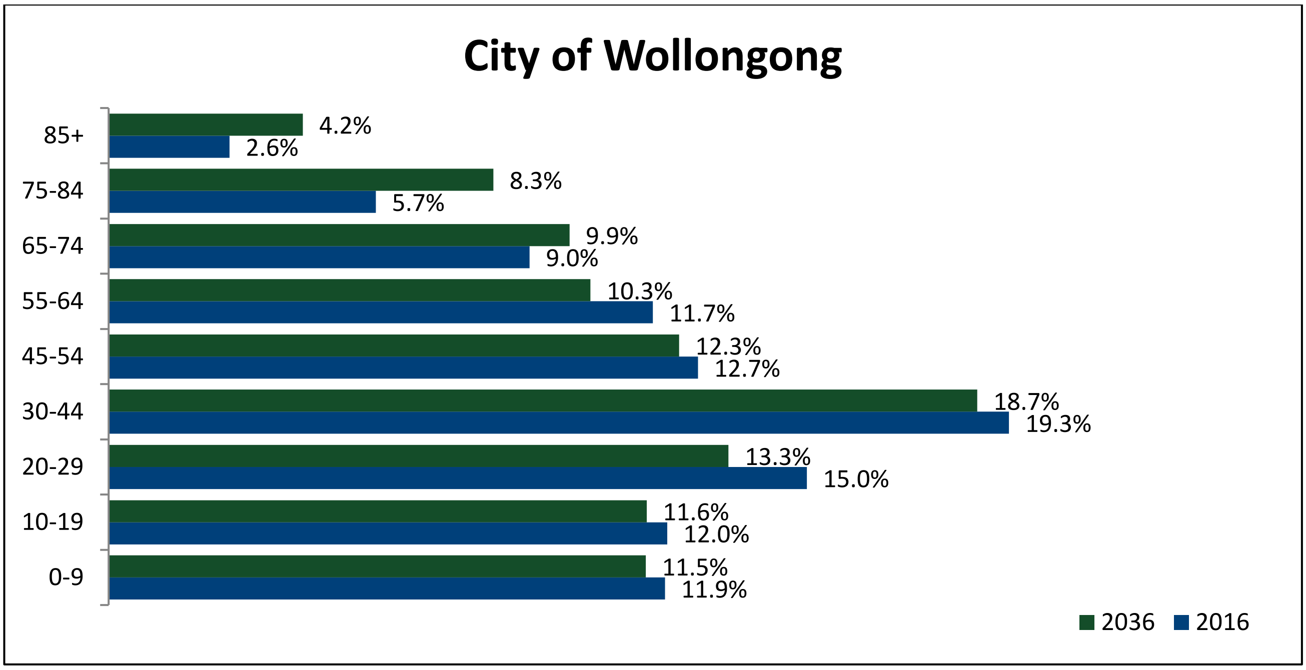

Figure 3.8 Population Projections by age category – City of Wollongong

Source: 2016 New South Wales State and Local Government Area Population and Household Projections, and Implied Dwelling Requirements

3.1.4 Skills, Education and Training

3.1.4.1 Primary and Secondary

Table 3.3 presents the highest levels of school-based education attainment in the City of Wollongong. As indicated, levels of school-based education attained within the City of Wollongong are lower than Greater Sydney and the NSW state average, with 52% (around half) of the population having obtained Year 12 as their highest level of secondary education.

According to the Census data, around a third of the City of Wollongong population left school at Year 10 (28% non-Indigenous and 33% of the Indigenous population). In general, the level of secondary education attainment is proportionally lower for the Indigenous population.

Table 3.3 Highest Level of Schooling Attained

Level of Schooling Attained	WCC		Greater Sydney		NSW	
	% non-Indigenous	% Indigenous	% non-Indigenous	% Indigenous	% non-Indigenous	% Indigenous
Year 8 or below (%)	6	8	4	7	5	9
Year 9 or equivalent (%) (non-indigenous/indigenous)	7	11	4	12	5	14
Year 10 or equivalent (%) (non-indigenous/indigenous)	28	33	18	32	23	34
Year 11 or equivalent (%) (non-indigenous/indigenous)	6	9	4	9	5	10
Year 12 or equivalent (%) (non-indigenous/indigenous)	52	38	67	40	59	33

Source: ABS Census (2016)

Table 3.4 includes available information from schools via the My School website that relate to:

- proportion of students that are either Indigenous and/or from non-English speaking backgrounds
- attendance rates
- school positioning on the Index of Community Socio-Education Advantage[5] (ICSEA) scale. This scale represents levels of educational advantage.

It should be noted that the data only includes primary and secondary schools located within the study communities, however it is likely that the students within the communities would travel to other schools within the LGA. The City of Wollongong has a total of 113 public or private primary or high schools (Australian Schools Directory 2018).

In summary, the My School data, and relevant information from the City of Wollongong strategic planning documents, indicate that:

- In general schools within Russell Vale and Corrimal have higher percentages of students in the bottom quarter of the ICSEA, than in the top quarter; the exception is St Columbkille's Catholic Primary School.
- Schools in Corrimal have a relatively high proportion of students who speak another language than English at home (from 13% - 19%), the exception is St Columbkille's Catholic Primary School where only 3% of students speak another language other than English at home.
- Attendance rates across all primary schools are between 90% - 94%.
- Corrimal High has the highest proportion of Indigenous students (16%).

[5] Research shows that there is a strong relationship between the educational advantage a student has, as measured by the parents' occupation and level of education completed, and their educational achievement. The Index of Community Socio-Educational Advantage (ICSEA) is a scale that represents levels of educational advantage. A value on the scale assigned to a school is the averaged level for all students in the particular school. (http://docs.acara.edu.au/resources/Guide_to_understanding_ICSEA.pdf)

Table 3.4 Educational Facilities

Locality	School/Facility	Level	Enrolments (2017)	Proportion Aboriginal Students	Student Attendance Rate (2018)	FTE Teaching Staff	Other Relevant Information (2017)
Russell Vale	**Russell Vale Public School**	K-6	256	5%	93%	13.1	8% language background other than English 17% of students in the top quarter of the ICSEA 20% of students in the bottom quarter of the ICSEA
Corrimal	**Aspect South Coast School**	U*	137	2%	90%	34.0	Autism Spectrum Australia (Aspect) is the country's largest not-for-profit autism-specific service provider. Aspect builds confidence and capacity in people with an autism spectrum disorder (ASD), their families and communities by providing information, education and other services. Aspect schools provide specialised evidence-based programs for children aged 4 - 16 with ASD, who require an autism specific program. The school comprises an administrative base at Corrimal which has early childhood and primary school classes and a range of satellite classes.
	Corrimal East Public School	U*, K-6	212	4%	94%	15.0	13% language background other than English 11% of students in the top quarter of the ICSEA 36% of students in the bottom quarter of the ICSEA
	Corrimal High School	U*, 7-12	326	16%	85%	42.0	19% language background other than English 3% of students in the top quarter of the ICSEA 61% of students in the bottom quarter of the ICSEA
	Corrimal Public School	K-6	196	8%	94%	19.6	17% language background other than English 16% of students in the top quarter in the ICSEA 30% of students in the bottom quarter of the ICSEA
	St Columbkille's Catholic Primary School	K-6	411	3%	93%	20.9	3% language background other than English 24% of students in the top quarter of the CSEA 13% of students in the bottom quarter of the ICSEA

Source: MySchool. 2018. *School Profile* https://www.myschool.edu.au/

* 'U' refers to students and/or classes, which cannot readily be allocated to a specific year of education; for example, students with special education needs

3.1.4.1.1 Non School Qualifications and Fields of Study

Aside from the primary and secondary school facilities outlined in **Table 3.4**, vocational education and training courses offered in the City of Wollongong include:

- TAFE NSW – this has two campuses within the City of Wollongong - Wollongong West and Wollongong.
- University of Wollongong – offering bachelors and post graduate degrees across a range of subject areas. The University was ranked in 2018 by Quality Indicators for Learning and Teaching (QILT) as the number one university in NSW (University of Wollongong 2018).
- Australian Careers Business College - offering a range of diplomas and advanced diplomas in tourism, early education, accounting, administration leadership, management and legal services.
- Nan Tien Institute - government accredited higher education provider, offering studies in the areas of arts, health, mindfulness and well-being, within an environment that incorporates contemplative pedagogy. It also offers postgraduate programs in Health and Social Wellbeing and Applied Buddhist Studies, as well as customised Continuing Professional Development (CPD) programs and special interest subjects across the areas of mindfulness, meditation and health (Nan-Tien 2018).

In relation to levels of secondary equivalent education, the data suggests that levels are:

- Comparable to the State average for the City of Wollongong (both 49%)
- Marginally above the State average in Russell Vale (51%) and marginally below the State average in Corrimal (48%)

As shown in **Table 3.5**, there is a lower proportion of population with postgraduate or bachelor qualifications, in Corrimal and Russell Vale than in Wollongong, with the differences particularly pronounced in Russell Vale. Proportions of these qualifications across all communities including Wollongong are lower than the State average.

Certificate levels of qualifications are also more prominent across all communities (including the wider LGA) and higher than the NSW state average.

Table 3.5 Non School Qualifications

Level of Qualification	Russell Vale	Corrimal	City of Wollongong	Greater Sydney	NSW
Postgraduate Degree Level (%)	5	5	8	12	9
Graduate Diploma/Graduate Certificate Level (%)	3	3	3	3	3
Bachelor Degree Level (%)	18	20	22	31	26
Advanced Diploma and Diploma Level (%)	16	16	15	15	15
Certificates (%)	46	41	37	24	30
Post-secondary equivalent education [6] (%)	51	48	49	52	49

Source: ABS Census (2016)

[6] Includes Cert III and IV, Diploma and Bachelor level degree

Of those in the study communities who were recorded in the 2016 Census as having pursued a non-school qualification, Engineering and Related Technologies were the most common fields of study, followed by Management and Commerce and Society and Culture (refer to **Table 3.6**).

Table 3.6 Tertiary Fields of Study

Tertiary Fields of Study	Corrimal	Russell Vale	City of Wollongong
Engineering and Related Technologies (%)	22	23	21
Management and Commerce (%)	19	18	20
Society and Culture (%)	14	13	13
Health (%)	10	11	11
Architecture and Building (%)	9	10	7
Education (%)	10	10	10
Food, Hospitality and Personal Services (%)	6	7	5
Creative Arts (%)	4	4	4
Natural and Physical Sciences (%)	3	2	3
Information Technology (%)	2	2	3
Agriculture, Environmental and Related Studies (%)	1	1	2
Mixed Field Programmes (%)	0	0	0

Source: ABS Census (2016)

3.1.5 Health Characteristic

The study communities fall within the Illawarra Shoalhaven local health district, a catchment area that extends approximately 250 km along the coastal strip from Helensburgh in the north to North Durras in the south, servicing a population of more than 400,000 residents. Key health status characteristics of the Illawarra Shoalhaven local health district include:

- Life expectancy at birth of 82.4 years in 2016 (HealthStats NSW 2018).
- Higher than state average proportions of people receiving disability support, in the form of the aged pension or disability and sickness benefits (refer to **Table 3.7**).
- Lower than state average levels of high or very high psychological distress (refer to **Table 3.7**).
- From 2016 - 2017, 3,931 men and 3,770 women were hospitalised for respiratory diseases. This is an average of 1,642.2 persons per 100,000 of the population, which is marginally higher than Sydney (1512.8 per 100,000), but lower than South Western Sydney and Hunter New England, which have similar industry profiles historically (1885.9 and 1707.5 per 100,000 respectively) (refer to **Figure 3.9**).

Table 3.7 Illawarra Shoalhaven Local Health District Health Indicators

Indicator	Local Health District	
	Illawarra Shoalhaven	NSW
High or very high psychological distress (%)	14.5	15.1
Disability – Aged pension (% persons aged 65+)	80.3	71.1
Disability – Disability and sickness benefits (%)	14.1	10.5

Source: Health Stats NSW (2018)

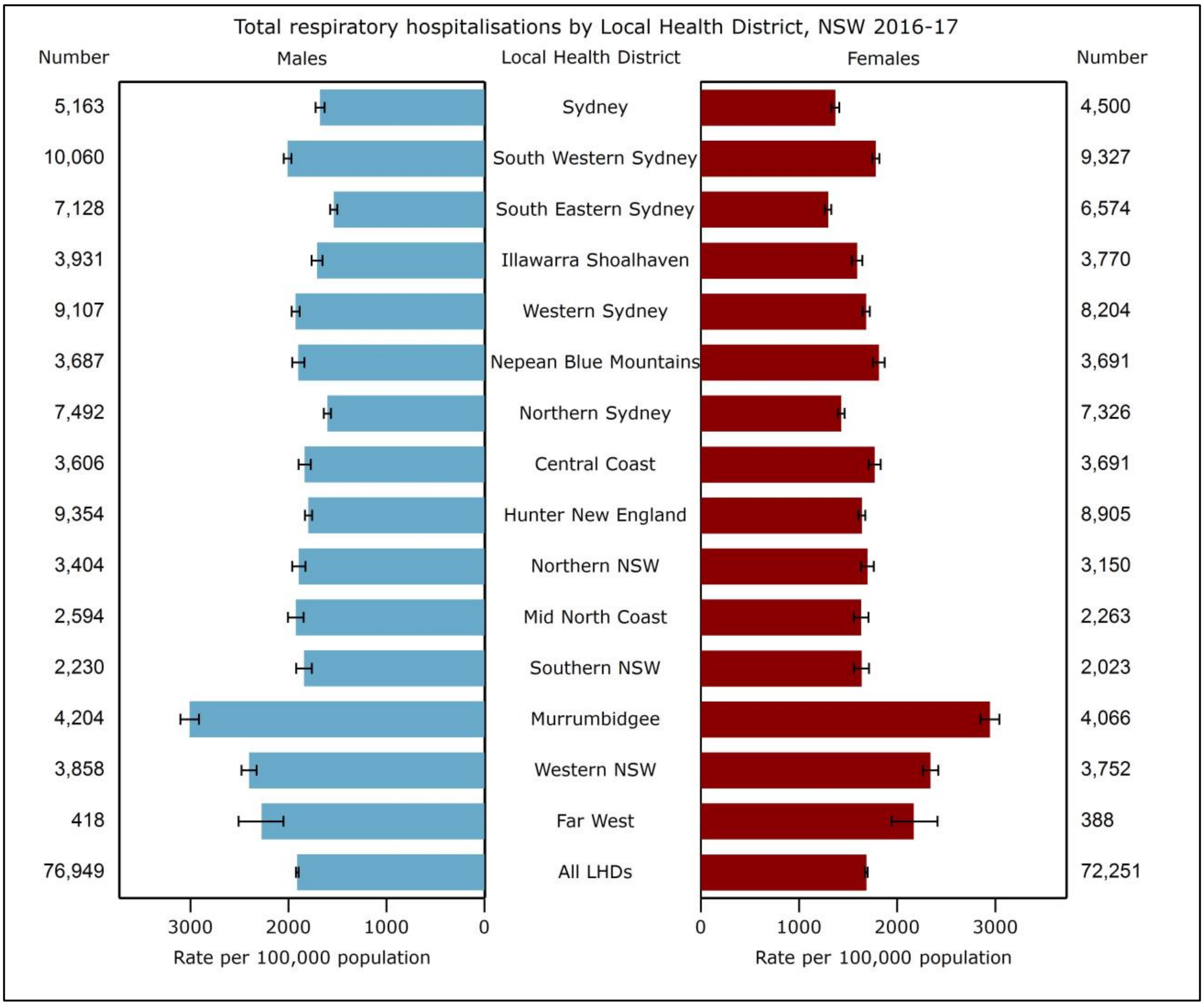

Figure 3.9 Total respiratory hospitalisations by Local Health District, NSW 2016-2017
Source: Health Stats NSW (2018) www.healthstats.nsw.gov.au

Health related statistics for the City of Wollongong specifically highlight:

- Risky levels of alcohol consumption, smoking and obesity with the rates of these indicators proportionally higher in the City of Wollongong than in Greater Sydney (refer to **Table 3.8** and **Figure 3.11** to Error! Reference source not found.).
- High proportions of persons aged 65 years or over receiving the aged pension (refer to **Table 3.8**).
- Higher than State average proportion of persons with poor or fair health assessment or with a profound or sever disability (refer to **Table 3.8**).
- Proportion of persons in Wollongong who are able to get support from persons outside the household in a time of crisis is comparable to the State and Greater Sydney (refer to **Table 3.8**).
- Levels of intentional self-harm hospitalisation, exceed the state average from 2001 - 2017, for both females and males, with females more likely to be hospitalised for self-harm than males (refer to **Figure 3.10**).

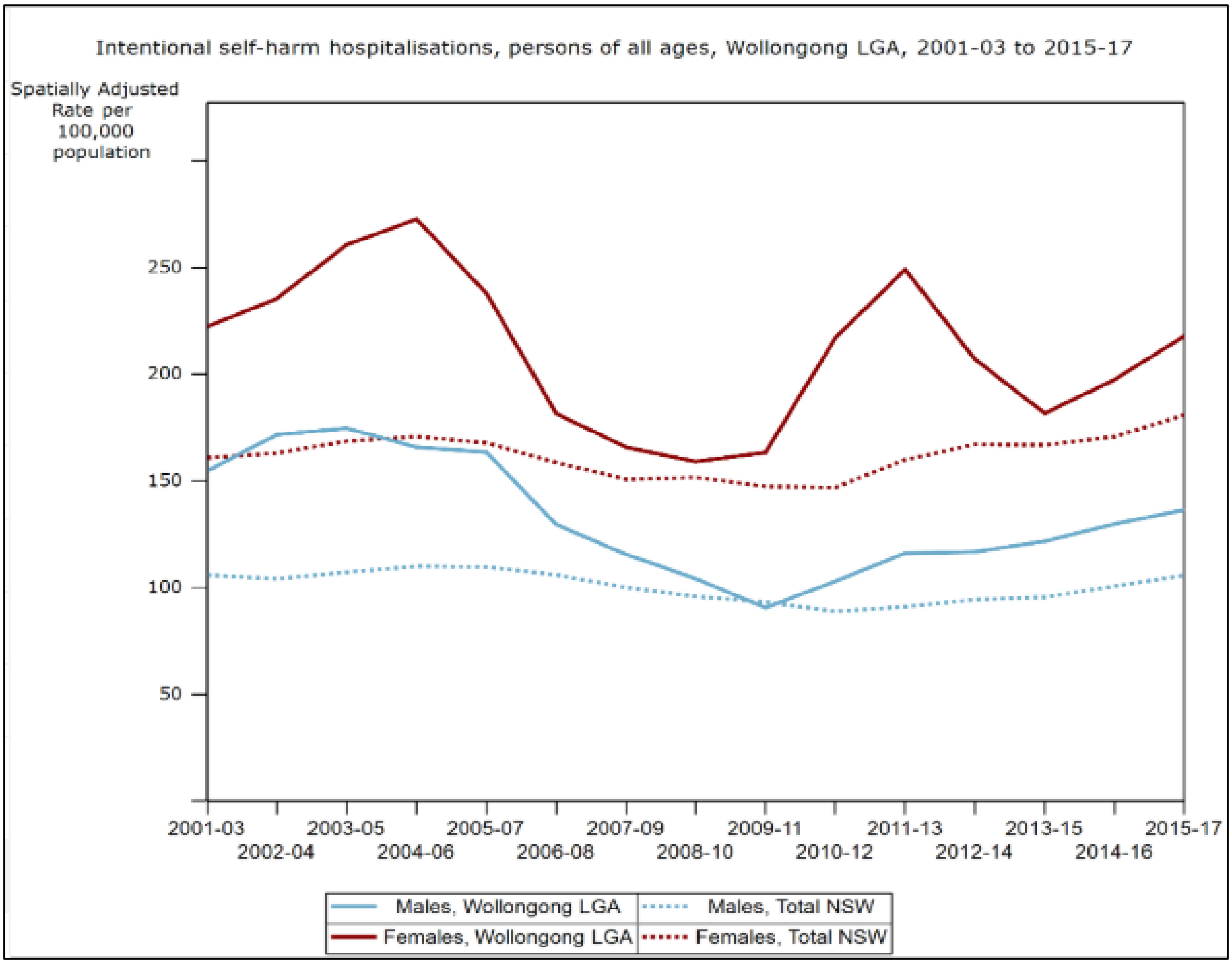

Figure 3.10 Intentional Self-harm Hospitalisations, (persons of all ages), the City of Wollongong (2001-03 to 2015-17)

Source: Health Stats NSW (2018)

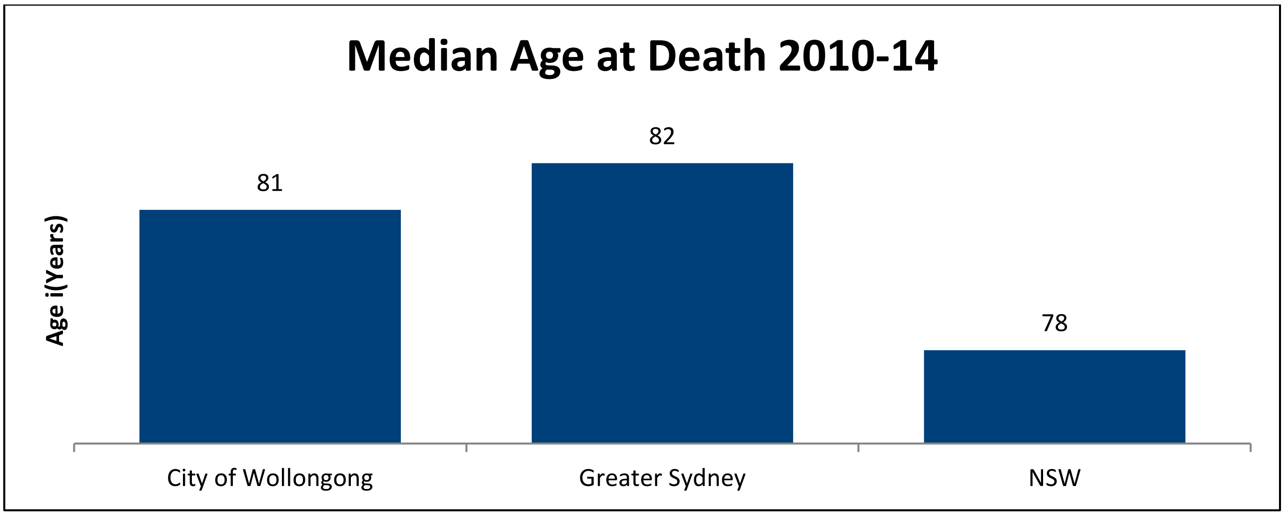

Figure 3.11 Median Age at Death (2010-14)

Source: PHIDU (2018) Social Health Atlas of Australia

Table 3.8 City of Wollongong Health Indicators

Indicator	City of Wollongong	Greater Sydney	NSW
Persons with fair or poor self-assessed health 2014-2015 (ASR per 100)	16.1	13.3	14.3
Proportion of persons who are able to get support from persons outside the household in a time of crisis 2014 (ASR per 100)	93.4	93.2	93.4
Risky level of alcohol consumption 2014-2015 (%)	16.7	14.8	16.7
Smoking 2014-2015 (%)	18.8	14	16
Obesity 2014-2015 (%)	29.3	24.5	28.2
Persons with a profound or severe disability (%)	6.7	5.1	5.6
*Age pension recipients 2016 (%)	76.3	62.9	67.6

Source: PHIDU (2018) Social Health Atlas of Australia

*Percentage of people receiving a pension

The Wollongong rates of risky levels of alcohol consumption, smoking and obesity rates are all risk factors for heart disease and a range of chronic conditions that can contribute to a higher median age at death. More concerning is the potential for these behaviours to negatively impact on the quality of life, particularly of older members of the community. On the positive side, these risk factors can be easily reduced through good public or community health programs that promote a healthy lifestyle.

Consistent with national trends, the increase in pension recipients and disability rates are likely to correlate with an aging population. These health characteristics are reflected in WCC Strategic Plans which focus on disability inclusion and supporting programs to encourage residents to increase their participation in recreation and lifestyle activities (*Our Wollongong 2028,* 2018). Further details of these aspects will be discussed in **Section 3.8.**

Additional information on available health infrastructure and services is provided in the Physical Capital Section at **Section 3.4.**

3.1.6 Human Capital Summary

The median age of the City of Wollongong and the study communities is older than the State average and has been increasing since 2016. While the populations of Russell Vale and Corrimal have grown more marginally; the wider LGA has experienced a growth in population, with this growth predicted to continue in line with the overall population ageing within the LGA more broadly.

Levels of secondary education are lower than the State average in the City of Wollongong; however, levels of post-secondary equivalent education are comparable to the State average. Certificate levels of qualification being the most prominent non-school qualification across Russell Vale, Corrimal and the wider LGA. Engineering and related technologies are the most popular fields of tertiary study in all communities.

Overall there is considered to be a high level of Human Capital in the local area and in the Wollongong locality more broadly. There are no key issues in terms of current or projected demographic makeup, social health indicators, education or vulnerable groups.

Key indicators of health indicate that the Wollongong population has slightly worse self-assessed health, and increased levels of health risk factors including obesity and smoking than the population of wider NSW.

There are considered to be no issues identified of direct relevance to the project across the indicators analysed.

The SEIFA Index of Education and Occupation (IEO), prepared by the ABS, reflect the general level of education and occupation related skills of people within an area. It is important to note that a low score indicates relatively lower education and occupation status of people in the area in general. However, the population numbers across the communities vary which can make comparisons difficult and can skew results.[7]

A comparison of the SEIFA IEO scores (refer to **Figure 3.12**) for the study communities reveals:

- Russell Vale and Corrimal have lower education and occupation status than the wider LGA.
- Wollongong has a relatively high score indicating a high education and occupation status.

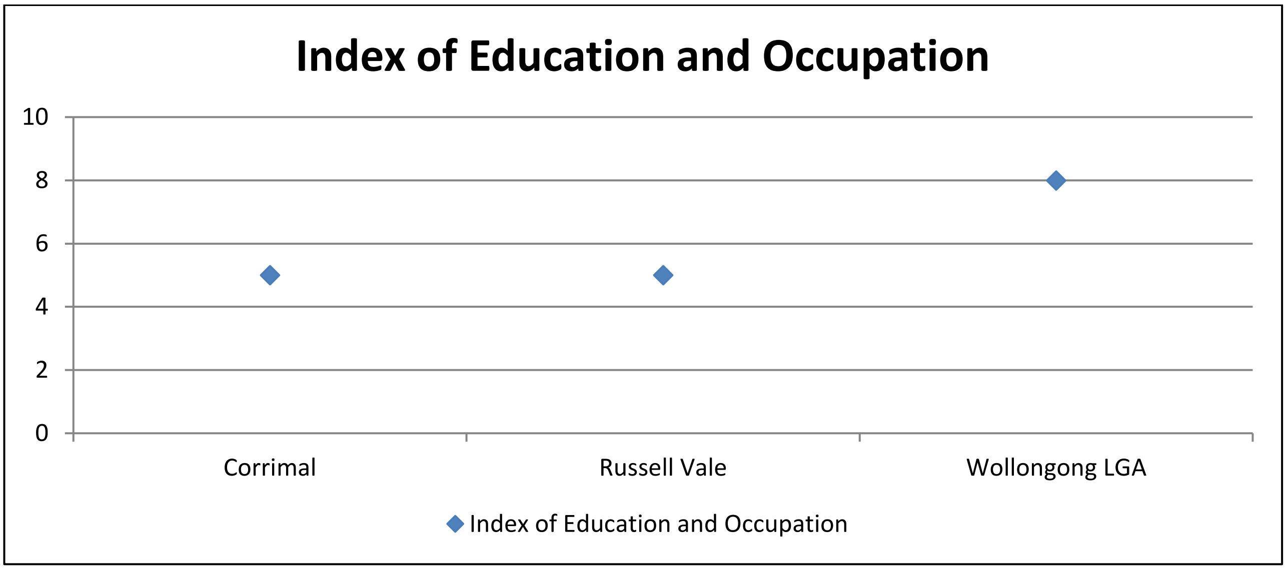

Figure 3.12 Index of Education and Occupation (IEO)
Source: ABS, SEIFA Indexes 2016

3.2 Social Capital

Various indicators have been used to examine social capital. These include the level of volunteering, population mobility, crime rates, the demographic composition of the community e.g. percentage of people born overseas, language proficiency. The influx of visitors to an area and the presence of a transient workforce population can also contribute to varying levels of social capital and resilience within a community.

Table 3.9 provides a summary of the key social capital indicators for the study communities relevant to the Revised Project and compared to the broader state of NSW and the Greater Sydney region, with further discussion regarding these indicators provided in the subsequent sections.

[7] The ABS notes that if there are five people in an area, then each person is equal to 20%. If one person in the area is a 'Manager', then an area with 100 people must have 20 'Managers' to be equivalent. One more 'Manager' would matter a lot to the smaller area, but little to the larger area.

Table 3.9 Summary of Key Social Capital Indicators (2016)

Indicator	Russell Vale	Corrimal	Wollongong	Greater Sydney	NSW
Married (%)	51	46	47	49	49
Families with children (%)	46	42	45	50	46
Families with no children (%)	37	38	36	33	37
Single parent family (%)	18	18	17	15	16
Group Households (%)	2	2	4	4	4
Proportion living at a different address 5 years ago (population mobility) (%)	28	33	36	40	39
Volunteered through an organisation or group (last 12 months) (%)	19	18	19	17	18
Proportion of the population over 65 years receiving a pension (%)	-	-	76	63	68
Poor proficiency in English (%)	-	-	3	6	4

Source: ABS Census 2016

3.2.1 Mobility

The levels of mobility in the study communities are generally lower that the state average, the larger LGA is comparable to the state average. In Russell Vale, 11% of the population reported living at a different address 12 months prior to Census night in 2016 (refer to **Figure 3.13**).

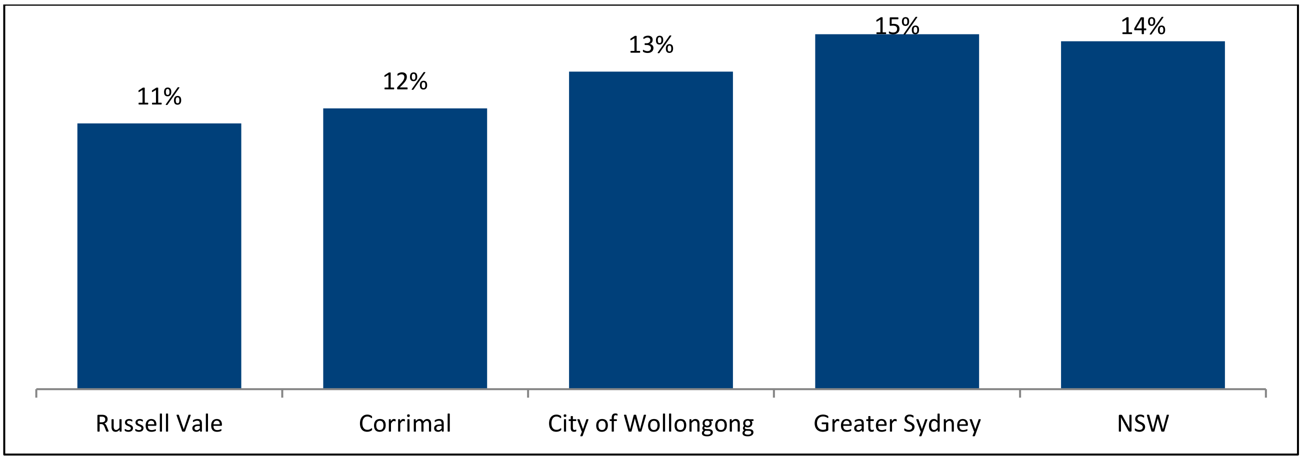

Figure 3.13 Mobility rates 12 months preceding Census night 2016

Source: ABS (2016) Census of Population and Housing

When considering mobility over the past 5 years, the proportion of the population who lived at a different address 5 years ago across the communities is also relatively low. Again, Russell Vale has the lowest mobility rates over a 5 year period, while Corrimal and the wider LGA are also below the State average.

This data suggests relatively stable communities with a greater proportion of long-term residents (refer to

Figure 3.14).

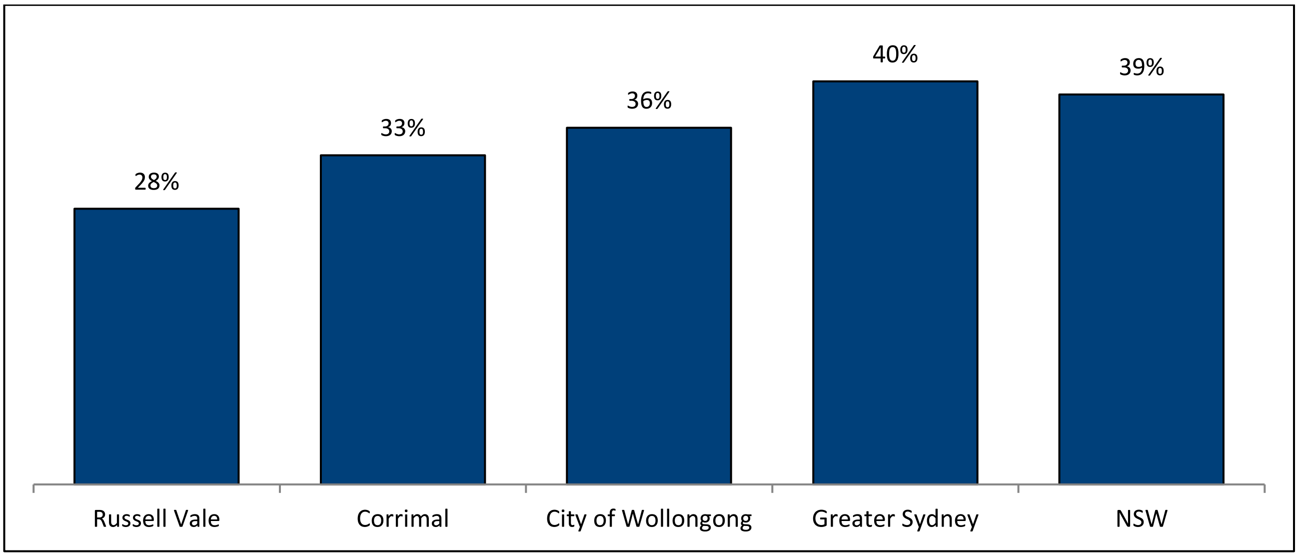

Figure 3.14 Mobility: Proportion living at a Different Address Five Years before Census night 2016
Source: ABS (2016) Census of Population and Housing

3.2.2 Volunteering

Rates of volunteering (in a group/organisation for persons aged 15 years and over in the past 12 months) (2016) in Corrimal (18%) are consistent with the NSW State average, while rates of volunteering in Russell Vale and the City of Wollongong are marginally higher (both 19%).

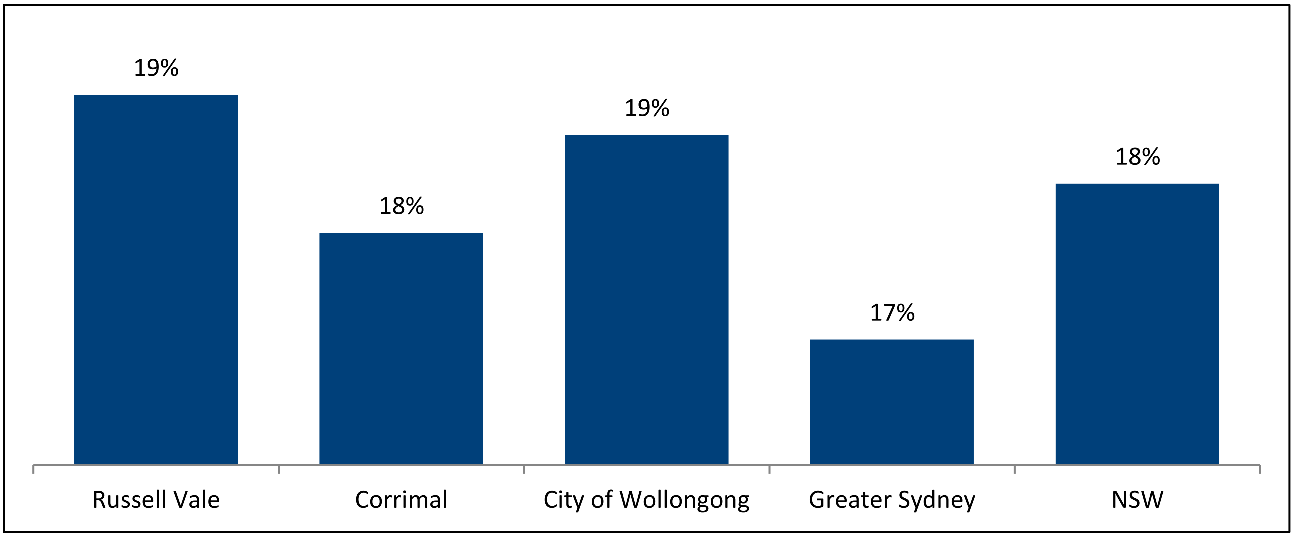

Figure 3.15 Volunteering rates (2016)
Source: ABS (2016) Census of Population and Housing

3.2.3 Family and Household Composition

The majority of households within the study communities are couple families with children, followed by families without children and one parent families with children. These trends are comparable to the NSW average.

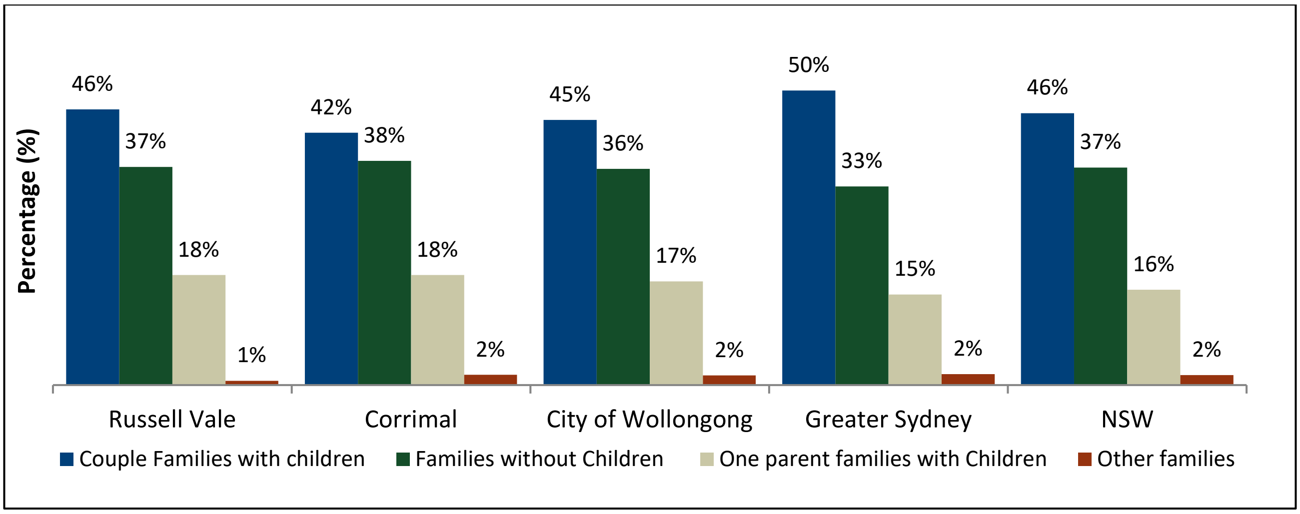

Figure 3.16 Family Composition

Source: 2016 ABS Community Profile

3.2.4 Justice and Crime

The number and rate of reported offences are collected by the NSW Bureau of Crime Statistics and Research (BOCSAR), with a quarterly and annual report series examining trends in crime reported to, or detected by, the NSW Police Force. These reports focus on statistical trends across a 24-month period.

Utilising data extracted from the Computerised Operational Policing System (COPS) of the NSW Police Force, the most recently available crime statistics for the City of Wollongong, suggest that:

- In general crime rates are stable or declining in the area.
- Both domestic and non-domestic related violence offences are decreasing (over a 5-year period).
- Rates of sexual assault have increased in the past 2 years.
- Rates of possession and or use of amphetamines have increased on average by 15.3% in the past 5 years.
- Prohibited and regulated weapon offences have been increasing over the past 5 years.
- Robbery with a weapon (not a firearm) offences have generally been decreasing over the past 5 years but have experienced a more recent resurgence (increasing by 80% per year on average between 2016 - 2018.

A review of the WCC Strategic Plans outlines the following key focus areas for creating a 'healthy and liveable city':

- Local crime continues to be prevented and levels of crime reduced.
- Safety is considered in the planning and design of any development.

Table 3.10 Crime rates in Wollongong between 2013 and 2017

Offence type	Jul 2013 - Jun 2014	Jul 2014 - Jun 2015	Jul 2015 - Jun 2016	Jul 2016 - Jun 2017	Jul 2017 - Jun 2018	Rate per 100,000 population Jul 2017 - Jun 2018	2-year trend and annual percent change (Jul 2016 - Jun 2018)	5-year trend and average annual percent change (Jul 2013 - Jun 2018)
Domestic violence related assault	773	717	806	695	644	304.9	Stable	↓ 4.5%
Non-domestic violence related assault	985	879	834	820	850	402.5	Stable	↓ 3.6%
Sexual assault	159	128	177	129	164	77.7	↑ 27.1%	Stable
Robbery with a weapon not a firearm	53	37	27	20	36	17	↑ 80.0%	↓ 9.2%
Break and enter dwelling	925	1130	812	760	756	358	Stable	↓ 4.9%
Motor vehicle theft	528	474	388	393	411	194.6	Stable	↓ 6.1%
Steal from retail store	623	706	759	896	830	393	Stable	↑ 7.4%
Steal from dwelling	656	798	596	579	573	271.3	Stable	↓ 3.3%
Steal from person	159	122	108	80	70	33.1	Stable	↓ 18.5%
Arson	224	219	210	143	204	96.6	↑ 42.7%	Stable
Malicious damage to property	1995	1932	1899	1783	1738	822.9	Stable	↓ 3.4%
Possession and/or use of amphetamines	138	200	253	313	244	115.5	Stable	↑ 15.3%
Prohibited and regulated weapons offences	313	369	441	463	538	254.7	Stable	↑ 14.5%
Trespass	268	294	312	326	374	177.1	Stable	↑ 8.7%
Transport regulatory offences	4403	4602	4653	6968	6777	3208.8	Stable	↑ 11.4%

Source: NSW Bureau of Crime Statistics and Research (2018)

Assessment of crime hotspots indicates that there are areas of relatively higher crime proximal to the Russell Vale Colliery, illustrated in **Figure 3.17** and **Figure 3.18**.

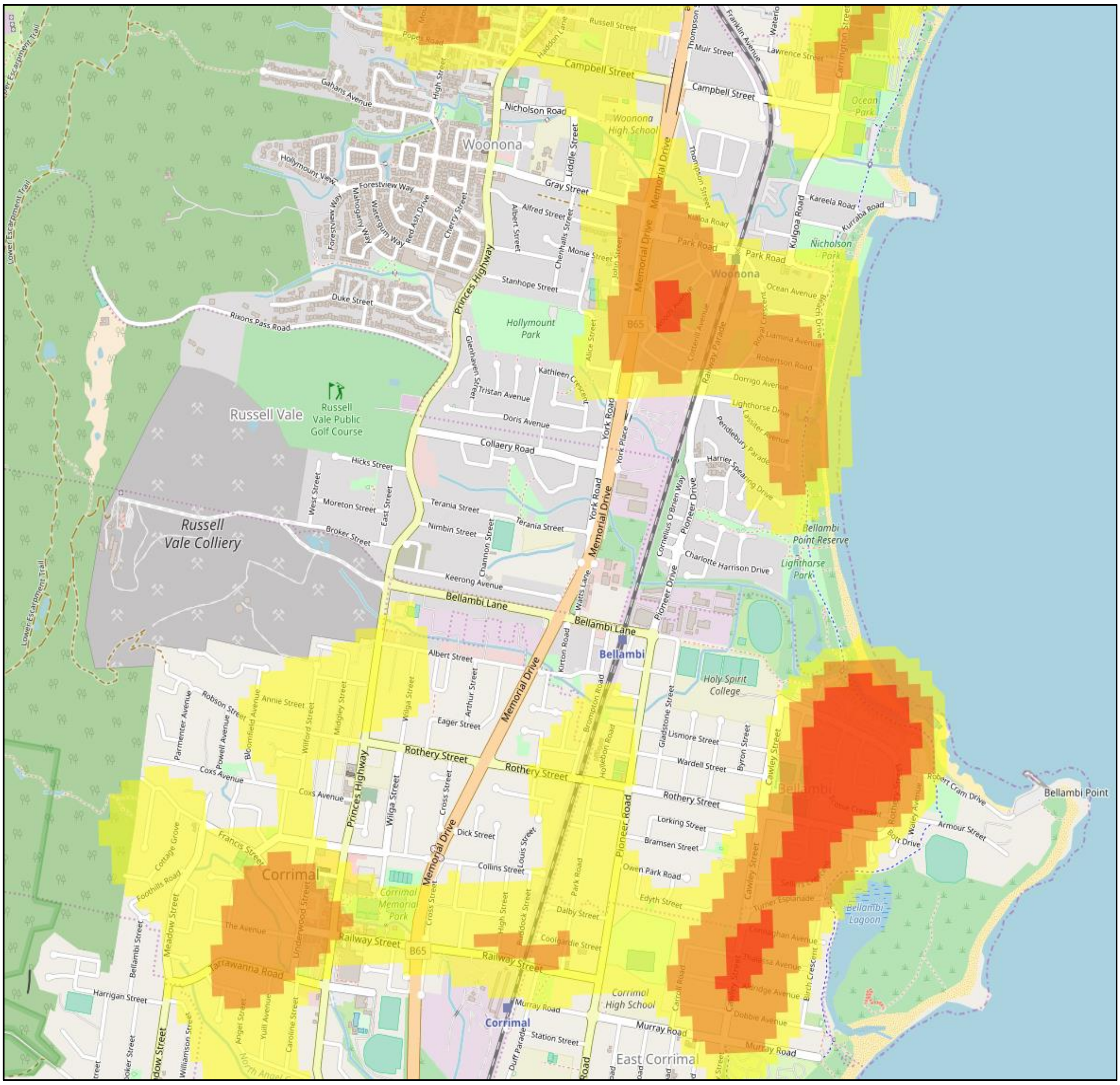

Figure 3.17 Incidents of theft (break and enter dwelling) for July 2017 to June 2018

Source: http://crimetool.bocsar.nsw.gov.au/bocsar/

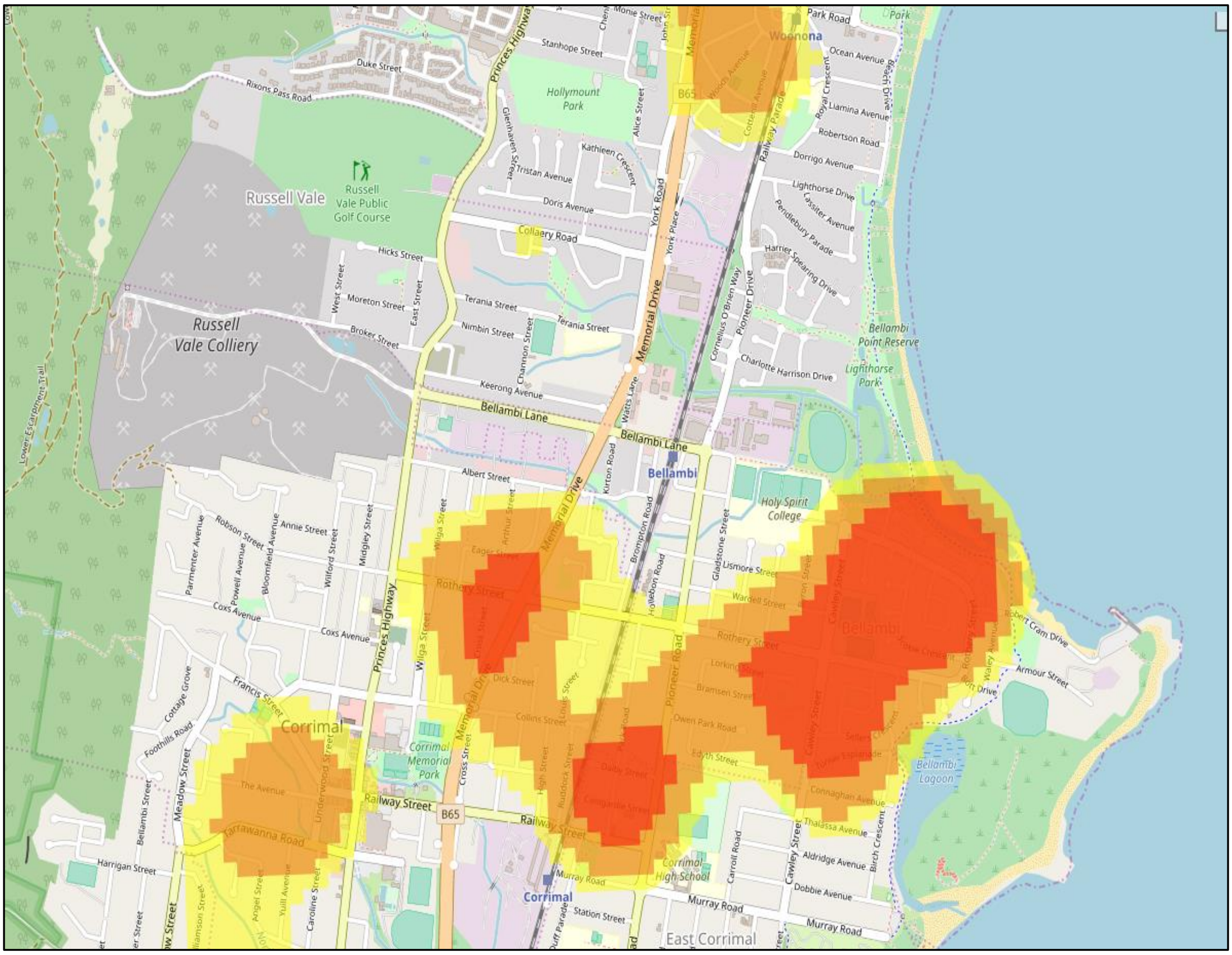

Figure 3.18 Incidents of Domestic Assault for October 2017 to September 2018

Source: http://crimetool.bocsar.nsw.gov.au/bocsar/

3.2.5 Social Capital Summary

Figure 3.19 provides an overall socio-economic status and level of disadvantage within each community, as determined by the Index of Relative Socio-Economic Disadvantage (IRSD) – a SEIFA score prepared by the ABS which ranks areas in Australia according to relative socio-economic disadvantage, with a low score indicating more disadvantage.

Russell Vale is seen to experience levels of disadvantage, that are comparable to the LGA, while Corrimal is seen as experiencing higher levels of disadvantage.

Across the wider LGA, there is also a lower proportion of the population who have poor proficiency in English compared to the NSW average. Within Russell Vale and Corrimal there are low levels of mobility, with the majority of households being families with children.

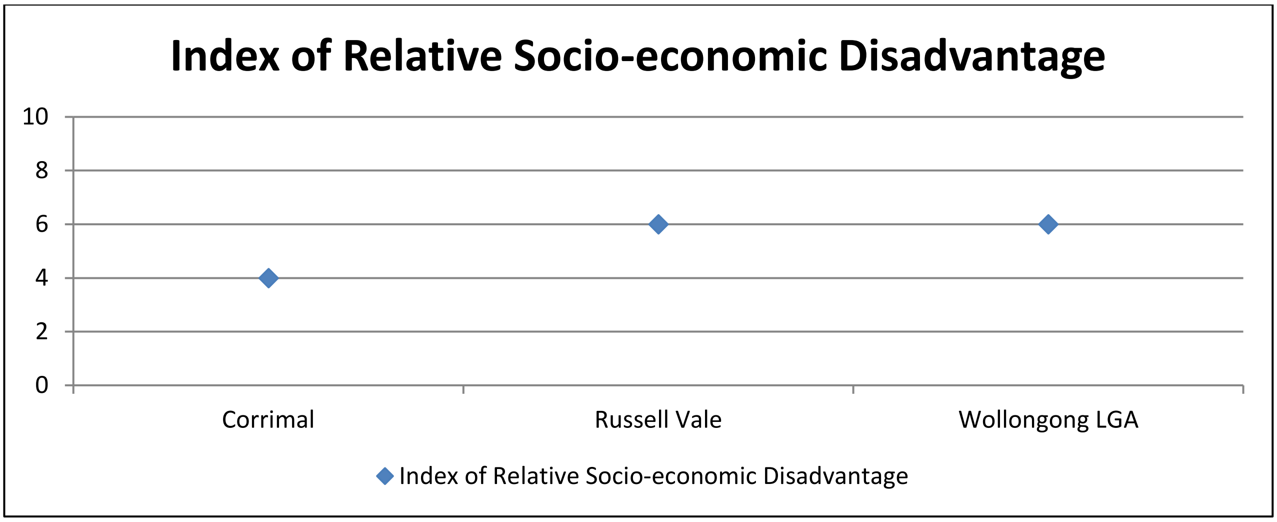

Figure 3.19 Index of Relative Socio-Disadvantage (IRSD)

Source: ABS (2016) 2033.0.55.001 Socio-Economic Indexes for Australia (SEIFA), 2016

3.3 Economic capital

The indicators of economic capital, analysed through the development of the profile, include economic diversity, employment across industry sectors, workforce participation and unemployment, income levels and cost of living pressures, such as weekly rent and mortgage repayments.

Table 3.11 provides a summary of the key economic capital indicators for the relevant communities with further discussion regarding these indicators provided in subsequent sections.

Table 3.11 Summary of Key Economic Capital Indicators for Study Communities

Indicator	Russell Vale	Corrimal	Wollongong	Greater Sydney	NSW
Median total personal income ($/weekly)	633	605	584	719	664
Median total household income ($/weekly)	1452	1230	1339	1750	1486
Median mortgage repayment ($/monthly)	1950	2000	1950	2167	1986
Median rent ($/weekly)	350	310	320	440	380
Labour force participation (15-85 years) (%)	60	57	57	62	59
Unemployment (%)	4	6	7	6	6
Youth unemployment (%)	13	13	16	13	14
Financial stress from mortgage or rent (2016) (%)	-	-	28.5	33.8	29.3
Employment in mining (%)	4.5	2.1	2	0.2	0.9

Source: ABS Census (2016) Community Profiles; Social Health Atlas of Australia, NSW

3.3.1 Industry and employment

3.3.1.1 Employment and Labour Participation

Levels of unemployment in the LGA are slightly higher than the State average (7.1% compared to 6.0%), however unlike those in NSW, unemployment rates in Wollongong have been decreasing over the past few census years (refer to **Table 3.12**).

The unemployment rate in Corrimal is comparable to the State average, while in Russell Vale the unemployment rate is lower than the State average.

Table 3.12 Unemployment Rate (2006 to 2016)

Location	2006	2011	2016	Change ↑↓
Russell Vale (%)	6.7	7.6	4.0	↓
Corrimal (%)	6.7	6.0	6.1	↓
City of Wollongong (%)	7.5	7.0	7.1	↓
Greater Sydney (%)	5.3	5.7	6.0	↑
NSW (%)	5.9	5.9	6.3	↑

Source: ABS Census (2016) Quickstats

Levels of unemployment are substantially higher amongst the Indigenous population across the LGA, with the proportion in the City of Wollongong marginally lower than the State average (14.7% compared with 15.3%) (refer to **Figure 3.20**).

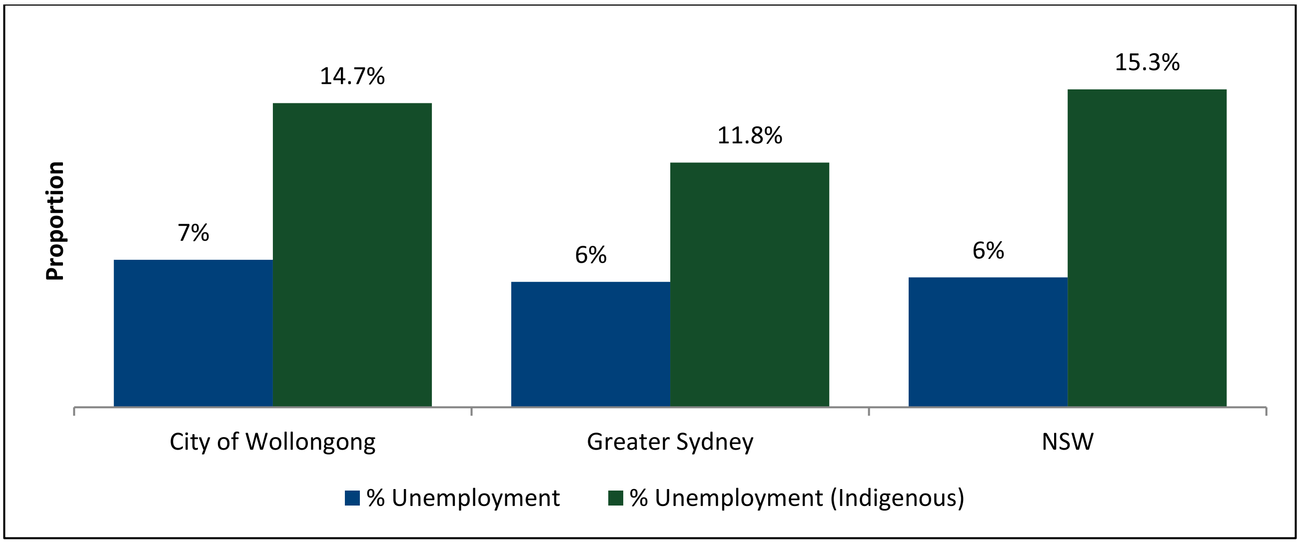

Figure 3.20 Proportion of Population Unemployed – Indigenous vs Non-Indigenous (2016)
Source: ABS Census (2016) – Community Profiles

Levels of labour force participation for those aged 15 - 85 years, i.e. the number of people who are either employed or are actively looking for work, in the City of Wollongong fall marginally below the State average (56.9% compared to 59.2%). While unemployment is significantly higher for the Indigenous population across the LGA, the labour force participation rate of the Indigenous population is comparable to the non-Indigenous population (refer to **Figure 3.21**).

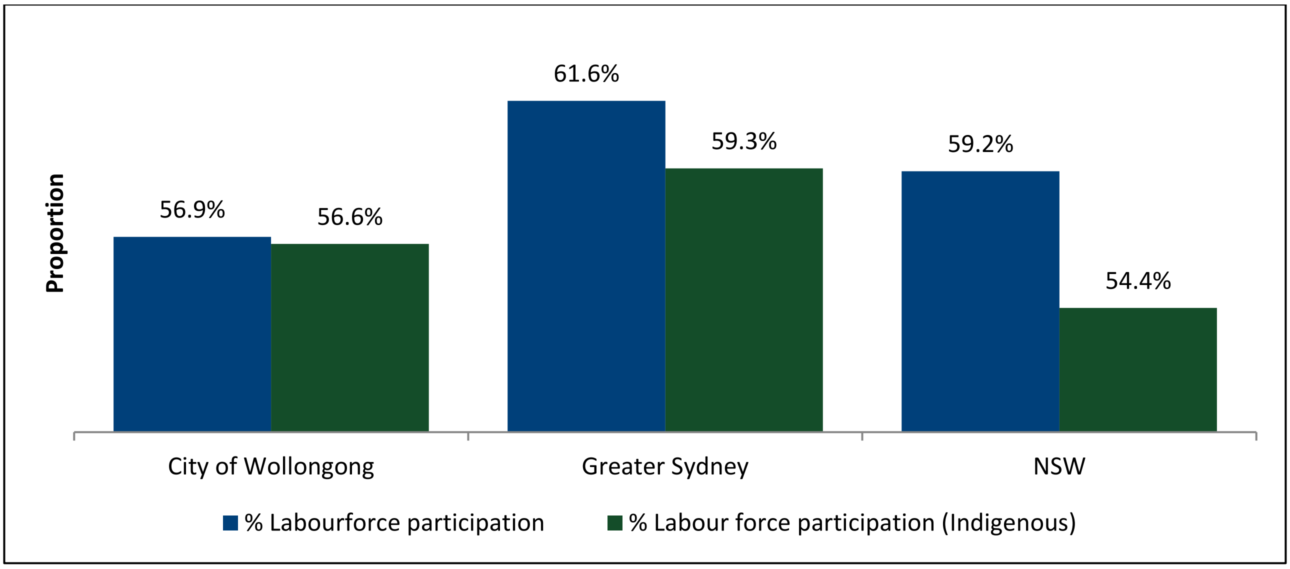

Figure 3.21 Labour Force Participation – Indigenous vs Non-Indigenous (2016)

Source: ABS Census (2016) – Community Profiles

3.3.1.2 Key Industries and Occupations

With regards to key industries of employment:

- Healthcare and social assistance are the primary industries of employment across all communities and the wider LGA (ranging between 14.6% - 15.8%).
- Education and training sectors are also significant employers in the LGA (11.8%) and in the study communities of Russell Vale (12.6%) and Corrimal (10.5%).
- Mining represents a small percentage of the industries of employment across the LGA (2.0%) and Corrimal (2.1%). However, these figures are above the state average (0.9%) (Refer to **Figure 3.22**)
- Mining represents a more significant proportion of the employment in Russell Vale (4.5%). This higher proportion may be indicative of the locally based workforce for the Russell Vale Colliery.

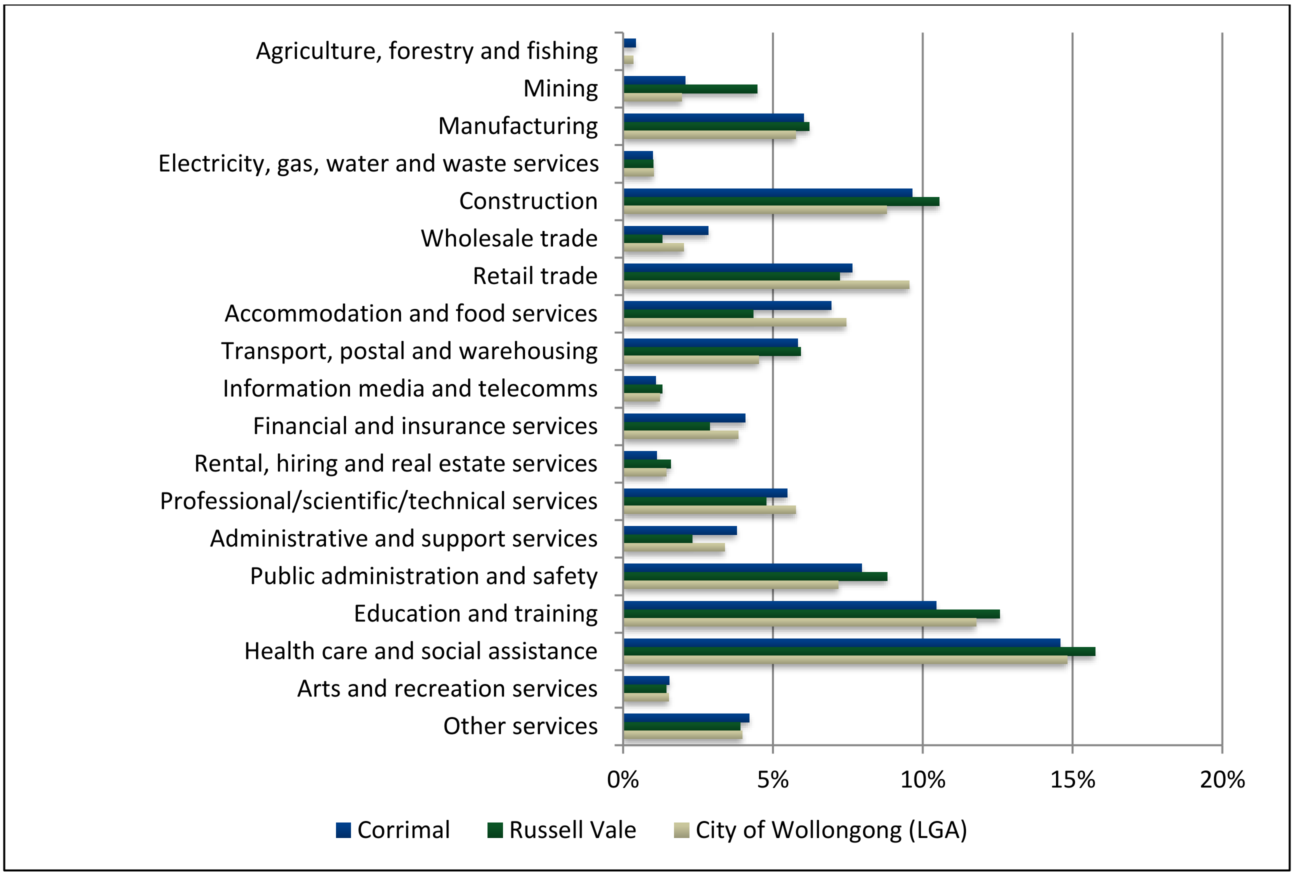

Figure 3.22 Industries of Employment

Source: ABS Census (2016) – Census of Population and Housing

Key occupations within each community are presented in **Figure 3.23** and indicate that:

- In the Wollongong Shire the primary occupation group are professionals (23.2%), followed by technicians and trade workers (14.8%).
- In Russell Vale, the primary occupation group are professionals (19.7%), followed by technicians and trade workers (18.5%).
- In Corrimal, the primary occupation group are professional (20.7%), followed by technicians and trade workers (15.2%) and clerical and administrative workers (15.2%).
- The rates of technicians and trade workers are above the NSW average (12.7%). This could be indicative of the lower education levels in the LGA.

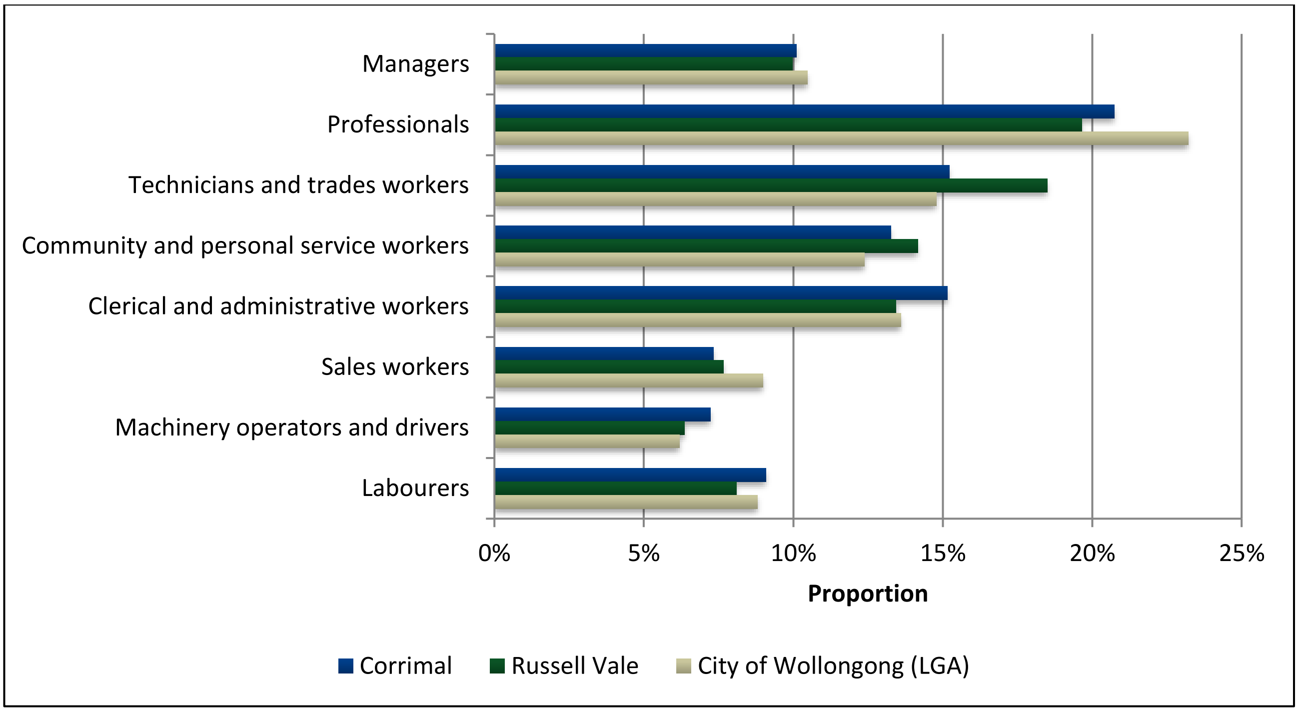

Figure 3.23 Occupations

Source: ABS Census (2016) – Census of Population and Housing

Regional employment projections[8] indicate decreases in manufacturing (-1400 jobs) and mining (-500 jobs), and increases in healthcare (+4500 jobs) and education and training (+1500 jobs) by 2020. This is reflective of the ongoing 'professionalisation' of the workforce at a demographic scale. In the context of a projected retraction within the mining industry, employment provided by the Revised Project may assist ongoing employment for those already within the sector, without the need for retraining.

3.3.2 Industry and Economic Diversity

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. The Herfindahl indices for the City of Wollongong, Corrimal and Russell Vale are 0.012, 0.011 and 0.016 respectively. The scores for all areas indicate highly diversified economies typical of urban areas, with no notable economic sensitivities.

Table 3.13 Herfindahl Index, 2016

	Russell Vale	Corrimal	City of Wollongong	Greater Sydney
Herfindahl Index	0.016	0.011	0.012	0.010

Source (ABS 2016)

3.3.3 Income, Spending and Cost of Living

For the wider LGA, Corrimal and Russell Vale, the average weekly income is less than the State average ($1,468), with Corrimal having the lowest average income ($1,230) while Russell Vale ($1,452) is more comparable to NSW.

[8]Department of Employment *2016 Employment projections for the five years to November 2020,* based on ABS projection data

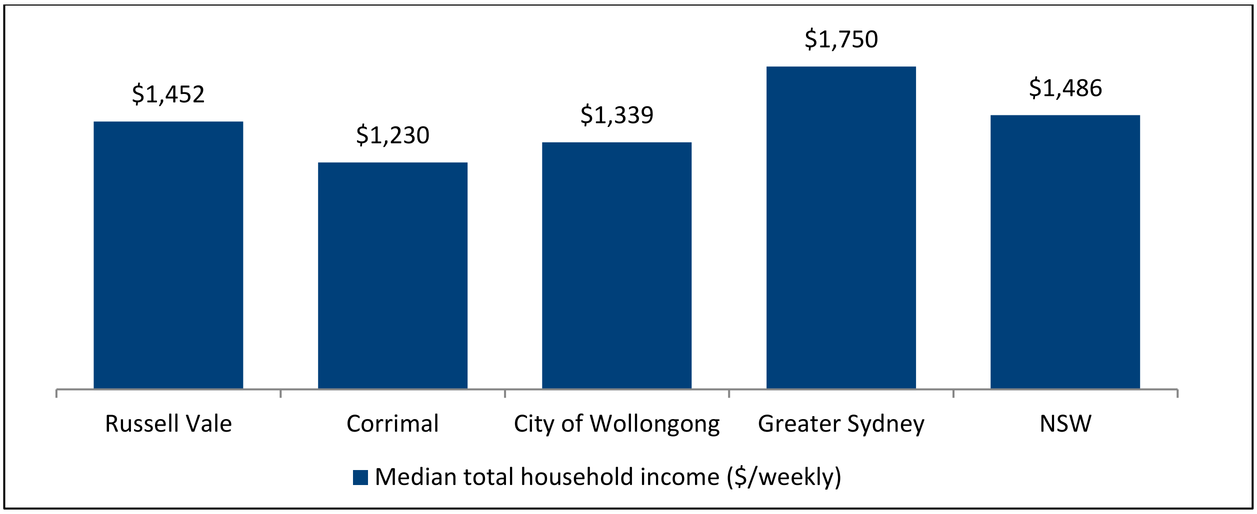

Figure 3.24 Median total household income ($/weekly)

Source: ABS Census (2016) – Census of Population and Housing

Within the wider LGA, core living expenses are marginally lower than the State average, with mortgage payments comparable to the State average, while weekly rental costs are below the State average and the average price in Greater Sydney.

When looking at time series data from 2006 - 2016, WCC area has experienced stable mortgage rates, with an increase in average mortgage repayment from 2006 - 2011, and a stabilisation of payments between 2011 - 2016.

Conversely, average rental costs have increased since 2006, a trend which has also been experienced in Greater Sydney and NSW more broadly.

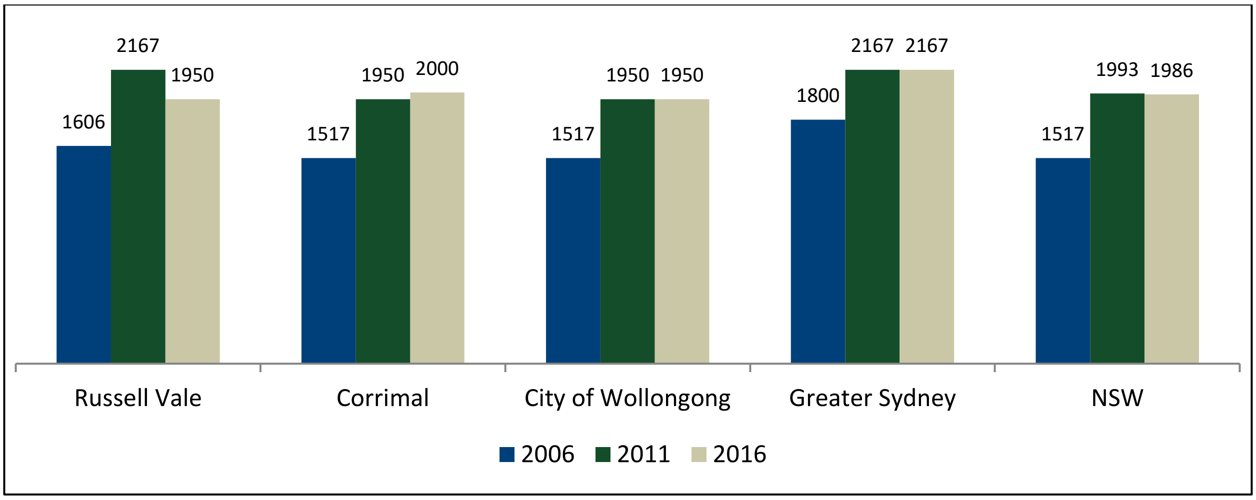

Figure 3.25 Median Monthly Mortgage Repayments - change over time (2006 - 2016)

Source: ABS Census (2016) – Census of Population and Housing.

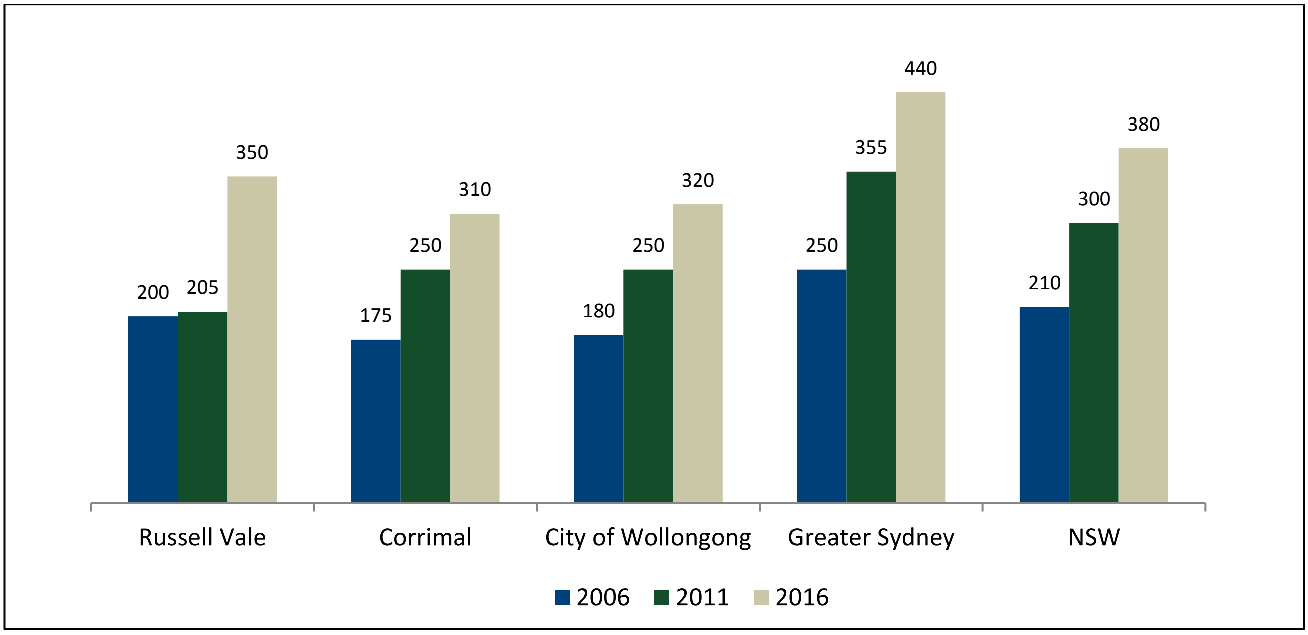

Figure 3.26 Median Weekly Rent - change over time (2006 - 2016)

Source: ABS Census (2016) – Census of Population and Housing

When compared with NSW and Greater Sydney, the City of Wollongong has a lower proportion of low-income households that are experiencing financial stress from mortgage and rental payments (i.e. those that are spending more than 30% of their income on rent or mortgage payments). Low income households are defined as households in the bottom 40% of income distribution (those with less than 80% of median equivalised income) (refer to **Table 3.14**).

Table 3.14 Financial Stress from Mortgage or Rent (2016)

Financial stress from mortgage or rent	City of Wollongong	Greater Sydney	NSW
% Low income households under financial stress from mortgage or rent	28.5	33.8	29.3

Source: PHIDU (2018) – Social Health Atlas of Australia

3.3.3.1 Local Business Profile

An analysis of local businesses present in the City of Wollongong, as of June 2017, highlights that:

- The largest numbers of businesses were engaged in the construction industry, followed by professional and scientific and technical services (refer to **Table 3.15**).
- Most businesses in the LGA are non-employing, followed by businesses with 1 - 4 employees (**Figure 3.27**).
- Most businesses had a turnover of either $200,000 to less than $2 Million annually (36.6%) or $50,000 to less than $200,000 annually (36.2%).
- Only 23 out of 12,911 businesses in the LGA were engaged in mining.

Table 3.15 Number of Businesses by Industry, 30 June 2017

Industry	Count

Industry	Count
Construction	2386
Professional Scientific & Technical Services	1688
Rental, Hiring, & Real Estate Services	1335
Health care and social assistance	1194
Financial and insurance services	1108
Retail trade	903
Other services	708
Transport, Postal and Warehousing	707
Accommodation and food services	601
Manufacturing	514
Administrative and support services	471
Wholesale trade	335
Education and training	253
Arts and recreation services	211
Agriculture, Forestry and Fishing	141
Currently unknown	129
Information media and telecommunications	121
Public administration and safety	51
Electricity, Gas, Water & Waste Services	27
Mining	23
Number of Businesses by Industry - Total	**12911**

Source: ABS 2018, 8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2013 to Jun 2017; Available http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun+2013+to+Jun+2017

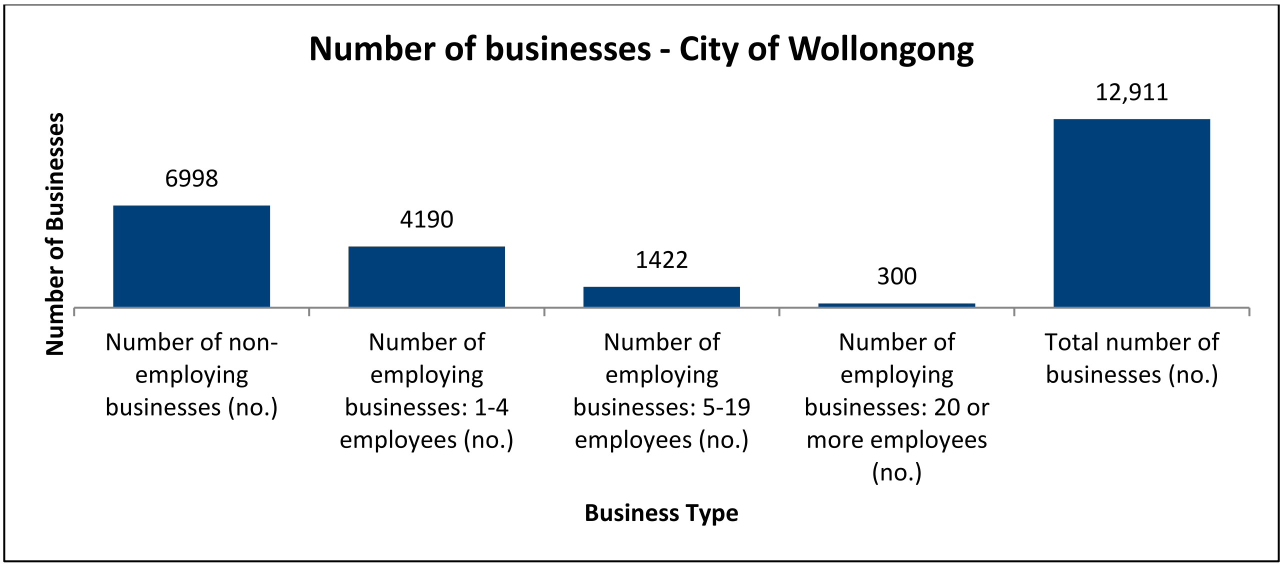

Figure 3.27 Number of Businesses in Wollongong as at 30 June 2017

Source: ABS 2018, 8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2013 to Jun 2017; Available http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun+2013+to+Jun+2017

3.3.4 Economic Capital Summary

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 the fact that the lowest scoring 10% of areas are given a decile of 1, and the highest a 10, the data indicates that:

- Corrimal has the lowest access to economic resources (cumulatively) with a lower score than Russell Vale and the wider LGA.
- Russell Vale has a score that is slightly below the LGA suggesting that it has less access to economic resources than the average for the City of Wollongong.

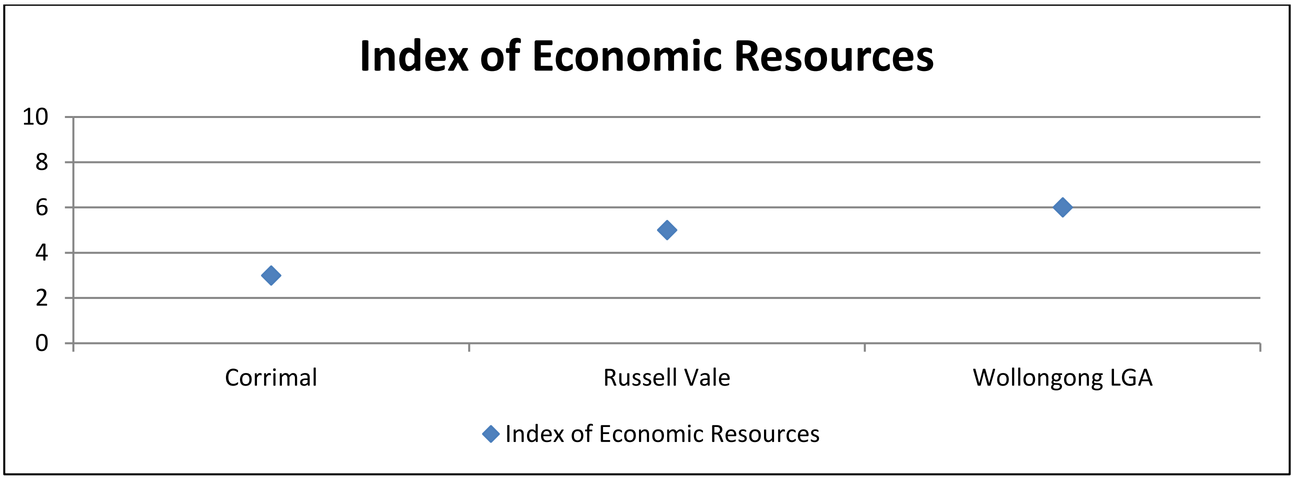

Figure 3.28 Index of Economic Resources
Source: ABS (2016) 2033.0.55.001 Socio-Economic Indexes for Australia (SEIFA), 2016

Unemployment rates across Wollongong and Corrimal are comparable to the State average, while rates in Russell Vale are below the State average and whilst unemployment has been increasing across NSW on average since 2006, it has been decreasing within the study communities.

Overall, the local areas of Russell Vale and Corrimal are considered to have reasonably robust economies, as part of the wider Wollongong economy. The higher proportion of mining industry employees in Russell Vale (refer to **Table 3.11**) is considered to correlate with data in other sections, such as certificate level education (**Section 3.1.4**) and higher median incomes (**Section 3.3.3**). Additionally, the increasing rate of workforce participation in a context of employment growth, illustrated by a more consistent unemployment rate, is considered to provide a good basis for economic projections into the future.

Healthcare and social assistance are the primary industries of employment across all communities and the wider LGA. The study communities (including the wider LGA) have higher than state average proportions of the population employed in mining, with this proportion being the highest in Russell Vale.

Mortgage repayments in Russell Vale, Corrimal and the City of Wollongong are comparable to the State average, while rental prices are slightly lower than the State average.

3.4 Physical capital

Physical or built capital includes provision of infrastructure and services to the community. Within this capital area, it is important to consider the type, quality and degree of access to public, built and community infrastructure (including amenities, services and utilities) and housing and accommodation.

A sound level of physical capital is vital to ensuring social health and well-being. For example, a highly remote community that lacks access to basic services is likely to lack the capacity to enhance its local human skills base. However, in a city most aspects of physical capital are developed to an extent that supports the development of opportunities for further industry and economic growth.

Table 3.16 provides a summary of the key physical capital indicators for Revised Project communities with further discussion regarding these indicators outlined in subsequent sections.

Table 3.16 Summary of Key Physical Capital Indicators

Key Physical Capital Indicators	Russell Vale	Corrimal	City of Wollongong	Greater Sydney	NSW
Total Occupied Dwellings (number)	546	2,584	73,953	1,623,872	2,604,314
Total Private Dwellings (number)	579	2,785	80,279	1,759,927	2,889,057
Owned outright (%)	37	36	35	29	32
Owned with a Mortgage (%)	40	30	31	33	32
Rented (%)	20	30	30	34	32
Other Tenure Type (%)	1	1	1	1	1
Average Household Size (number)	2.7	2.4	2.6	2.8	2.6
Average Number of people per bedroom (number)	0.9	0.8	0.9	1	0.9
Internet accessed from dwelling (%)	84	79	82	88	85
Travel to Work as a Driver (%)	68	69	66	53	58
Average number of cars per dwelling	1.8	1.6	1.7	1.6	1.7
Rent assistance from the Australian Government (2016) (%)	-	-	18.3	15.0	17.4
Overcrowding** (%)	-	-	3.6	6.6	5.0

Source: ABS Census (2016) – Census of Population and Housing
** % Dwellings with one or more extra bedrooms

3.4.1 Infrastructure and Services

Table 3.16 provides a summary of the key physical infrastructure present across the City/LGA.

Table 3.17 Infrastructure and Services

Category	Description
Community	A number of Community Centres both WCC and community managed offer education, social and recreational facilities. Wollongong Youth Centre offers education, advocacy and support. Wollongong Town Hall
Arts, culture and history	Wollongong Art Gallery Annual community arts festival, 'Viva la Gong'
Education	University of Wollongong, Wollongong TAFE, a range of pre-schools, primary and secondary schools, both public and private, including the High School of Performing Arts.
Emergency Services/Policing	See hospital listing in **Table 3.18**. Major emergency services presenting across the City include NSW Police, NSW SES, NSW RFS, NSW Fire and Rescue, RMS and Counter Terrorism.
Local businesses and service other facilities	Small Business Planning Team (City of Wollongong) Business Chambers (Corrimal and Illawarra)
Accommodation and tourism	Three Tourist Parks (Bulli, Windang, Corrimal) offer self-contained holiday facilities, and a wide range of hotels/motels, B&Bs and alternate accommodation across the City.
Transport	Community Transport service to eligible community groups. Buses service regions such as Figtree, Unanderra but not further afield. A night bus services the city and surrounds, and train lines run from Bondi in Sydney south through Wollongong down to Kiama.
Recreational Facilities/ Services	Russell Vale Golf Course, Beaton park Leisure Centre, Lakeside Leisure Centre
Open Spaces	Several open spaces including foreshore parks, playgrounds, public parks and gardens. 17 patrolled beaches and 9 public pools between Stanwell Park and Windang. Wollongong Botanic Garden.

Key local infrastructure and services also include:

- Local shops along the Princes Highway and surrounds in Corrimal, including Corrimal RSL, Service NSW and other government agencies, banks and community facilities.
- Nearby light industrial area located along the Princes Highway.
- Russell Vale Preschool, located at the corner of Broker Street and the Pacific Highway.
- Russell Vale Primary School, located off Terania Street to the west of the Pacific Highway.
- Aspect South Coast School, a special school for children aged 4 - 16 years with autism, located on Wilford Street, immediately south of the mine access road.
- Russell Vale Community Hall, located on Keerong Ave and adjoining Cawley Park, a locally significant recreation area. The hall and park are actively used for sport, dance and personal training groups as well as local birthday parties and events.

There is extensive community infrastructure provision, with a City of Wollongong works budget of between $13.8 - $15.6 Million annually between the financial years 2017 - 2018 and 2020 - 2021, including upgrades to some roads in Russell Vale, and a new kitchen and amenities for the Russell Vale community centre in 2016 - 2017 (WCC 2016).

3.4.1.1 Health

Table 3.18 provides a list of hospital-based services provided to residents in the City of Wollongong area. Health facilities include a mix of private and public hospitals that provide a range of acute care services.

Table 3.18 Regional Health Care Infrastructure

Facility	Services
Wollongong Hospital (Public)	Between 200 – 500 beds. Units: acute renal dialysis, alcohol and drug, bone marrow transplantation, cardiac surgery, clinical genetics, coronary, diabetes, domiciliary care, emergency, geriatric assessment, infectious disease, intensive care, maintenance renal dialysis, major plastic/reconstructive surgery, neonatal intensive care, obstetrics, oncology, paediatric, psychiatric, rehabilitation. The emergency department treats approximately 48,000 patients annually
Wollongong Hospital (Private)	Between 100 – 199 beds. Units: acute spinal cord injury, cardiac surgery, coronary care, diabetes, geriatric assessment, intensive care, major plastic surgery or reconstructive surgery, neonatal intensive care, neurosurgical, obstetric, oncology, paediatric, rehabilitation.
Shellharbour Hospital (Public)	Between 100 – 199 beds. Units: Emergency, Acute renal dialysis, Alcohol and drug, Domiciliary care, Geriatric assessment, Maintenance renal dialysis, Major plastic or reconstructive surgery, Psychiatric.
Port Kembla Hospital (Warrawong) (Public)	Between 50 – 100 beds. Units: alcohol and drug, domiciliary care and geriatric assessment, hospice care, rehabilitation.
Figtree Private Hospital	Between 100 – 199 beds. Units: coronary, intensive care, obstetric, paediatric.
Wollongong Day Surgery - Private	No information on My Hospitals. Specialties: Dental surgery, Ear/nose/throat, endoscopy/colonoscopy, eye/ophthalmology, general surgery, gynaecology/fertility, orthopaedics, plastic and reconstructive.
Illawarra Mental Health Services - Public	Fewer than 50 beds.
Bulli Hospital (Bulli) -Public	Between 50-99 beds. Units: Emergency, alcohol and drug, domiciliary care and geriatric assessment.
Lawrence Hargrave Private Hospital (Thirroul)	Between 50 – 99 beds. Units: Rehabilitation, medical, palliative.
Coledale Hospital Public	Fewer than 50 beds. Units: alcohol and drug, domiciliary care, rehabilitation and geriatric assessment.

Source: My Hospitals (2018); NSW Health (2018)

Table 3.19 shows that the City of Wollongong area has lower rates of residential care places (per 1,000 population aged over 70 years). With an increase in the aging population, as identified in the human capital section, this shortfall makes the elderly population in the City of Wollongong area a more vulnerable group. Without the support provided by residential care facilities, issues such as social isolation and accessibility are likely to hinder the well-being of Wollongong's elderly population and increase demand for accessible and relevant infrastructure.

Table 3.19 Residential care places per 1,000 population aged 70 years and over (June 2016)

Aged Care Facilities	City of Wollongong	Greater Sydney	NSW
Residential care places per 1,000 population aged 70 years and over	79.9	84.2	83.4

Source: PHIDU (2018) Social Health Atlas of Australia

3.4.2 Transport

Wollongong is well connected to Sydney and other national and international hubs through major roads and rail networks. The following outlines the key transport infrastructure in the City of Wollongong:

Port Kembla: Port Kembla is a key infrastructure asset for the City of Wollongong and NSW more broadly and an economic driver in the Illawarra region. Port Kembla is the home to the state's largest motor vehicle import hub and grain export terminal and is the second largest coal export port in NSW. The port handles a range of dry bulk, bulk liquid and general cargo.

Public transport networks: Wollongong has a comprehensive and convenient public transport network which includes buses and trains that provide access to suburbs within the City of Wollongong but also to other locations within the LGA. These services also offer night transport options. Wollongong is also well connected to the Sydney Rail networks.

Airports: Sydney airport is within 1-hour drive of Wollongong, or a 2-hour train ride. Illawarra Regional Airport is located approximately 18 km south of Wollongong in Shellharbour LGA but has no current public passenger services.

Princes Motorway: Princes motorway is a predominately dual carriage un-tolled motorway that links Wollongong to Sydney and Southern areas of the Illawarra region. The emergence of Wollongong as a commuter city of Sydney has kept the freeway and the adjacent Mount Ousley Road busy and congested at times.

3.4.3 Housing

In terms of housing structure, the City of Wollongong has comparable rates of separate dwellings with NSW (64% compared with 60% in NSW), but higher than Greater Sydney (53%).

Russell Vale has a higher proportion of separate dwellings and higher rates of home ownership (both owned outright and owned with a mortgage) than Corrimal which is more consistent with the wider LGA (refer to Table 3.20). This is consistent with a less transient community in Russell Vale, as identified in **Section 3.2.1.**

Table 3.20 Housing indicators

Housing indicator	Russell Vale	Corrimal	Wollongong
Total Dwellings (number)	579	2,785	80,279
Proportion of separate houses (%)	74	58	64
Owned outright (%)	36.81	36.49	34.79
Owned with a mortgage (%)	39.74	29.64	31.15
Rented (%)	20.15	29.64	30.26
Other tenure type (%)	0.55	1.28	0.92

Source: ABS Census (2016) – Census of Population and Housing

The lower rental rates in Russell Vale in 2016 could be connected to the fact that less rentals that were available through real estate agents (43% compared with 55 - 58% in Corrimal and Wollongong), with only minor differences in rates of rentals through Housing NSW or other providers (see Table 3.21).

Table 3.21 Rental providers

Rental provider	Russell Vale	Corrimal	Wollongong
Real estate agent (%)	43	58	55
State or territory housing authority (%)	30	22	24
Person not in same household (%)	23	13	16
Housing co-operative/community/church group (%)	5	4	2
Other landlord type (%)	0	1	2
Landlord type not stated (%)	0	2	1

Source: ABS 2016 Community Profiles

Average household size in Russell Vale and the City of Wollongong are comparable to the State average, while in Corrimal the average household size is below the State average (refer to **Figure 3.29**). In addition, the City of Wollongong had a lower proportion of dwellings that need 1 or more extra bedrooms, indicating that overcrowding is not common across the City of Wollongong (refer to **Figure 3.30**). This could be as a result of a larger proportion of separate dwellings available across the City of Wollongong.

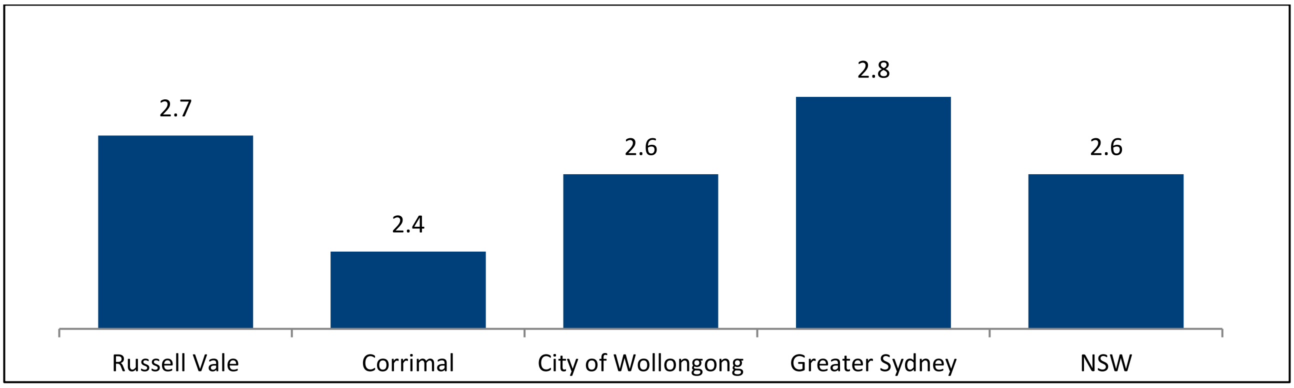

Figure 3.29 Average Household Size (2016)

Source: ABS Census (2016) – Census of Population and Housing

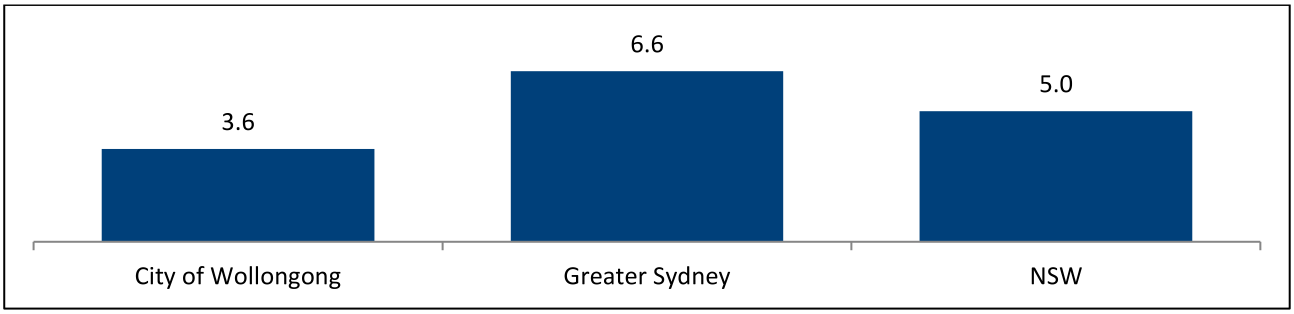

Figure 3.30 Overcrowding

ABS Census (2016) – Census of Population and Housing

Housing prices in Russell Vale and Corrimal have demonstrated an increase since 2009. Unit prices have also increased in Corrimal (data is not available for the unit prices in Russell Vale).

- In Russell Vale house prices have nearly doubled since 2009, from $399,000 - $765,000 (2017). Although between 2016 - 2017 prices have decreased slightly (from $770,000 - $765,000) (refer to **Figure 3.31**).
- In Corrimal house prices have more than doubled since 2009, from $380,000 - $799,000 (2017). Similarly, unit prices have also increased over this time from $295,000 (2009) - $518,000 (2017) (refer to **Figure 3.32**).

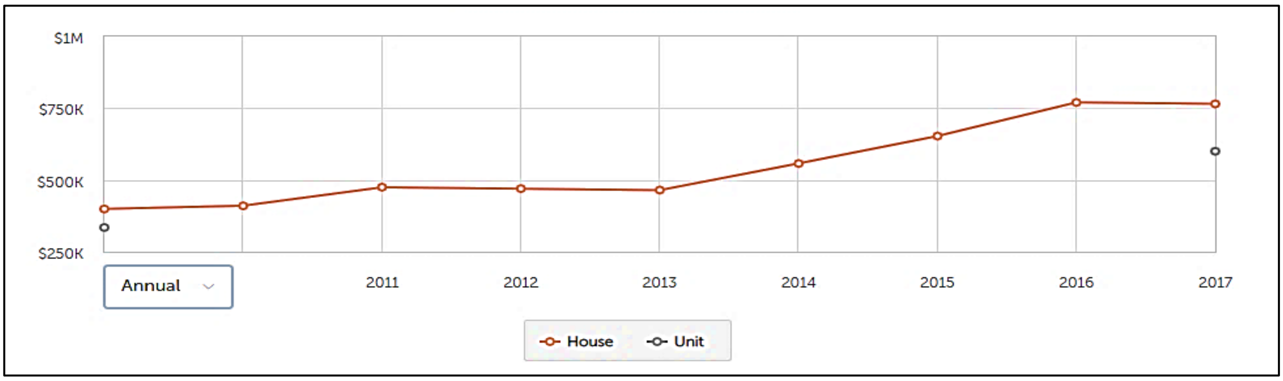

Figure 3.31 Russell Vale NSW Housing Price Trends (2009-2017)
Source: RealEstate.com

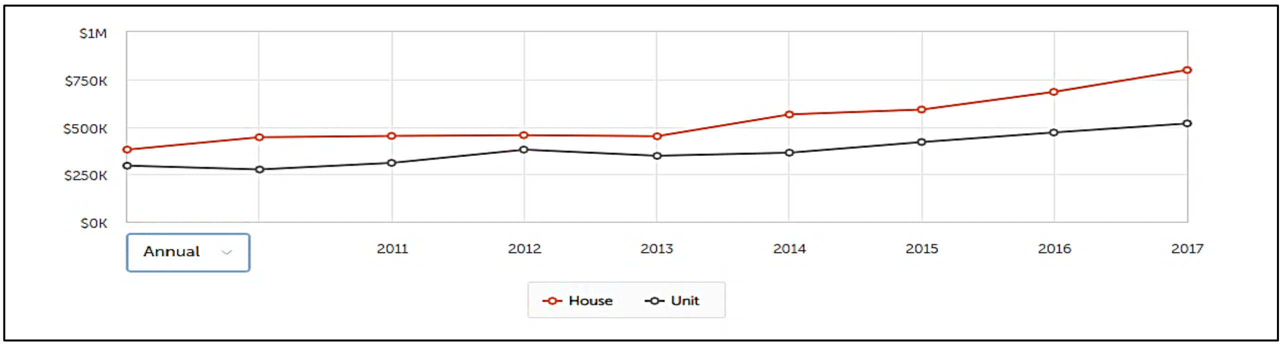

Figure 3.32 Corrimal NSW Housing Price Trends (2009-2017)
Source: RealEstate.com

3.4.4 Physical Capital Summary

Wollongong has a range of services and infrastructure that are indicative of a small urbanised city. WCC has key road and rail networks providing access to Sydney, Canberra and other places in the State. Locally, analysis is indicative of sufficient physical capital to sustain the livelihoods of those who reside there. This includes the presence of linear infrastructure, health and education service provision, and other community infrastructure such as halls and parks.

The City of Wollongong however does have low rate of residential care facilities (per 1,000 population aged over 70 years), this is likely to become more important as Wollongong has been identified as having an aging population.

In terms of housing, separate houses are the most prominent dwelling structure across the LGA as well as in Russell Vale and Corrimal. Russell Vale also has higher rates of home ownership, and lower levels of rentals than Corrimal or the City of Wollongong.

Across the communities and the wider LGA there are comparable levels of cars per dwelling to the State average, however a higher than State average proportion of the population in these areas use cars to get to work.

3.5 Natural Capital

Overall, there is a generally high level of natural capital within the local area. Noting the proximity of highly valued natural places to the urbanised areas of the Illawarra; the local community is sensitive to potential for impacts to the natural capital of the area. This means that the potential for technical impacts as a result of mining (for example surface cracking, surface or groundwater impacts and creek/beach pollution) are likely key areas for community and stakeholder concern.

WCC Environmental Sustainability Strategy 2014 - 2022 states:

> *Wollongong is a place of natural beauty and ecological diversity. Bordered by sandy beaches and flanked by the sharp rise of the Illawarra Escarpment, visitors and residents alike enjoy its many bushland and beachside attractions. We want to ensure that as Wollongong grows, the natural areas which make it unique are looked after and the community's quality of life continues to improve.*

The strategy also identifies the variety of natural assets present in the region:

> *There is approximately 2100Ha of natural area on community land in the Wollongong LGA and less than 5% of this is under active management (via contract or Bushcare restoration sites). Approximately 45% of the LGA is covered by forest or woodland vegetation and there are 12Ha of wetlands with make up less than 1% of all vegetation types in the LGA.*

Protecting the natural environment is a key focus area for the Illawarra Shoalhaven Regional Plan and the Our Wollongong 2028 Community Plan, suggesting that residents and visitors enjoy the natural assets of the area, not just for their intrinsic value but also their recreational and tourism values.

The WCC is biologically diverse and contains a high number of ecological communities (17), native plants (29 species) and animals (80 species) that are listed in the *NSW Threatened Species Conservation Act 1995*.

WCC is home to a range of natural assets, as noted below:

- **Port Kembla:** Seaport with a long history of industry use particularly coal, as in 1883 a port was opened to ship coal brought from the mine at Mount Kembla. Today the port is a major export location for coal mined in the Southern Coalfields, including that from the WCL operations.

- **Lake Illawarra:** a large coastal lagoon located between the Illawarra escarpment and the Pacific Ocean, which contribute a mix of fresh and salty water to the lake. The lake (16 kms from the site of the Revised Project) is popular for recreational fishing, prawning and sailing with 13 boat ramps around the edge. The Lake is approximately 9.5 km long and 5.5 km wide, with an area of 33 km^2 and a maximum depth of 3.7 m. There is also a natural gas-powered Power Station on the western shore (VisitNSW 2018).

- **Sandstone plateaus:** Values of 'naturalness' extend to the sandstone plateau to the west of the urbanised Wollongong/Illawarra region. The highly incised sandstone plateau is part of the Sydney drinking water catchment and holds numerous conservation areas, including the Illawarra Escarpment State Conservation Area. The geography, presence of coastal upland swamps and high Aboriginal cultural values of the plateau mean this is a very highly valued natural area. The high values placed on the plateau and the natural features were prominent areas of value for community groups and areas of concern in relation to the impacts of previous project proposals.

- **Illawarra Escarpment State Conservation Area**: 300-million-year-old rock formation comprising sandstone cliffs and a range of vegetation types, including many plant communities that are rare or restricted to the Illawarra region. In addition, the park is home to 12 threatened animal species and contains quality habitat for threatened fauna. The park is also a popular recreation spot for hiking, bird watching, picnicking and walking. Landscape is also culturally significant to Indigenous and European heritage (NPWS 2018; OEH, 2011).

- **Coal Resources and mining heritage:** The Illawarra region is rich in natural coal deposits. The area has a long history of coal mining with the first coal discovery in the Illawarra occurring in 1797, and first mining operations commencing in 1849 (WCC 2006).

- **Coal Seam Gas**: More recently Coal Seam Gas (CSG) exploration has caused concern within the local community, with WCC advocating for increased consideration of potential impacts to surface and groundwater resources.

- **Dharawal National Park:** situated between the Illawarra Escarpment and the Georges River, north-west of Wollongong, Dharawal is an important site for the Dharawal Aboriginal people. It is also significant for its biological diversity, as it contains extensive upland swamps, that comprise some of the highest species-rich values in the world and which characterise a large proportion of the reserves. It is also home to around twenty endangered or vulnerable fauna species including the Koala and Eastern Pygmy Possum. The park is also used for recreation (NPWS 2018; OEH, 2006).

- **Garawarra State Conservation Area:** On the border of Royal National Park near Sydney, Garawarra State Conservation Area is a peaceful spot with scenic waterfalls ideal for bushwalking, mountain biking, horse riding and picnicking. An important purpose of the area is to protect rainforest in the upper catchment of the Hacking River as an important link between the rainforests of Royal National Park and those of the Illawarra Escarpment and Sydney Water catchment areas to the south and south-west (NPWS 2018; OEH, 2000).

- **Cordeaux Dam:** Featuring Egyptian inspired architecture, the Cordeaux dam is surrounded by picnic grounds and several lookout spots making it popular with tourists and locals for bushwalking and picnicking. Cordeaux is one of four dams that make up the Upper Nepean water supply scheme south of Sydney on the Illawarra Plateau (WaterNSW 2018).

- **Local beaches:** Local beaches are highly valued and regularly used public spaces. Beaches are often valued for their 'naturalness' and cleanliness. A key local beach is Bellambi Beach, with notable recreational values for boating and fishing. *It was noted through the media review that WCL was fined in September 2015 as a result of coal fines entering Bellambi Creek, which flows to the beach.*

3.6 Summary of Capitals Analysis

In summary, the City of Wollongong and study communities can be categorised as outlined in **Table 3.22**.

Table 3.22 Summary of Capitals analysis – Wollongong

Capital	Key Findings
Human Capital	• Aging population. • Population growth, with population projections identifying growth in post-retirement age groups. • Due to the aging population there are increased levels of disability and a higher proportion of the population that are receiving the pension. • Lower rate of secondary education in the LGA, while rates of post-secondary equivalent are comparable to the state. • Growth in the proportion of the Indigenous population.

Capital	Key Findings
Social Capital	• Relatively low mobility. • Primarily families with children. • Low proportion of the population with a poor proficiency in English.
Economic Capital	• Unemployment rate has decreased since 2006. • Weekly household incomes in Russell Vale, Corrimal and the LGA are lower than State average. • Mortgage repayments across all communities are comparable to the State, while rental prices are slightly lower. Similarly, mortgage repayments have remained relatively stable while rental prices are increasing. • Corrimal is seen as the more economically disadvantaged when compared to Russell Vale and the wider LGA.
Physical Capital	• City of Wollongong is well serviced in terms of health, education, community, visitor and transport infrastructure. • Elderly population identified as a vulnerable group due to limited availability of aged care infrastructure and facilities. • Housing is primarily separate houses. • Russell vale has a higher proportion of home ownership when compared to Corrimal and the wider LGA. • House prices are increasing across the communities.
Natural Capital	• The area's rich natural assets are seen as a significant draw card and feature of the area. • The area contains a range of parks and bushland which are home to a variety of threatened or endangered species. • Coal deposits, river systems and the sea port have shaped the industrial and community development of the area.

Key considerations identified in the profile include:

- Mining has been, and continues to be, a key part of the local and regional economy, through employment, local contracting and flow on expenditure. There is no notable strategic planning at a regional or council level in relation to mining development in the next 5 - 10 years.
- The Russell Vale and Corrimal communities, as part of the wider Wollongong community and Illawarra region, are considered to have high levels across all the sustainable livelihood capitals. No weaknesses or risks identified within the community profile are of such a magnitude to cause serious concern.
- The Natural Capital of the area is of high importance to the local, regional and wider community. In relation to the Revised Project this is played out in the interplay between the efficient extraction of coal resources, potential (and previously experienced) impacts to the values associated with the 'naturalness' of the area, including the presence of water courses within the Sydney drinking water catchment; and a cognisant and active local community.
- Issues that may arise for the project include air quality (dust), noise, water quality, traffic and road issues, or proximity to particular facilities as noted below.
- A range of key locations and areas of importance to the community were also identified. These include:
  - Local schools, including the Aspect South Coast School.
  - Russell Vale community Hall, Russell Vale Public School and neighbouring Cawley Park.
  - The Grand Escarpment Walk and escarpment more generally due to its high environmental values.

- The Sydney drinking water catchment, including the Cataract Dam and surrounding waterways.
- Bellambi Beach.

3.7 Public Interest Issues

A review of media relating to the Illawarra region over the past 5 years has been undertaken to identify any particular issues or items of concern in relation to mining in the region more broadly, and with regard to WCL's operations specifically. The summary highlights a range of media coverage from the previously proposed Project, speculative and ongoing coverage of the current operation, particularly from a financial viability perspective, and reflects the broad external interest in the natural features of the area and mining activities generally. This summary is presented in **Appendix A**.

There were two ongoing news stories in local and regional media with repeat coverage in the study communities. The first of these were with regards to asbestos contamination of a Russell Vale housing subdivision with stories on the topic running between May 2015 and July 2018 in local ABC online news and the Illawarra Mercury. The second story concerned the implementation of a government-funded trauma project for Syrian refugees in Russell Vale and ran throughout May 2018 in the Illawarra Mercury and the St George and Sutherland Shire Leader.

Other one-off articles specific to Russell Vale included two articles describing local community events, namely the Wollongong Walk4BrainCancer charity event (11/11/2018) and the Lord Mayor's Picnic in the Park (4/11/2018).

Common issues emerging from the review of media specifically relating to WCL and the Revised Project are further detailed below.

Environment

The interplay between the natural environment of the area and mining activities is a common issue present within the media reviewed. This primarily relates to the effective extraction of coal resources in the area and the consequent potential and actual impacts of longwall mining and mine runoff on water courses and natural landscapes. In particular, there are several articles around the delayed removal of waste coal stockpiles from the Russell Vale mine site, and issues with drainage management works at Bellambi Creek, following the discharge of dirty water into the creek from the Russell Vale operations.

Finance/economy

In relation to economic sustainability, media (as typified within various articles in the Illawarra Mercury between 2014 - April 2015), has followed key changes at local mining operations, including Russell Vale and Wongawilli Collieries. Changes include the reduction of workforces with decreasing extraction rates, operations being put into care and maintenance and changes from employee to contract labour.

Later articles in the Illawarra Mercury (between 2016 - 2019) have focused on analysis of company reports of financial losses and troubles, with many reporting on legal proceedings brought against WCL by government agencies. Other reporting has focused on ongoing updates around planned reopening of the Russell Vale mine and accompanying analysis of employment strategies.

In contrast, a proportion of media also acknowledges the positive financial input of WCL into the community, particularly in regard to specific community contributions.

Governance

In relation to operational and council governance, media has reflected the flow-on fluctuations in social support occurring from decreasing/closing and ongoing mining operations. It has provided a forum for community groups, especially environmental groups, to present opinions and perspectives. These typically relate to negative perceptions of government and company management of mine-related issues. Other media discusses changes in management strategies of safety and community issues, in an attempt to limit injury and alleviate community concerns. More recently in 2019, reports regarding the closure of the Wongawilli operation and inflated mine valuations have also appeared in local media.

Social License to operate

Matters relating to social license to operate include all those mentioned above, particularly in regard to the financial position of WCL and environmental concerns raised by community and the EPA around tardiness to meet requirements. Other matters within the media include the use of existing mining infrastructure, such as the inability for operators to secure the appropriate modification approvals to undertake continued mining activities; the subdivision of mine-owned land for residential purposes; and a local council member's concern over mine ownership of the local golf-course. Other concerns raised relate to truck movements and road impacts.

3.8 WCC Visioning and Planning

This section summarises the outcomes of a review of relevant WCC Strategic Plans and documents to highlight the visions, challenges and opportunities relevant to the Wollongong City region.

WCC documents that have been sourced for this review include:

- Our Wollongong 2028 Community Strategic Plan 2018
- Economic strategy 2013 - 2023

In addition, the DPIEs *Illawarra Shoalhaven Regional Plan 2015* has also been reviewed.

In 2018, WCC conducted extensive community engagement in the development of its strategic plan 'Our Wollongong 2028'. During this community engagement process, 1,026 community members participated. Engagement involved a community satisfaction survey (608 people); neighbourhood forums (92 people); 90 primary school students; 131 community residents engaged through community kiosks and a program called Wishes for Wollongong (where residents were asked to make a 'Wish for Wollongong' and identify what they would like Wollongong to look like in 10 years). Further groups engaged included councillors, council staff and state representatives; representatives of the University of Wollongong and the business community.

Newsletters, community flyers and social media posts were also included in providing information in relation to the process. The engagement program resulted in the identification of a range of community aspirations which have been reflected in the goals of the strategic plan and which outline WCC priority areas and objectives for 2018 through to 2028 (refer to **Table 3.23**).

Table 3.23 Our Wollongong 2028 Goals and Community Identified Challenges

Our Wollongong 2028 Goals	Community Identified Challenges
We value and protect our environment	Environment and Climate Change Waste management Renewable energy Green spaces

Our Wollongong 2028 Goals	Community Identified Challenges
We have an innovative and sustainable economy	Population growth and management Financial sustainability The economy, employment and local jobs Low-rise buildings, development and urbanisation
We have a creative, vibrant city	Effective public relations and good planning
We are a connected and engaged community	Homelessness and advocacy
We have a healthy community in a liveable city	Health and ageing population Affordable housing Maintenance of Community facilities
We have affordable and accessible transport	Roads, traffic and infrastructure Transport, parking and connectivity

Source: Wollongong City Council. 2018. *Our Wollongong 2028*
http://www.wollongong.nsw.gov.au/council/publicdocuments/Documents/Our%20Wollongong%202028%20Community%20Strategic%20Plan.pdf

Our Wollongong 2028 also considers the *Illawarra Shoalhaven Regional Plan 2015*, a 20-year plan with the broad goals of:

- Developing a prosperous Illawarra-Shoalhaven.
- Providing a variety of housing choices, with homes that meet needs and lifestyles.
- Creating communities that are strong, healthy and well-connected.
- Making appropriate use of agricultural and resource lands.
- Cultivating a region that protects and enhances the natural environment.

Our Wollongong 2028 aligns with regional priorities in relation to fostering the national competitiveness of Wollongong metropolitan area in relation to jobs and housing; developing Port Kembla as an international trade gate; facilitating greater economic diversity in priority growth sectors; growing strategic assets; supporting industrial activity; and facilitating economic self-determination of Aboriginal communities.

The WCC identifies in *Our Wollongong 2028* and the *Economic Strategy 2013 - 2023* a range of industries which are currently experiencing strong growth namely: tourism, health, disability and aged care, ICT/knowledge services, education and training, aviation/defence, creative industries and advance manufacturing, clean technologies, mining technology and services, and freight and logistics.

The WCC economic development unit also identifies several significant projects for development in 2013 - 2023, which include:

- Revitalisation of the CBD – Crown Street Mall, GPT shopping complex, office accommodation.
- West Dapto land release – anticipated to provide an additional 17,000 dwellings that will house approximately 50,000 people.
- 'Innovation Campus' and R&D technology precinct focussing on mining services, health and sustainability and innovative materials.
- Kembla Grange - earmarked as a key employment zone with expansion planned for additional manufacturing, a business park and service industries. The zone will support the expansion of the NSW Ports Port Kembla operation.

- Tallawarra Business Park, Lake Illawarra – a multipurpose employment/tourism zone, proposed to include residential land, open space and environmental conservation land.
- Expansion of Port Kembla, which is managed by NSW Ports on a 99-year lease. Redevelopment of the Ports Outer Harbour (stage 1 was completed in 2012 and development is continuing).

It is recognised that the region's proximity to Sydney is both positive and problematic for WCC. While Sydney is a source of tourism and employment, it also acts as a drain on Wollongong by increasing housing prices, drawing workers out of the City of Wollongong and decreasing interest in investment within the region.

WCC has a range of activities to meet the strategic goals outlined in their *Our Wollongong 2028* strategy. **Appendix B** provides a list of the activities proposed to deliver the outcomes related to each broad strategy area.

Table 3.24 also summarises the key factors that may both facilitate (opportunities) and inhibit (issues and challenges) change within the region.

The issues and opportunities listed below have been sourced from WCC and regional strategy and planning documents, and through a review of demographic data.

Table 3.24 Wollongong Governance Challenges and Priorities

Issues and Challenges	Theme	Opportunities/Facilitating Factors
Pockets of social disadvantage	Social	Disability Inclusion Plan is being implemented by the WCC (includes focus areas such as transport, infrastructure, access, employment and awareness).
Poor external image of Wollongong due to its industrial past and perceptions of low socio-economic status		Promoted as a liveable city, recent increase in arts and cultural events. Thriving cultural and creative industry.
High social cost of DIDO workers that live in the region but commute out of the region work		Connected and engaged community. Increased sense of community.

Issues and Challenges	Theme	Opportunities/Facilitating Factors
Population drain to Sydney, losing youth for education and employment	Human	Presence of University of Wollongong promoted as one of the top Universities in the World. Multiple TAFE campuses.
Ageing population		Older population provide a range of benefits to the community (unpaid childcare or other forms of care, volunteer work). Wollongong seen as a good place for older people to live.
High youth unemployment	Economic	Services directly targeting youth training, employment and education (Wollongong Youth Services, Illawarra Shoalhaven Youth Employment Action Plan).
High unemployment among unskilled workers **Lack of entrepreneurs and new business start ups** **Economy still reliant on traditional sectors**		Economy is shifting from industrial to service industry focus. Diverse industry base within the LGA. Wollongong continues to expand as a place of learning. Expanding and improving the profile of Wollongong as a regional City of the Illawarra.
Rising housing prices	Physical	Strategies in place to decrease the proportion of households experiencing mortgage/rental stress through providing more diverse housing opportunities.
Lack of A grade office space		Innovation Campus at University of Wollongong provides office space to (non-university) businesses. Opportunity to develop commercial spaces within the CBD, Kembla Grange and West Dapto.
Access to telecommunications is inconsistent		Information and communication technology is a key research focus areas for the University of Wollongong.
Transport infrastructure and parking facilities not keeping up with demand and population growth		Existing connections by rail and major arterial roads. Region is a key focus area for future transport infrastructure (airport, major freeways). Community transport options for frail older people, people with disabilities and the transport disadvantaged are actively promoted and available.
Potential Waste management issues as population increases and consumption increase		Wollongong Waste and Resource Recovery Park has been upgraded to improve functionality. Wollongong Botanic Garden Discovery Centre hosts composting workshops.
Degradation of natural assets by development/natural disaster	Natural	Opportunities to preserve natural environment and increase or improve greenspace within the City.
Flooding issues due to being located between the escarpment and the sea		Unique natural environment seen as important to the community.

Source: *Our Wollongong 2028 Community Strategic Plan 201;* Illawarra Shoalhaven Regional Plan 2015; Economic strategy 2013-2023; Aging Plan 2018-2922; Illawarra Shoalhaven Youth Employment Action Plan 2016.

4.0 Stakeholder Issues and Opportunities

This section considers the outcomes of the engagement with community and other stakeholders relevant to the Revised Project. Stakeholders engaged include residents nearby to the site from the Russell Vale and Corrimal areas, local businesses and groups, community organisations and other stakeholders as summarised in **Section 2.4.**

As discussed in **Section 2.4**, there were two distinct phases of stakeholder engagement undertaken as part of the Revised Project. During the first phase, 44 individuals were consulted via 34 interviews/meetings. These interviews included:

- 27 with neighbouring and nearby landholders;
- 7 with local businesses and special interest groups (i.e. education, and community).

During the second phase of engagement, engagement activities have included:

- Targeted meetings with key local community organisations (i.e. the IRRM and the KNAG;
- Community Information Session - with 67 attendees that included WCL employees, residents from proximal suburbs (i.e. Russel Vale, Corrimal, Woonona and Bellambi), interested Illawarra residents, members of the CCC, the IRRM and the KNAG.

The issues and concerns identified via the engagement process are presented in this section. This section also includes perceptions of WCL generally and the Russell Vale operation specifically. During engagement activities, participants were also asked about potential mitigation measures to address perceived issues, these are further described in **Section 4.1.3**

4.1 Community concerns and opportunities with the Project

Issues and concerns of importance to the community relevant to the Revised Project, have been identified through analysis of materials from the previous UEP PAC processes and through direct engagement with potentially affected stakeholders (refer to **Section 2.4**)

4.1.1 Submissions received during PAC hearings

There have been two PAC review hearings for the Revised Project. The first hearing was held on 3 February 2015, with the second held on 8 December 2015. Submissions were received from public authorities, special interest groups and the general public.

A total of 88 submissions were received across both hearings (45 submissions at the initial PAC meeting and 43 at the second). Of the submissions received, 53% supported the project, while 46% opposed the Revised Project. The main impacts/issues raised by stakeholders included: subsidence, surface and groundwater water, air quality, traffic, biodiversity, noise, aboriginal heritage, compliance record of the company and general health and wellbeing issues.

Table 4.1 Top six issues identified through PAC Meetings and Submissions

Initial PAC	Second PAC
The approval process	The WCL reputation
Noise (traffic and pit top related)	Health impacts (from particulate matter)
Socio-economic impacts	General plan concerns (scope creep, consideration of regional plans

Initial PAC	Second PAC
Water resources (drinking)	Economic considerations
Upland swamps	Water resources
Air quality and greenhouse gas emissions	Amenity impact

4.1.2 Issues and Opportunities Relating to WCL

As part of the engagement process for the Revised Project, all participants were asked a range of questions that related to their perception of WCL, their history with the Russell Vale mine operation, perceived issues/impacts of the Project and suggested mitigation measures.

The following sections outline the results of this aspect of the engagement.

4.1.2.1 Perception of WCL

More than half of the participants in the first phase of engagement (18 out of 34) reported that they have had some contact with WCL either with the previous (n=11) or the current owners (n=7).

Discussions with engagement participants suggest largely negative views of the company, with more than half of the participants (17 out of 34) noting a negative response when asked about what comes to mind when WCL is mentioned. Only three interviews included top of mind associations of a positive nature (**Figure 4.1**).

These negative views were further highlighted during the second phase of engagement as a result of discussions with members of the IRRM, the KNAG and in a letter submitted by a Russell Vale resident to Umwelt via email.

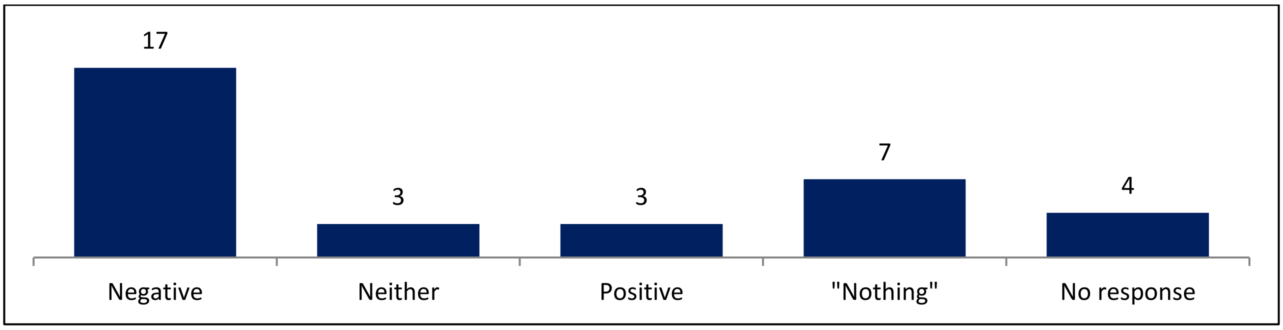

Figure 4.1 Phase 1 - Top of mind associations with WCL (frequency)
© Umwelt, 2018

Examples of some of the comments provided included:

"They are a good company. It's a good opportunity."

"The name is deceptive; it gives the impression of being local when it's not."

"Untrustworthy, they want to mine with poor standards"

4.1.2.2 Experience of Russel Vale Operation

Negative sentiment in responses were also evident when engagement participants (phase 1) were asked to comment on their perceptions of the history of the Russell Vale operation in the community, with almost half of those interviewed providing responses that indicated an opposition to the operation (n=14) (refer to **Figure 4.2**).

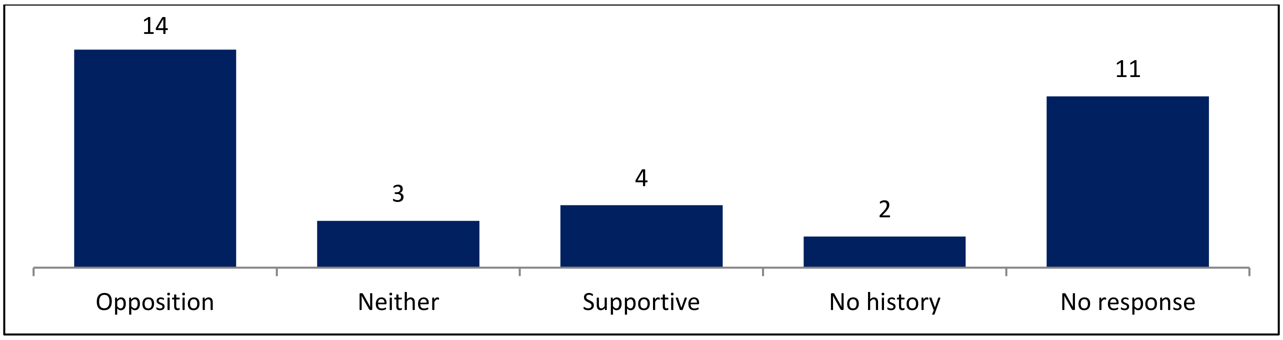

Figure 4.2 Phase 1- Community history with site (frequency)

Examples of the comments made in relation to the history of the operation in the community included:

"Long history of support"

"Need additional business, we are a mining town."

"There has been a definite improvement during care and maintenance. Now there is no dust or noise."

"They didn't address issues in a satisfactory way."

"Their dirty coal gets into Bellambi Creek."

"The media around the company has been concerning."

"The mine is an appalling idea; the escarpment and the landscape are precious."

"It has been heaven without the mine operating."

"Coal mining in residential areas should be a thing of the past."

4.1.3 Issues and Impacts of the Revised Project

Participants in phase 1 engagement activities were asked to identify any issues or impacts in relation to the Revised Project. Responses were categorised into 37 different social impact categories and 6 overarching impact themes that included:

- Operational (i.e. issues related to the operation of the mine).
- Heavy vehicle (i.e. issues in relation to the use of heavy vehicles (trucks) in and around the operation).
- Environment (i.e. issues around the potential impacts on social amenity and the environment).
- Economic (i.e. issues around the economic impacts of the Revised Project).
- Company Management (i.e. issues around governance, modification, and viability of the Revised Project).
- Property (i.e. concerns in relation to decreased property values and increased property maintenance costs).
- Provision of information (i.e. timing of public engagement and provision of test results to the community).

There were also two participants that indicated that they had no concerns with the Revised Project.

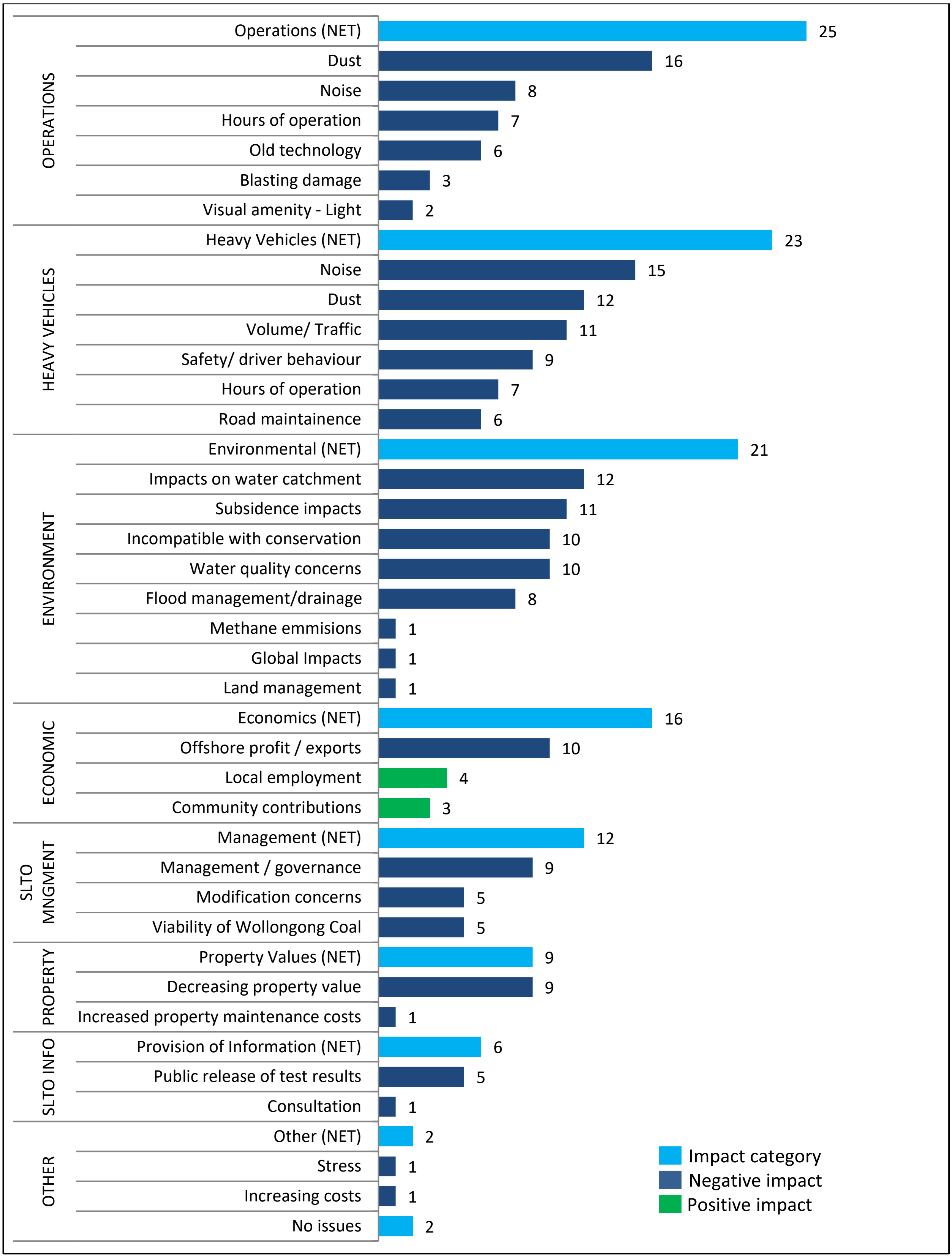

Figure 4.3 Phase 1 - Perceived social impacts (frequency)

Stakeholders consulted in the first phase of engagement were also asked to suggest mitigation measures that could be employed by the company to address the impacts that they had raised. A range of suggestions were provided which have been grouped into the following categories:

- Changes to operations.
- Dust control.
- Transport related mitigation.
- Information provision.
- Community contribution.

Further information on each of these categories is provided in **Sections 4.2.1** to **4.2.5** below. In addition to the above categories, five participants felt that the only solution was to close the mine and a further five responses have been categorised as 'other'. Responses in the 'other' category included 'build trust by doing the right thing'; put up walls to filter noise, fix drainage, consider gas offset and create shields for lights'.

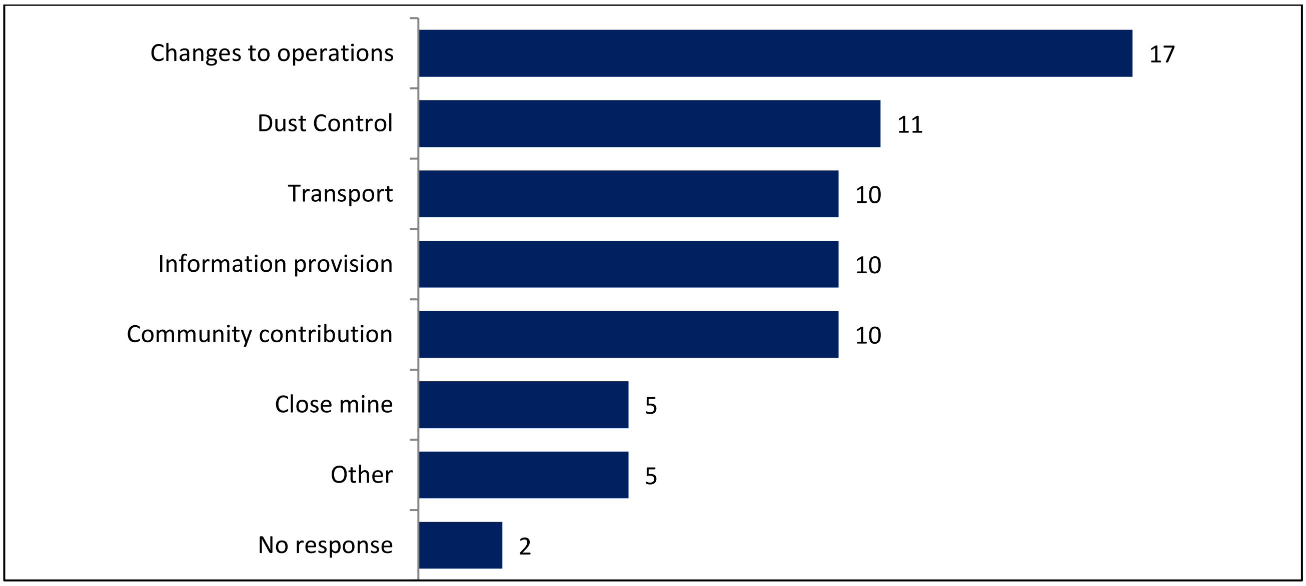

Figure 4.4 Phase 1 - Mitigation categories (frequency)
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The issues shown in **Figure 4.3** were presented during the second phase to attendees at the Community Information Session, once they had the opportunity to view displays and discuss concerns with representatives from the company and consultant team. Attendees were then given five sticky dots to place on the overall list of issues identified in Phase 1 engagement activities. Attendees were given the option to distribute their allocated 5 dots however they wished (e.g. one dot on five issues; 5 dots on one issue or any combination in between). In total 178 were distributed across all issues. The outcomes are presented in **Figure 4.5** and reflect the views of the participants in attendance collectively.

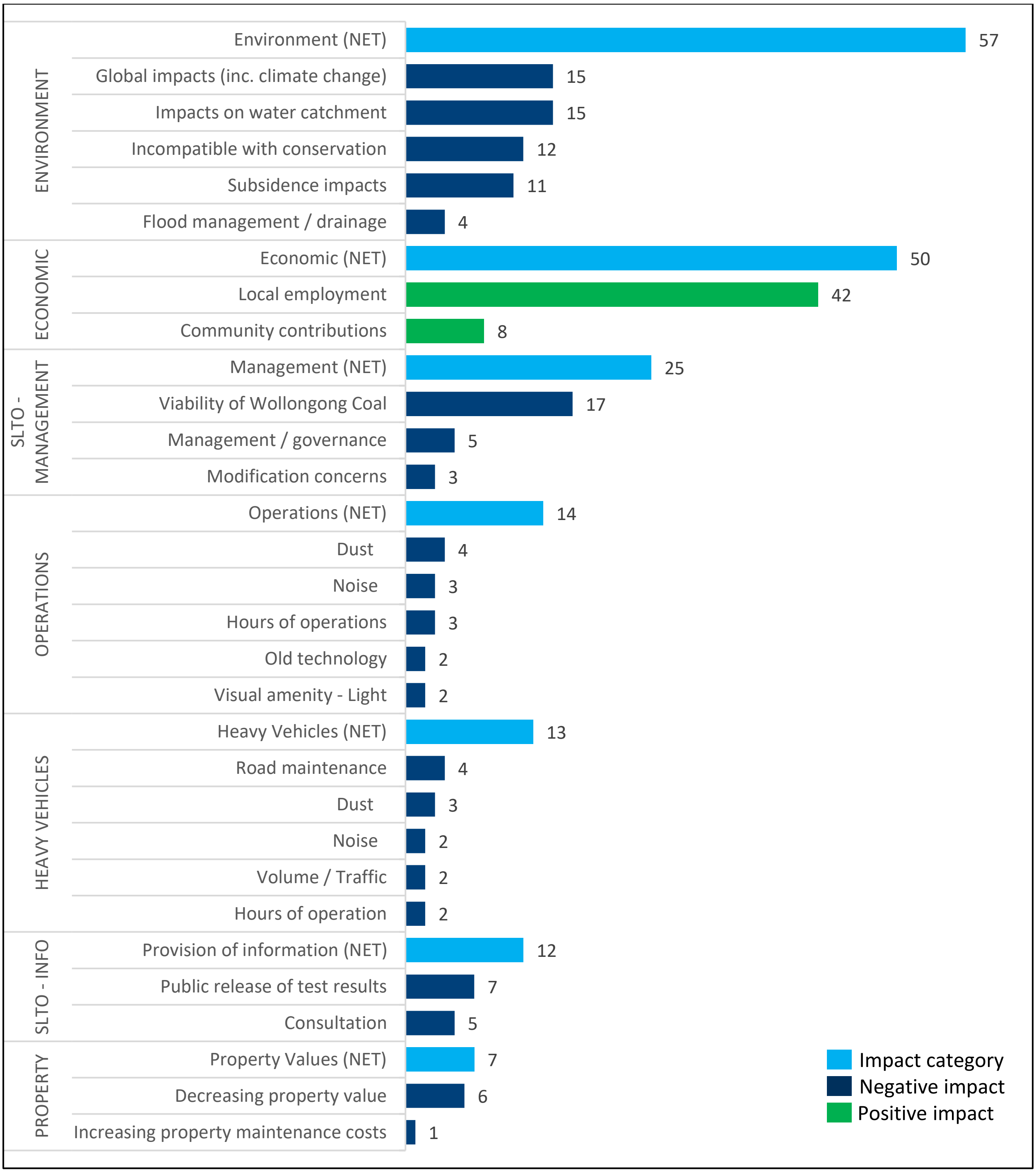

Figure 4.5 Phase 2 - CIS Issues Ranking Exercise Results (Community Information Session attendees)

The results indicate that in the broader community, issues relating to the environment were the most salient with a range of environmental issues identified by attendees including the potential impacts of subsidence on the Cataract Dam and subsequent impacts on water quality, water access and flood management.

The broader community residents that attended the information session during Phase 2, also gave greater weighting to the positive economic impacts – particularly increased local employment opportunities associated with the Revised Project.

Issues regarding mine management were also high on the list in the second round of engagement. Whist operational issues like dust, noise and traffic remained concerns, they were not rated as highly as the other impact categories.

The following sections provide further detail on each of the key themes identified in **Figure 4.3** and any related mitigations suggested by community participants during both rounds of engagement, as shown in **Figure 4.4**.

4.1.3.1 Operational issues and impacts

As indicated at **Figure 4.3** above, concerns related to the mining operations at the Russell Vale site were identified by the greatest number of participants during the first phase of engagement. The greatest operational issue of concern related to the amount of dust likely to be generated from the site, with 16 out of the 34 participants noting social amenity, due to dust impacts, as a concern. This was followed by impacts of noise (8 mentions) and the hours of operation (7 mentions). Other operational issues raised included the use of old and dated operational technology, the potential damage caused by blasting and light spillage at night (refer to **Figure 4.6**).

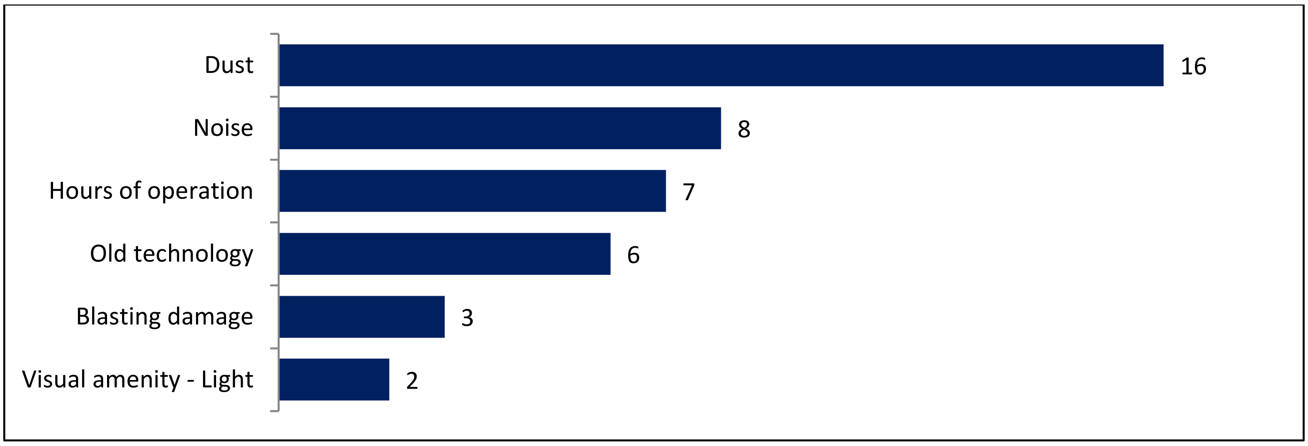

Figure 4.6 Phase 1 - Operational issues and impacts (frequency)
© Umwelt, 2018

Examples of responses provided in relation to operational concerns (engagement Phase 1) included:

"The mine needs to use sprays and covers"

"They should only operate during usual business hours"

"It is good to have it coming back"

"The experts at the site need to make sure they do their jobs properly"

"You should put up walls to reduce the noise"

Around half of all participants (n=17) suggested possible changes to existing operations, with these including changes to the hours of operation, i.e. operating during daylight hours only, no early morning operations and no operations on the weekend.

Outcomes of phase 2of engagement, indicated some positive changes to people's perceptions regarding operational issues; with operational concerns weighted lower than in engagement round 1 with only 14 of the total 178 dots being attributed to this issue in the risk ranking exercise. This is likely to be a result of the different stakeholders involved in phase 2, with phase 1 largely focusing on residents and key stakeholders in proximity to the operations.

Interviews with the IRRM and the KNAG, in relation to operational issues, also saw a number of concerns addressed in relation to air quality and noise; and while representatives from both organisations remained cautious, there was a positive response to the mitigations that had been applied. Some scepticism was noted regarding the effectiveness of noise bunds during discussions with the IRRM and the KNAG, as these had been promised when the mine had been previously operational and were not deemed to be satisfactory by the local community, according to these groups.

The Russell Vale Pre-School also raised concerns relating to dust, recalling that dust was an issue when the mine was previously operational. There was concern about the potential health impacts on children, given the proximity of the pre-school to the operations and the fact that a number of children suffer with asthma and respiratory related conditions.

An additional issue relating to the visual amenity of stockpiles was also raised during the interviews conducted as part of the engagement in Phase 2. This is likely to be as a result of recent media attention in relation to the current process of removal of existing stockpiles on the site. Members of the CCC and representatives from both the IRRM and the KNAG raised concerns about ensuring that stockpiles were managed effectively should the Revised Project proceed.

4.1.3.2 Heavy Vehicle issues and impacts

The second most frequently raised issue category of concern identified in Phase 1 of the engagement, related to the use of heavy vehicles in and around the site. Specifically the noise and dust generated by these vehicles were of concern; with 15 out of the 34 participants mentioning vehicular noise emissions and 12 noting dust emissions associated with vehicle use (refer to **Figure 4.7**).

Traffic and road safety were also noted as areas of concern with 11 stating they were worried about the increased volume of traffic and 9 concerned about their safety in connection to truck driver behaviour. Other concerns included the vehicles hours of operation and the need for increased road maintenance as a result of damage to public roads associated with heavy vehicle usage.

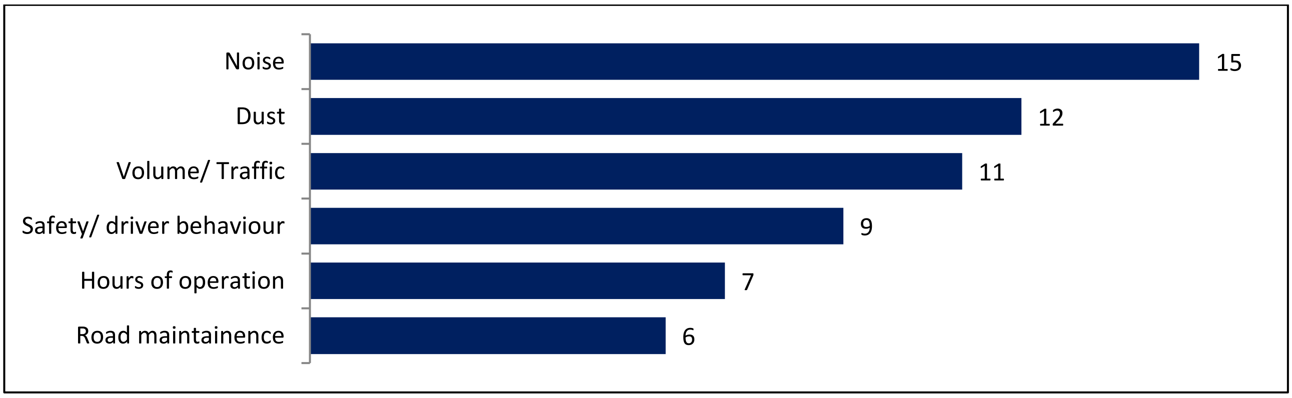

Figure 4.7 Phase 1 - Heavy vehicle usage issues and impacts (frequency)

Examples of comments made in relation to heavy vehicle use included:

"Don't want to see dog-trailer type trucks, semi-tippers are okay"

"The trucks should be loaded in a covered space and then covered"

"I'm worried about the number of trucks and the amount of dust they generate. A lot of trucks could cause damage or seriously injure people if there are accidents."

"Trucks can be pretty noisy, especially when they use their brakes. At night this could be a problem."

A total of 11 participating stakeholders identified mitigation measures related to improved dust control, which included:

- covering trucks and stockpiles (n=6)
- spraying trucks, roads and stockpiles (n=4)
- the use of ‘cyclones’ to draw dust away, and
- monitoring wind direction (n=1).

Of these covering and spraying trucks was mentioned the most frequently (n=6). Reducing truck speed and applying a curfew for truck were suggested by two participants as a means of managing impacts associated with heavy vehicle use. Limiting the size of trucks and purchasing new trucks were also offered as suggestions.

Concerns relating to traffic were once again noted during Phase 2 of the engagement with 13 of the 178 dots being attributed to this issue during the CIS risk ranking exercise. Interviewees from the IRRM and the KNAG also raised concerns about the timing of the traffic assessment and whether it was done pre or post the construction of the Bunnings warehouse, expressing that this development would significantly change traffic assessment outcomes, given increased traffic experienced as a result of this new development. It was outlined that the traffic assessment for the project had been undertaken prior to the construction of the Bunning warehouse though the construction of it was factored into future traffic projections undertaken as part of the modelling process. Despite this, there was a positive response to other mitigation strategies such as speed monitoring, the provision of a truck waiting area on site, reduced traffic hours, water sprays and truck covers.

4.1.3.3 Environmental issues and impacts

nvironmental concerns were ranked third during Phase 1 of engagement, in terms of the number of participants citing issues and impacts, this category raised the greatest breadth of concerns, with nine individual impacts identified. The issue of most concern was the proximity of the mine to the Cataract Dam and the potential for subsidence impacts on the water catchment (n=23 participants).

In addition to the above, incompatibility with conservation values in the area and concerns regarding impacts on water quality also generated a large number of responses (n=10) followed by concerns relating to flood management/drainage (n= 8) (**Figure 4.8**).

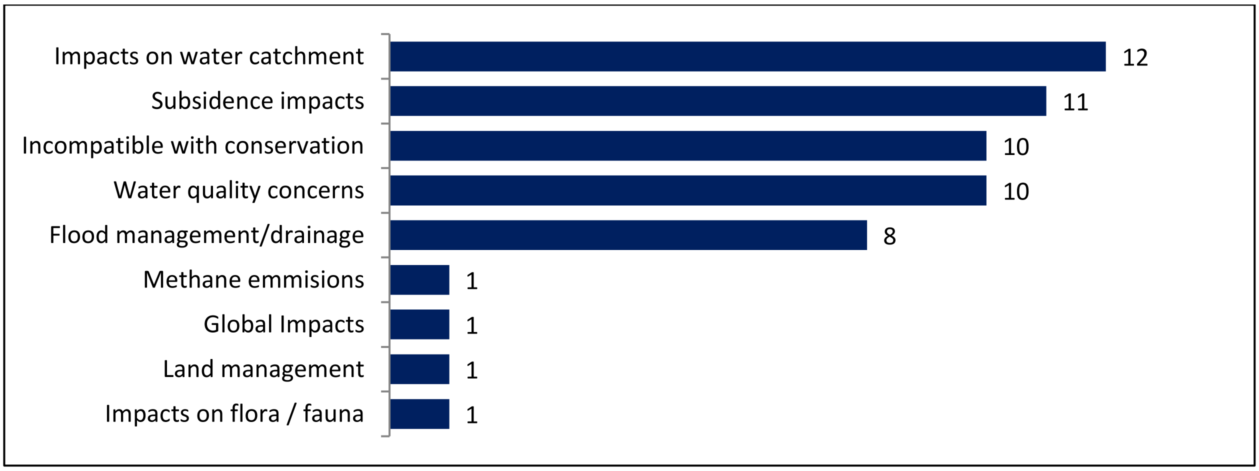

Figure 4.8 Phase 1 - Environmental issues and impact (frequency)

Examples of comments made in relation to environmental issues and impacts included:

"They need to move away from the dam."

"I am not confident that the land isn't going to shift."

"I think it will change the way Helensburgh Creek flows."

"If things go wrong, think of the environmental damage it could cause."

Such issues were again reiterated in the second phase of engagement among members of the broader community with the environment receiving the largest number of dots (57 of the total 178) in the risk ranking exercise. These issues were again identified in discussions with the key community groups, particularly the potential impacts of subsidence in the Sydney Water catchment and impacts on climate, as a result of greenhouse gas emissions. Whilst concerns relating to subsidence were widely addressed in the discussion, both parties indicated scepticism in relation to the environmental assessment outcomes and requested further information to validate the findings of the relevant technical reports.

4.1.3.4 Economic impacts (positive)

During Phase 1 of the engagement, a total of 6 participants raised positive economic impacts as a result of the Revised Project. Local employment was raised by 4 participants. In the second phase, particularly during the Community Information Session, this positive impact was given more weight amongst attendees (refer to **Figure 4.5**). Whilst it should be noted that 17 of the 67 (25%) of the attendees were employees of WCL, local employment was regarded more highly amongst the wider community.

The potential for WCL to make contributions to the community was raised by 2 participants in the first phase of engagement. Community contributions were given 8 dots of the total 178 indicating a similar weighting to that seen in phase 1.

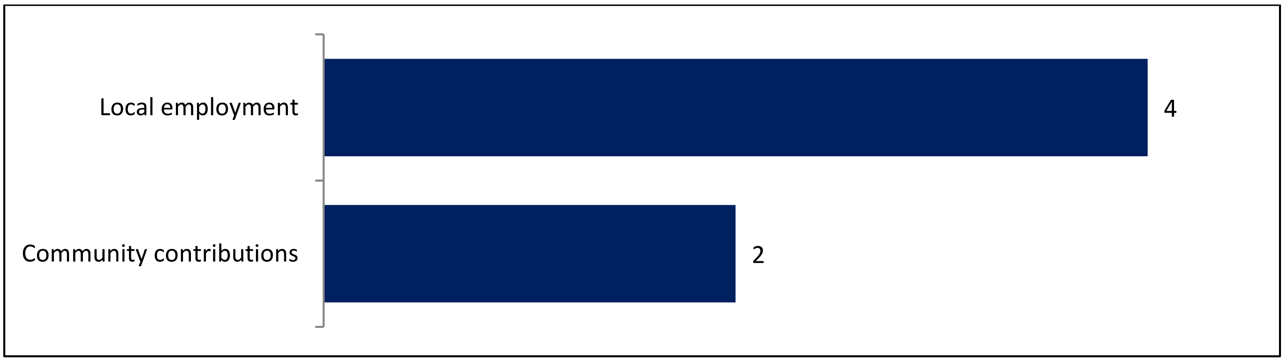

Figure 4.9 Phase 1 - Positive Economic Impacts

4.1.3.5 SLTO – Governance and management

In total, 14 participants raised concerns in relation to mine management and the economic viability of the Project during the first phase of engagement. A key issue in this regard included the extent of offshore profit and exports being generated (n= 10) (**Figure 4.10**). Two participants were also concerned about the likelihood of the mine making any future contributions to the community. These results combined indicate concerns around the reduction in, or loss of, economic benefit to the local. These issues were again raised during the second round of engagement by CCC members and representatives of the IRRM and the KNAG.

The second issue of concern centred on fears of poor management and governance of the Project (n=9). Participants also raised concerns relating to the sustainability of the mine and the possibility of future modifications (n=5).

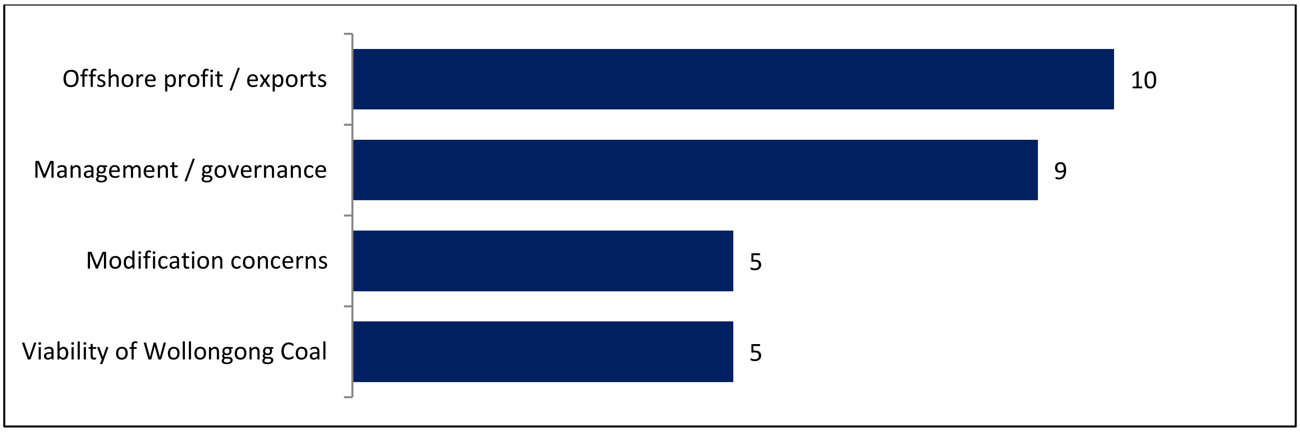

Figure 4.10 Phase 1 - Company Management and project viability (frequency)

"They don't pay"

"It's not as high grade as they say"

"In terms of the project the numbers just don't add up"

"The long-term problems don't outweigh the revenue generation"

These issues were raised consistently across both engagement phases. Overall 25 of the total 178 dots were attributed to the issue of governance and management overall during the risk ranking exercise of the second phase. The viability of WCL was ranked the highest in the is phase, receiving 17 of the 25 dots in this category.

4.1.3.1 SLTO - Provision of information

During the first phase of engagement, issues relating to the provision of information about the Revised Project were reported by a total of 6 participants. The primary issue of concern related to a lack of public access to monitoring results (n=5 out of 6 participants). One person also reported that some members of their organisation were not happy with the consultation process and felt that the stakeholders consulted were not broad enough. This was addressed in phase 2 via the Community Information Session being opened to the wider community.

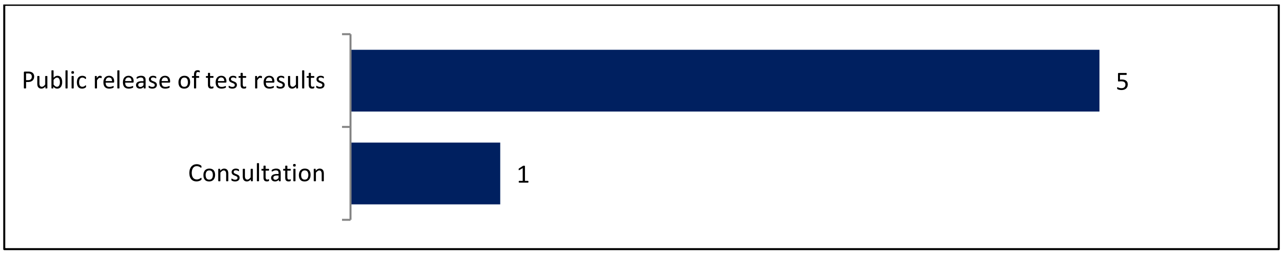

Figure 4.11 Phase 1 - Provision of information issues and impacts (frequency)

Below are examples of the comments made by participants in relation to the provision of information about the Revised Project:

"The company should supply the community with air quality test results"

"They should communicate more monitoring results"

"All test results should be made public"

A need to increase the provision of information and contact with the community, as a means of mitigating negative impacts was noted as a possible strategy by a number (10) participants. Two participants suggested that providing the community with more information may also counter any misconceptions and lack of trust. There was also a desire to have greater community access to the results of monitoring activities (e.g. air, noise and water quality), with this also perceived as a way to build trust (n=7) at the community level.

The theme of information provision, as a means of increasing trust in the company was again raised in phase two of the engagement, with a number of attendees of the Community Information Session, expressing this as a failing of the company to date during conversations throughout the day. Some requested they be informed when additional information is publicly available. Some attendees also felt there was a need for additional public forums to be held to help inform the public further about the Revised Project. In term of the dots attributed to the issue in the ranking exercise, overall 12 of the 178 dots were attributed to the issue in the risk ranking exercise.

4.1.3.2 Property related impacts and issues

More than a quarter of participants (n= 9) indicated that they were concerned about decreases in their property values in the first round of stakeholder engagement. One stakeholder also noted concerns regarding the potential for increased property maintenance costs (i.e. cleaning as a result of dust relating to the Revised Project).

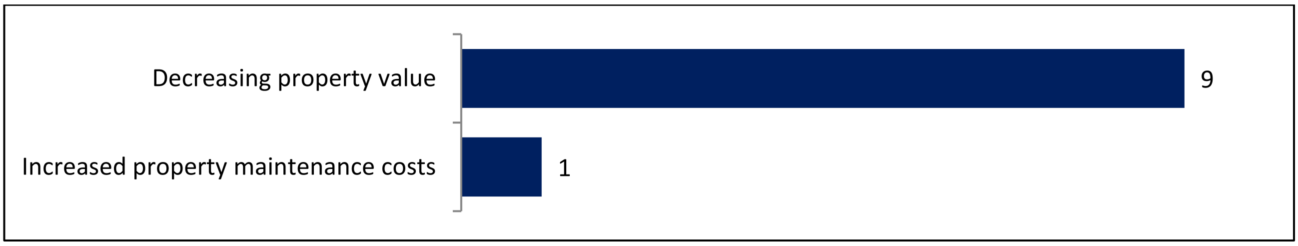

Figure 4.12 Phase 1 - Property related issued and impacts (frequency)

Below are examples of quotes obtained in regard to property related issues and impacts:

"I don't want the increased household maintenance costs"

"The company should compensate us for any drops in property value"

"The quiet is better for resale"

Property related issues were also raised during the information session, as part of Phase 2 of the engagement but were not considered a key issue with only 7 of the 178 dots being attributed overall in the risk ranking exercise. This may reflect the involvement of residents of the wider locality compared to the near neighbours consulted in Phase 1.

4.1.4 Positive and Negative Impacts

Participants in the first phase of engagement were asked to identify any perceived positive and negative impacts to the community resulting from the Revised Project. With respect to positive impacts, these were noted by 14 participants, with the top positive impact to the community identified being jobs (n=13). Community investment was also seen as an associated flow on benefit (n=6) along with training opportunities and royalties/taxes (both n=1). One-third of participants (n=13) also felt that there was 'no or nil benefit' to the community as a result of the Project. (Note: Participants were able to provide multiple responses. The green bars in **Figure 4.13** indicate positive impacts').

At the same time, participants were also asked to identify any negative impacts to the community resulting from the Revised Project, with a total of 24 participants noting that these existed. The 'environment' (e.g. global warming, ecology etc.) was the most frequently mentioned negative impact (n=9) followed by traffic/transport (n=7) and dust (n=5). Project viability, loss of the sense of community and devaluation of property values were also raised. Four participants simply said that they felt the costs outweighed the benefits. (Note: the aqua blue bars in the **Figure 4.13** indicate negative impacts).

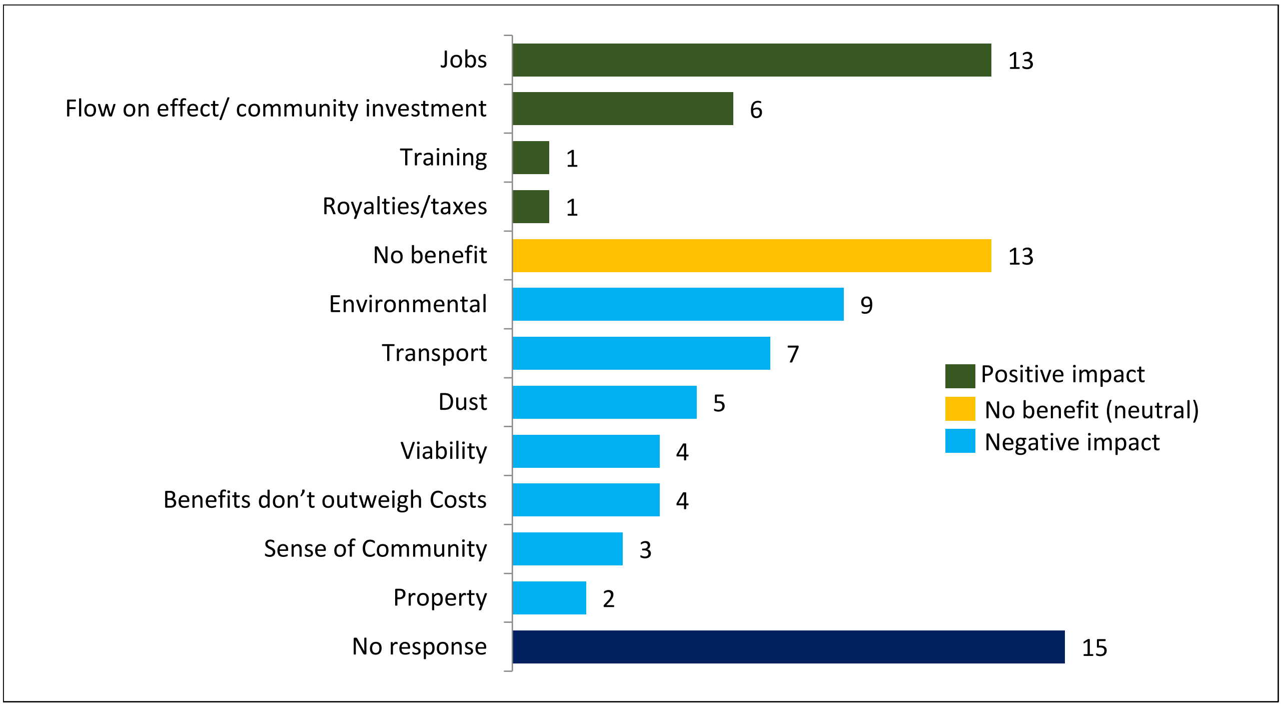

Figure 4.13 Positive versus Negative Perceived Impacts (frequency) – Engagement Round 1

Ten participants provided ideas for mitigation that related to the company contributing to the community in some positive way. Cleaning roads and houses was mentioned the most frequently (n=5) followed by setting quotas for local jobs (n=2). It was also thought that the company could compensate property owners for any loss of property value resulting from the Revised Project.

During the Community information session, conducted as part of the second phase, attendees were also able to identify what they felt were the positive and negative issues relating to the Revised Project. The impacts mentioned tended to relate to changes to the project design, as shown in **Table 4.2**.

Table 4.2 Positive and negative impacts of Revised Project – Engagement Round 2

Positive Impacts	Negative Impacts
No subsidence from mining method	Noise pollution
Mine contribution to local community	Potential for increased traffic on Memorial Driveway
Reduced noise & dust	Dust pollution leading to increase in health issues e.g. asthma attacks
Social aspects	Coal is not a renewable resource
Local employment and procurement opportunities	Proximity to Sydney water catchment area
Flow on economic benefits of mine to the community	
Improved perception of the company	

The negative issues identified, mirrored those raised in Phase 1; with similar positive impacts including local employment and procurement and community contribution. However, session attendees, did note the changes made to the Revised Project in relation to the management of dust, noise and subsidence impacts as a result of the Revised Project redesign.

5.0 Assessment of Social Impacts

Acknowledging the constantly changing nature of communities, the aim of the current assessment is to consider any changes to the baseline social environment as a result of the Revised Project. To do so, the SIA integrates assessment of all the data presented throughout this document, including Revised Project details, data relating to the existing community, and issues and concerns of local landholders and other key stakeholders, to develop a layered picture of the potential social risks, impacts and opportunities that arise as the result of the Revised Project.

The SIA has utilised data from a range of sources to develop a layered picture of the potential social impacts arising from the Revised Project. This section further assesses the social impacts associated with the Revised Project, 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 Revised Project the potential social impacts are expected to occur e.g. Pre-construction, Construction, Operation, Closure, Post-closure 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 (sensitivity), 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 guidelines (DPE, 2017) in relation to estimating material effects.

5.1 Predicting Social Risks/Impacts

This section provides an evaluation of the significance of each potential negative and positive social impact both with and 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 social risk matrix (**Table 5.1**), 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 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, 2012), and relevant agency guidelines (IAIA, 2015). These definitions are outlined in **Table 5.3**.

The social risk assessment process for the current SIA, has therefore involved four main steps:

- **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, for others it may be a positive consequence (positive risk rankings are delineated in italics). Impacts may also differ by stakeholder group. These consequences are assessed against impact-specific consequences and are categorised as 'catastrophic', 'massive', 'major', 'moderate', 'minor' or 'minimal' (refer to **Table 5.1**).

- **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 5.2** presents the **likelihood definitions** that were used to assess the likelihood of social impact consequences associated with the Project, categorised as 'almost certain', 'likely', 'possible', 'unlikely', or 'rare' (DPE, 2017).

- **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 5.1**). In the case of some impacts, this risk assessment has involved referencing the respective technical reports of the EIS (e.g. economic, water, blasting, traffic), however the associated social impacts have been assessed through the social risking process. The social risk ratings are presented both without and with mitigation, the latter being assessed in relation to the proposed mitigation and enhancement strategies proposed (refer to **Section 6.0**).

- **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*, *medium*, and *high*) is determined by the frequency that an issue was raised by a stakeholder group 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. 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.

Table 5.1 Social Risk Matrix

		Consequence Level				
		1 Minimal	2 Minor	3 Moderate	4 Major	5 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 5.2 Social likelihood definitions

Likelihood Category	Definition
A. Almost certain	Common repeating occurrence, ongoing Will occur in most circumstances
B. Likely	Will probably occur in most circumstances There is at least a 50% chance that it may happen
C. Possible	Might occur at some time Could occur but not often 5% chance it could happen
D. Unlikely	Unusual occurrence Unexpected
E. 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 Project. These have been categorised in line with the Social Impact and related matters outlined in the SIA guideline (DPE, 2017, p.5 and p.34) and then further defined within impact themes, as noted in **Table 5.4**.

At the conclusion of each impact theme, a table is presented which summarises the project aspect, the social impact matter 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 significant impacts, are further described in **Section 6.0,** with social risks then reassessed (mitigated) in light of the various mitigation/enhancements proposed.

Table 5.3 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 and 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.
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**	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**	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	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**	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 Catastrophic	2 Major	3 Moderate	4 Minor	5 Minimal/ Negligible
	>$5m - $10m of health cost due to hazard. **or** Demand exceeds capacity of health services by >30-40%.	>$1m - $5m of health cost due to hazard. **or** Demand exceeds capacity of health services by >20-30%.	due to hazard. **or** Demand exceeds capacity of health services by >10-20%.	Demand exceeds capacity of health services by >1-10%.	
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 of economic and environmental impacts are undertaken as part of the EIS (please refer to the relevant sections of the EA for further detail).

5.2 Social Impact Themes

A range of social impacts have been identified in relation to the Revised Project, that require prioritisation for assessment and appropriate management/enhancement. **Table 5.4** outlines the social impact themes relevant to the project.

Table 5.4 Social Impact Themes and related social matters

Social Impact Themes	Relevant Social Impact Categories	Social Impact Matters
Operational	Way of Life Community Health and wellbeing Surroundings	Population change due to construction and operational workforce influx and subsequent impacts on infrastructure and community service use. Social amenity and health issues relating to noise and dust from construction and operational project phases.
Heavy Vehicle	Access to infrastructure, services and facilities Personal and property rights Community Way of Life	Social amenity issues relating to increased traffic and transport (dust and noise) and access issues. Increased traffic/truck movements and subsequent impacts on road safety. Damage to roads and vehicles.
Environment	Way of Life/Personal and Property rights Health and wellbeing Surroundings	Reduced access to clean water due to potential subsidence impacts. Health issues resulting from potential water contamination. Impacts on local flora and fauna.
Economic	Surroundings Personal and property rights Way of Life Community	Opportunity to improve livelihoods through local employment and procurement. Benefits to the broader community and local community groups through company contributions/ investment.
Social Licence to Operate – Governance and Trust	Community	Lack of trust in company to operate the project appropriately due to limited community engagement, lack of provision of information, poor perceived impact management. Uncertainty regarding economic viability of the project .
Property	Way of Life Personal and property rights	Potential decline in property values due to proximity of homes to the operations

Assessment of the social impacts categories such as: way of life, community, access to and use of infrastructure, services and facilities, culture, health and wellbeing, surroundings, personal and property rights, decision-making systems, fears and aspirations (DPE, 2017); will also be assessed with consideration of the baseline indicators and findings from the technical studies relating to air quality, noise, traffic, economic, greenhouse gas emissions, ecology, and environment.

5.2.1 Construction and Operational impacts

This section provides a summary of the social impacts relating to the operation of the mine. The social matters affecting the community include population change, due to potential construction and operational workforce influx and social amenity issues relating to dust/air quality and noise from the construction and operation of the project. These matters impact people’s way of life, sense of community, health and wellbeing and their surroundings.

5.2.1.1 Population Change and Impacts on Infrastructure and Services

The size of a community can influence the behaviours, diversity, characteristics and relationships within that community. Changes to the population of a community, like an influx of workers, can impact these features and is therefore considered an important social impact. Population change also has the potential to affect the provision of and demand for community services and infrastructure such as housing, use of health and education services, local businesses etc.

In regard to the Project, the most likely influences of population change include:

- Introduction of the workforce for the construction phase – approximately 22 workers;

- Introduction of workforce for the operation phase - approximately 205 workers (and their family members) and Acquisition in relation to the project –no acquisitions are predicted as a result of the Revised Project.

Further assessment of the impacts of these phases are detailed in the following sections.

5.2.1.2 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. Because of the temporary, transient nature of construction work, families often do 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 Revised Project.

Construction works for the Revised Project is planned to take between 12 and 24 months and will involve the installation of new coal handling facilities and upgrades to existing surface infrastructure., The upgrades will include additional noise mitigation works (refer to **Section 6.0**). Construction will be conducted from 7.00am – 6.00pm Monday to Friday and from 8.00am – 1.00pm on Saturday. A construction workforce of approximately 22 people is anticipated. Construction laydown areas and construction workforce offices and facilities will be located within the existing pit top 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 Project, i.e. within WCC area, 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 (DIDO) daily

- all other factors will remain proportionally the same over the construction period.

The percentage of population change that will occur as a result of the influx of the construction workforce can be estimated using the peak construction workforce figure of 22 persons (refer to **Table 5.5**). As shown, the estimated influx of the construction workforce for the Revised Project in the WCC area would only constitute approximately a 0.03% temporary increase in population for the construction period.

Table 5.5 Predicted Temporary Population Change Associated with the Project Construction Workforce

Level of Analysis	Population Size*	Proposed Construction Workforce	Estimated resulting population	Percentage (%) Change
Wollongong LGA	203,629	22	55	0.03%

**Source: ABS (2016)*

While the influx of a construction workforce has the potential to influence population change, this change will be temporary in nature. The Revised Project will require up to 22 contractors during its peak construction period, and it is anticipated that such a workforce will be readily available.

The social baseline profile (refer to **Sections 3.1.4** and **3.3.1**) highlights some capacity in the construction sector, within the LGA of Wollongong. Consequently, there may be opportunities for local residents, currently employed in this sector, to be engaged by WCL in the project construction phase.

Therefore, as outlined in Table 5.5, the population change, due to the influx of a project construction workforce in the Wollongong LGA, are assessed as a *possible* but *minimal* consequence (*temporary but insignificant population change*), resulting in an overall mitigated social risk ranking of '***low***' (for both unmitigated and mitigated rankings).

The level of community concern in relation to population change associated with the presence of the Project's construction workforce, as identified through engagement with key stakeholders, was also perceived to be '***low***'.

As previously noted in **Section 4.1.3.4,** opportunities to maximise employment and procurement locally has been raised as a strategy by stakeholders to enhance economic impacts within their localities. WCL could address this opportunity by seeking to utilise, where appropriate, locally based construction service providers. Furthermore, the presence of the construction workforce is likely to provide positive impacts to local service and business providers, and the local economy in the Wollongong locality, for the construction period.

Table 5.6 Predicted Social Impact - Population and Community Infrastructure and Services (Construction Workforce)

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Construction workforce influx	Way of Life Community Surroundings	Population change – influx of construction workers	Wollongong LGA	12 to 24 months	Russell Vale and LGA residents	Low	Low
					Local Businesses and Service providers	Low (*positive*)	Low (*positive*)

5.2.1.3 Operational Workforce

The scenarios below detail possible influx of workforce related to the operational phase of the Revised Project.

Wollongong has a small proportion of its workforce working in the mining industry, with double the proportion of people working in the manufacturing industry (see **Figure 3.22**). The Russell Vale Colliery has been in care and maintenance for four years. During this time, the unemployment rate has decreased, and population growth has been below the state average, suggesting that local people in the area that used to work in the mine are likely to have found alternative work. This suggests that a significant proportion of the workforce may need to be sourced externally, rather than locally.

Consequently, four workforce scenarios have been proposed and assessed:

- **Scenario 1:** 100% employees sourced from the local area (lowest population impact);
- **Scenario 2:** 80% of employees sourced from the local area, 20% are externally sourced;
- **Scenario 3:** 20% of employees are sourced from the local area, 80% are externally sourced;
- **Scenario 4:** 0% are sourced locally, 100% are externally sourced (highest population impact).

Applying the above workforce scenarios, **Table 5.7** summarises the actual number of workers that will be required to be sourced externally, (i.e. those sourced from outside the Wollongong LGA), and the predicted number of family members that are likely to accompany them. Family size was calculated by taking the average household size Wollongong LGA (2.5) and multiplying this figure by the number of operational workers for each scenario.

Table 5.7 Population Influx Scenarios

Recruitment Scenario	Sourced Externally	Total person influx (operational workforce plus families)
Scenario 1: 100% local	0	0
Scenario 2: 80% local	41	103
Scenario 3: 20% local	164	410
Scenario 4: 0% Local	205	513

In SIA practice, the *80:20* rule is often applied which assumes that approximately 80% of persons would move into the area with 20% workforce absorbed from the existing area. In the application of this rule and consideration of the unemployment, mobility and proportion of the population employed in mining (as mentioned above) Scenario 3 is the most likely scenario.

The following table also outlines the predicted age breakdown of the incoming workforce and their families under Scenario 4 (highest impact) and Scenario 3 (most likely), based on the age distribution of population in the Wollongong LGA for the operational workforce.

Table 5.8 Age distribution for incoming population

Age	Wollongong (2016 Census)	Estimated no. of new residents Scenario 3 (most likely)	Estimated no. of new residents Scenario 4 (highest impact)
0-4 years	6%	30	37
5-14 years	12%	59	74
15-19 years	6%	30	37
20-24 years	8%	40	49
25-34 years	13%	64	80
35-44 years	13%	64	80
45-54 years	13%	64	80
55-64 years	12%	59	74
Total		418	523

The current population of the Wollongong LGA (according to the 2016 census) is 203,629 people. An influx of 523 people (highest impact scenario) would only represent a 0.3% increase to the population. Taking this into consideration, the likelihood of this scenario (Scenario 4) has been rated as *likely,* with the consequence rated as *minimal*. Accordingly, the impact of this population change/influx is therefore ranked as a *moderate positive* impact (both unmitigated and mitigated). The impact of the most likely scenario (Scenario 3) is also ranked as a *moderate* social impact.

Consistent with the construction workforce, opportunities to maximise employment and procurement locally has been raised as a strategy by stakeholders to enhance economic impacts within their localities (as noted in **section 4.1.3.4**). WCL have indicated an intention to address this opportunity by seeking to utilise, where possible, locally based employees. This will provide positive impacts to local service and business providers, and the local economy in the Wollongong locality, for the project life.

Furthermore, given that the Wollongong LGA is largely urban with a large population, the perceived stakeholder concern about the impact of the Revised Project on population change was not raised as a significant issue and for the purpose of this assessment has been assessed as a *low* perceived issue.

As previously noted, no acquisitions are predicted as a result of the Revised Project.

Table 5.9 Summary - population change impacts (Operational workforce)

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated and Mitigated)
Operational workforce influx	Way of Life Community Surroundings	Population change – influx of operational workers	Wollongong LGA Workforce Scenarios 3 and 4	Project Life	Russell Vale and LGA residents	**Low (*Positive*)**	**Moderate (*Positive*)**
					Local Businesses and Service providers	**Low (*Positive*)**	**Low (*Positive*)**

5.2.1.4 Access to infrastructure and Services

Population change can also have an influence on access to infrastructure, services and facilities as a result of an incoming population to an area. As outlined above**,** the worst case scenario of a 0.3% increase in the broader population of Wollongong (as a result of a 100% or 80% influx of the workforce from outside the area) is predicted to have marginal effects on the community in relation to pressure on housing and use of education and health services. Given the results of the population change modelling, any impacts on housing and access to community services as a result of the workforce influx for the project (construction and operation) are considered *possible but minimal*, resulting in a *low* social impact ranking (both mitigated and unmitigated).

The issue of access to services was not raised by stakeholders during the engagement process and therefore has also been rated as a *low* perceived *issue*.

5.2.1.5 Social Amenity and Health related impacts from construction and operations – Dust/Air Quality

The impacts on social amenity as a result of dust, associated with construction, operations and coal transport, was perceived by the community as of greatest concern; with 25 of 34 stakeholders citing this issue during the first phase of engagement.

Of those, 16 raised the issue in relation to operations, 12 raised the issue in relation to transport and 11 raised the issue specifically in relation to health concerns (noting that participants were able to provide multiple responses).

Specifically, concerns centred around the potential impacts on health and wellbeing, general discomfort and the impact that dust has on the cleanliness of their properties and the nuisance of having to clean more regularly. Accordingly, perceived social amenity and health impacts relating to air quality have been assessed in relation to three social impact categories – Health and Wellbeing, Way of Life and Surroundings.

In determining whether there are any vulnerable groups that are susceptible to respiratory conditions in the area, we have considered the prevalence of asthma as a proxy. A review of the NSW Health statistics[9] indicates that the prevalence of asthma amongst adults in the wider Illawarra Shoalhaven Local Health District is slightly above the state average (12.5% compared to 10.9%), whilst the prevalence amongst children is below the state average (11.5% compared to 12.9%). Therefore, while impacts on vulnerable groups within the community are not considered significant, continued monitoring of air quality is recommended during the life of the operation.

Given that participants throughout the engagement identified air quality and dust as a concern, the perceived social impact has been rated as '*high'* for both social amenity and in relation to perceived health issues

When considering the unmitigated risks in relation to the impact of dust on social amenity and health, the unmitigated rankings for these social impacts have also been ranked as high (*likely* and *moderate*).

The Revised Project has incorporated a range of mitigations to minimise any potential negative impacts associated with the impacts of dust on health and social amenity, these include:

- Enclosure of conveyors and coal transfer points.
- Enclosure of new Processing Plant.
- Automated water sprays on stockpiles and exposed areas triggered by weather conditions.
- Water sprays on the noise berms during construction.
- Water carts on unsealed haul routes.
- Trials of chemical dust suppressant sprays on long-term stockpiles and unsealed haul routes.
- Revegetation/rehabilitation of exposed disturbed areas.

Further to the above, additional proactive and reactive measures in **Table 5.10** will be taken to reduce any impacts relating to air quality.

Table 5.10 Proactive and reactive dust mitigation measures

Proactive measures	Reactive measures
Review of forecasted weather conditions daily so that operations can be modified (as required) to limit dust generation	Provision of a 6 monthly information sheet summarising the outcomes of noise and air quality monitoring for that period – distributed to all proximal households.

[9] www.healthstats.nsw.gov.au

Proactive measures	Reactive measures
Weather conditions and any required dust control measures will be discussed at daily pre-shift meetings	Monitoring visual conditions, such as visible dust from trucks above wheel height;
Modifying or suspending planned activities, as appropriate, to minimise dust impacts	Monitoring weather conditions, such as dry, windy conditions, with winds blowing towards residential areas;
	Monitoring ambient air quality conditions.

In addition, trucks will be washed before leaving the site and the roads sprayed and cleaned to further reduce dust. Further detail regarding the assessment of air quality can be found in the associated technical report (ERM, 2019).

With these proposed dust controls in place, the Revised Project is not predicted to result in any exceedance of air quality criteria at surrounding private residences off site. Further information relating to the mitigations in relation to air quality can be found at **Section 6.0**.

Given that potential negative impacts have been mitigated, the likelihood of any negative social impacts are *possible* but *minimal*. Therefore, with mitigations implemented, the social impacts have been ranked as *low*.

Table 5.11 Summary - air quality/dust from construction and operations

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operation of the Project	Way of Life Community Surroundings Health and Wellbeing	Social Amenity	Russell Vale Residents Wollongong LGA	Construction	Russell Vale and LGA residents	**High**	**High**	**Low**
				Operation	Russell Vale and LGA residents	**High**	**High**	**Low**
Construction and Operation of the Project	Way of Life Health and Wellbeing	Health and Wellbeing	Russell Vale Residents	Construction operation	Russell Value Residents Russell Vale Pre-school	**High**	**High**	**Low**

5.2.1.6 Social Amenity and Health related impacts from construction and operations – Noise

Noise related concerns featured highly for stakeholders in the first phase of engagement with 21 of the 34 noting this issue. Noise associated with the use of heavy vehicles was most frequently mentioned (n=15) (refer to **section 5.2.1.6**) with the noise from operations also generating 8 responses. Note that participants were able to provide multiple responses to this question.

Local residents feared that noise would impact dramatically on their social amenity. In addition, the Aspect South Coast School is a near neighbour and given that noise sensitivity is known to be an issue for people with Autism (Stiegler, L. N., & Davis, R., 2010), noise posed additional health concerns for this stakeholder. The school participated in the first phase of engagement and requested assurances that any potential impacts on students would be avoided.

As participants did not distinguish between the construction and operational phases, stakeholder perception of these impacts has been rated as *high*. While, there were fewer responses directly citing health concerns, we have also considered the request for assurance from the Aspect South Coast School that their students' health will not be impacted. In addition, the technical reports indicate that there will be a difference in the noise levels experienced during the construction and operational phases of the project; with both phases being assessed separately.

Given the above concerns, and in the absence of any mitigation, the unmitigated likelihood has been rated as *likely* and the consequence level as *moderate,* resulting in *high* unmitigated ratings for both the construction and operational phases of the Revised Project.

An assessment of noise and associated impacts was undertaken as part of the Revised Project (Wilkinson Murray, 2019).To reduce noise impacts associated with the Revised Project, WCL has undertaken a significant redesign of the Russell Vale Pit Top and identified additional noise mitigation measures to reduce the potential noise impacts associated with surface operations to an acceptable level. This design work builds on a range of noise mitigation measures that have already been implemented at the Russell Vale Pit Top over recent years, including:

- Acoustic treatment of the existing primary sizer building.
- Acoustic treatment of the existing tripper system.
- Semi-enclosure of the decline conveyor.
- Poly rollers and vulcanised joints installed to all conveyors.

As part of the design process for the Revised Project, a range of additional feasible and reasonable noise control measures were investigated to minimise, control or manage the noise impacts from the project. These measures were tested through an iterative design process to determine their effectiveness at reducing noise impacts.

These include:

- repositioning infrastructure to provide maximum topographical shielding from surrounding residences, for example relocating the surge bin and secondary sizer building from an exposed location to the toe of a batter
- acoustic treatment of new plant and equipment, including enclosing the Processing Plant and Secondary Sizer in an acoustically treated building, acoustic treatments to the Surge bin, conveyors, attenuation pack and the dozer
- extension and increase in the height of existing berms in strategic locations surrounding the Pit Top to shield trucks and equipment.
- construction of a 4 m high noise barrier along the northern side of the site access road between the site entrance and turn off to the truck parking area to mitigate impacts of trucks accessing the site. Construction of the access road noise barrier will be completed prior to the commencement of 'phase-in' operations
- establishing a temporary stockpile of ROM coal as early as possible in 'phase-in' operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile

- voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane
- 40 km/hr speed limit on site
- operational noise mitigation measures such as:
  - restricting the operation of the dozer, rejects front-end loader, rejects truck, and underground loader to daytime only use
  - generally restricting the operation of the reclaim conveyor system, Secondary Sizer, Surge Bin, Processing Plant and truck loading bins to daytime use only, however noise impacts of operation of these items during the evening period has been considered in the noise impact assessment to cater for unexpected Port closures or interruptions.
  - Dozer movements restricted to near ground level during 'phase-in' operation to maximise shielding provided by temporary ROM coal stockpile.

Furthermore, WCL will continue to investigate opportunities to reduce noise impacts from its operations, including consideration of evolving technologies and associated modifications to equipment.

It should be noted that noise impact assessment indicated that <u>during the operational phase</u> and <u>under adverse weather conditions</u>, there is the potential for minor exceedances (1-2 dB) of the target noise levels for the project during the night-time for 27 addresses within proximity to the site. Technically, a 1-2 dB exceedance is predicted to represent a *negligible* impact that would not be discernible by the average listener. Importantly, noise levels generated during the night-time are predicted to be below relevant sleep disturbance criterion at nearby residences. The assessment further predicted that noise from trucks transporting coal will comply at residences along Bellambi Lane and surrounds.

During the construction of noise bunds around the Pit Top, there are likely to be short periods when noise levels trigger the need for additional noise management practices. Given this finding, during the construction phase and in the absence of any mitigations in place, it is *likely* that impacts may be experienced at defined residences, with the consequence considered *moderate*, resulting in a *high* impact on amenity and potentially health and wellbeing.

With the proposed mitigations in place, the likelihood of noise impacts is considered *possible* but *minor*, resulting in a *moderate* social impact ranking overall (mitigated).

Table 5.12 Summary - noise from construction and operation impacts

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction of the Project	Way of Life Surroundings Health and Wellbeing	Social Amenity Health and Wellbeing	Russell Vale Residents	Construction	Russell Vale residents Aspect South Coast School	**High**	**High**	**Moderate**
Operation of the Project	Way of Life Surroundings Health and Wellbeing	Social Amenity Health and Wellbeing	Russell Vale Residents	Project Life	Russell Vale Residents Aspect South Coast School	**High**	**High**	**Low**

5.2.2 Social amenity and safety issues relating to heavy vehicle transport

This section provides a summary of the social impacts related to the use of heavy vehicles during construction and operational phases of the Revised Project, specifically social amenity issues relating to noise and dust from product transport from the site, potential impacts on road safety and road conditions.

When factoring in all the responses relating to heavy vehicles, a total of 23 out of the 34 stakeholders in the first phase of engagement indicated a concern in this regard. Of those responses, the majority (n=16) related to noise (n=15) and dust (n=12). Whilst these concerns have been factored into the assessment of air quality and noise, it is worth re-iterating the perceived impact that heavy vehicles have in relation to both these risk factors.

In addition to air quality, concerns were also raised about the impact of the size and volume of heavy vehicles would have on traffic conditions in the local area (n=11), the potential for traffic incidents and accidents as a result of the behaviour of the drivers of heavy vehicles (n=9) and the impact that the size and volume of heavy vehicles would have on local roads (n=9). Note that stakeholders could provide multiple responses to this question.

5.2.2.1 Increased Traffic – Social Amenity

Apart from noise and dust, the perceived impact of traffic was the biggest concern in relation to heavy vehicles amongst stakeholders during the first phase of engagement. This impact was perceived to reduce access to local businesses/residences and impact on way of life due to traffic disruption. Given the relatively high number of responses provided by stakeholders, the perceived impact has been rated as *high*. The unmitigated social impact ranking is also considered *likely* with a *moderate* consequence, resulting in a *high* unmitigated social impact.

A traffic impact assessment has been undertaken as part of the updated environmental assessment (Transport and Urban Planning , 2018). This study assessed the potential changes to existing conditions as a result of the Revised Project and the potential traffic impacts on the local road network, operational capacity of key intersections, road condition and road safety. The Revised Project proposes a trucking rate of approximately 16 truck movements per hour from the site and along Bellambi Lane to Memorial Dr from 7am to 6pm Monday to Friday and 8am to 6pm to on Saturday.

The traffic impact assessment predicted that with the traffic control measures, it is *unlikely* that the Revised Project will result in an adverse impact on the performance of the road network (including at key intersections), road safety or road users. Traffic conditions on the road network are predicted to remain satisfactory, with the Project operating at full capacity.

Measures to be applied to manage traffic impacts include:

- Reduced trucking rates and truck movement hours (7.00am - 6.00pm Monday to Friday and 8.00am – 6.00pm to on Saturday).
- No haulage or construction works on Sunday or Public Holidays.
- Haulage of reject material from rejects stockpile to the mine portal limited to 7.00am – 6.00pm Monday to Friday.
- Maximum of one truck per hour associated with fuel supplies, deliveries, maintenance, etc.
- Designated truck parking area on site to prevent queuing of trucks onto the adjoining public road system. All trucks awaiting loading will park in this area with engines switched off.

- Construction activities (and associated construction traffic) will be undertaken during standard construction hours 7.00am - 6.00pm Monday to Friday and 8.00am – 1.00pm Saturday.

Note that coal transport may occasionally be required until 10.00pm Monday to Friday as a result of unexpected Port closures or interruptions. If this is the case, outbound laden truck movements will be further limited to an average of 12 trucks per hour between 6.00pm - 10.00pm, Monday to Friday only.

Based on the controls to be implemented by WCL, and the retention of a satisfactory level of service at the principal intersections, the Revised Project is unlikely to result in an adverse impact on road safety, the road network or road users. The proposed contribution to the maintenance of Bellambi Lane would further mitigate any impacts of the Revised Project on the condition of this local road

Accordingly, the likelihood of social amenity impacts associated with traffic movements are *likely* with the consequence level considered to be *minimal,* resulting in a mitigated social impact ranking of *moderate*.

Increased Traffic – Safety

While only nine participants in the first phase of engagement identified the impact of driver behaviour on safety as an issue of concern, the fact that stakeholders felt that this could result in serious injury, or even death, has been considered when rating the perceived impact. As a result of this consideration, the perceived unmitigated impact has been rated as *moderate* (*possible* but *minor*).

WCL's Occupational, Health and Safety policy includes control measures such as monitoring of driver speed, a strategy that was identified by those consulted to reduce impacts on the safety of road users. WCL has also committed to further monitoring of truck speeds. In addition, WCL will review and update the existing Russell Vale Colliery Traffic Management Plan and Drivers Code of Conduct and implement the updated plan for the Revised Preferred Project.

As a result of the application of the Occupational Health and Safety policy, and the strategies noted above, safety issues associated with truck movements are considered *possible* but *minimal*; resulting in an overall mitigated social risk rating of *low*.

Increased Traffic - Road Conditions

The results from the engagement indicate that stakeholders are concerned about the impact that the increased volume and the size of heavy vehicles will have on local roads. The level of concern though, was not as high as the other traffic related issues noted, with only six stakeholders in the first phase of engagement identifying this as a concern. It was raised by interviewees from both IRRM and the KNAG in the second phase of engagement. As a result, the perceived impact has been rated as *medium*.

The unmitigated likelihood has been rated as *likely* and the consequence has been rated as *minimal*. Accordingly, the unmitigated risk has been rated as *moderate*.

WCL will be making contributions to WCC to ensure the regular maintenance of Bellambi Lane, with road resurfacing already underway on affected roads in the area. With the application of this mitigation, the likelihood of road deterioration has been rated as *possible* with the impacts, with mitigation, considered *minimal*, resulting in an overall social risk ranking of *low*.

Table 5.13 Summary - Traffic and road safety impacts

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Social Amenity (access to property, increased travel times, disruption)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**High**	**High**	**Moderate**
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Public Safety (traffic incidents)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**High**	**Moderate**	**Low**
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Social Amenity Public Safety (Road conditions)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**Medium**	**Moderate**	**Low**

5.2.3 Environment

This section provides a summary of the social impacts relating to the environment during construction and operational phases of the Revised Project. The matters of most concern to the community related to water, particularly water access and quality due to subsidence and runoff/flooding, increased greenhouse gas emissions and potential negative impacts on flora and fauna.

These matters can potentially impact people's health and wellbeing, way of life and their surroundings. The following subsections provide an analysis of the social impacts noted.

5.2.3.1 Water – Access and Quality

The key concerns raised during the first phase of engagement were around water related to the potential impacts of the Revised Project on the quality of surface and groundwater (n=10) as a result of subsidence (n=22) and the potential effects on the Cataract Dam and Sydney water catchment area more broadly (n=12). This has been a key issue historically within the region as a result of mining activities with such fears further highlighted in the social media posts of various local environmental action groups. These issues were again key consideration during the second phase of engagement with both the IRRM and the KNAG flagging them.

A further eight participants in the first phase of engagement (n=8) also noted the potential for water quality impacts on other local waterways, as a result of flooding and runoff from the site. Once again, this appears to have been an historical issue relating to the Russell Vale operations. In total, there were 18 out of 34 responses that related to impacts associated with increased pollution in dams and waterways, as a result of potential subsidence impacts on ground and surface water, noting again, that participants were able to provide multiple responses to this question.

Consequently, in relation to impacts of the Revised Project on water, the perceived risk has been rated as *high*.

Historic subsidence impacts associated with mining activities are directly linked to the company's original proposal to utilise a long wall mining method for the project. The project has subsequently been redesigned to propose that only a first workings mining method be utilised.

Detailed subsidence impact (SCT, 2019) and groundwater impact (GeoTerra, 2019) assessments have been completed based on the revised first workings mine plan. The assessment indicated that the Revised Project will result in negligible subsidence and negligible subsidence-related impacts on natural and built surface features (including the Illawarra Escarpment, upland swamps, creeks, slopes and built structures), and on biodiversity, surface water and groundwater within the Cataract Reservoir catchment. Additionally, the risk of proposed mining destabilising historical mine workings is also low.

The results of the groundwater assessment also indicate there is unlikely to be any observable groundwater drawdown effect associated with the proposed first workings mine plan. There is also predicted to be no observable impact on overall groundwater quality as a result of the Revised Project. Furthermore, the Revised Project is not anticipated to have any adverse impact on stored water quantity or quality in the Cataract Reservoir and is considered to satisfy the Neutral or Beneficial Effect test for the Sydney Drinking Water Catchment.

Consequently, the impact of the project on the Cataract Dam and the Sydney Catchment area, utilising a first workings mining technique, would substantially reduce the potential for subsidence and the risks associated with subsidence. Consequently, it is *possible* that some subsidence will occur, it *minimal*, resulting in a *low* unmitigated and mitigated social impact ranking. Subsidence monitoring will however be undertaken, to confirm that observed subsidence levels are within predicted negligible levels.

In relation to the potential for flooding and runoff from the site, impacting local waterways, it is *possible* that the Revised Project will have a *minor* impact, resulting in a *moderate* unmitigated social impact ranking. In this regard, technical studies have been completed on both surface water and ground water in relation to the Revised Project, with improvements to the existing surface management system, plus additional water quality improvement measures proposed for the Pit Top Facilities. The technical water assessments have concluded that the proposed improvements to the stormwater system and additional water quality controls, proposed for the Pit Top Facilities, will reduce the frequency and volume of upslope clean catchment runoff entering the Water Management System during high rainfall events and will improve water quality leaving the site during flood events, reducing flood impacts to downstream properties, the Princes Highway, Bellambi Lane and Bellambi Gully.

Therefore, mitigated, the impact of flooding and/or runoff from the site affecting local residents is *possible* but *minimal*, given the mitigations to be put in place, resulting in a low mitigated social impact ranking.

Table 5.14 Summary – Access to water and water quality, flooding and run-off

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Underground mining operations (First workings method only)	Surroundings Way of Life Personal and property rights Health and Wellbeing	Access to water Quality of water – drinking, recreation	Sydney Water Catchment	Permanent	Russell Vale Residents Wollongong LGA Residents Water Catchment users	**High**	**Low**	**Low**

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Pit Top Operations	Surroundings Way of Life Personal and property rights Health and Wellbeing	Flooding impacts Water Quality	Local Creeks Sydney Water Catchment	Project Life	Russell Vale Residents Wollongong LGA Residents Water Catchment users	High	Moderate	Low

5.2.3.2 Air quality - Greenhouse gas emissions

Greenhouse gas (GHG) emissions and concerns regarding climate change were raised by approximately 16 stakeholders in the first phase of engagement, however, was a key issue identified as part of the PAC and submissions process. The issue was also reiterated in the second phase of engagement with the IRRM, the KNAG and members of the CCC and the broader community attending the community information session. Consequently, the issue has been given a perceived risk ranking of *high*.

A Greenhouse Gas and Energy Assessment (Umwelt, 2019) has been undertaken to estimate the GHG inventory and energy use for the Revised Project. The assessment has concluded that the forecast GHG emissions and predicted energy use intensity of the Revised Project falls within the small scale operating range for an Australian underground coal mine.

WCL will review and update the Greenhouse Gas Management Plan to consider both the construction and operational phase of the Revised Project.

WCL will continue to seek operational energy use efficiencies where commercially feasible and will review renewable energy opportunities as new technology is developed and becomes viable

Given the results of the assessment and the mitigation measures proposed above, the likelihood level is *possible,* and the consequence level is *minor,* resulting in a *moderate* unmitigated and mitigated social risk ranking.

Table 5.15 Summary - Greenhouse Gas Emissions

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operations	Surroundings Way of Life Health and Wellbeing	Intergenerational equity Fears and aspirations	Project area	Project life	Key environmental groups Wollongong LGA residents	High	Moderate	Moderate

5.2.3.3 Biodiversity - flora and fauna

Perceived concerns regarding the environmental impacts of the Revised Project was *medium* amongst stakeholders, particularly the incompatibility of the project with conservation values (n=22, phase one of engagement) and impacts on biodiversity values such as upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir.

An updated biodiversity impact assessment (Biosis, 2019) has been undertaken to determine the potential impacts of the Revised Project on the natural features and biodiversity values. The assessment has concluded that as a result of the proposed first workings mining method, the Revised Project has removed the risk of subsidence-related damage to sensitive environmental features within the application area such as the Cataract River, Cataract Creek and Bellambi Creek, coastal upland swamps as well as rocky outcrops and cliffs. As such, threatened species occupying these sensitive environments (including Prickly Bush-Pea, Giant Burrowing Frog, Red Crowned Toadlet and the Giant Dragonfly) are considered at negligible risk of impact. The Revised Project will also result in imperceptible impacts to surface water flows and water quality within aquatic environments and therefore negligible impacts are anticipated to the habitat of threatened fish species.

The proposed upgrades to Pit Top will occur within existing disturbed areas, and no direct or indirect impact on biodiversity is anticipated as a result of these works.

WCL also has undertaken to continue to monitor and manage impacts to biodiversity in accordance with the current Biodiversity Management Plan (2018), including a revised Upland Swamp Management Plan.

Given these results, it is considered that while is *possible* that there may be impacts on flora and fauna as a result of the Revised Project, the consequence is likely to be *minimal* resulting in a *low* unmitigated and mitigated social impact rating.

Table 5.16 Summary - Biodiversity

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operations	Surroundings Way of Life	Intergenerational equity Fears and aspirations	Local National	Permanent	Local, regional and national residents Key stakeholders (IRRM, KKAG, CCC, other key environmental groups)	**Medium**	**Low**	**Low**

5.2.4 Livelihood Impacts – Local Employment, Procurement and Community Investment

This section provides a summary of the economic related social impacts during construction and operational phases of the Revised Project. The social impact matters include the opportunity for the project to provide local employment and procurement for the project life and community investment. These matters impact people's personal and property rights, way of life and sense of community. The following sub-sections provide a detailed analysis of the social impacts.

During the first phase of engagement, there was some acknowledgement of the positive economic impacts associated with the presence of WCL in the region, mostly in terms of direct (employment) and indirect flow on effects (n=4) to local suppliers and businesses. During the second phase of engagement, the potential for local employment and procurement, was given greater weighting as a result the involvement of more regional residents. Given this, the perceived social impact has been rated as a positive *medium* impact.

The Revised Project is likely to result in the creation of 22 construction jobs for between 12 and 24 months and at peak, 205 operational positions equating to a family level impact on the regional population of up to 513 new employees and their families depending upon the workforce scenario (refer to **Table 5.8**). This influx of workforce is likely to contribute to the local and regional economies through wages, annual household expenditure, use of services and participation in community life.

The results of the economic assessment (Cadence Economics, 2019) indicate a net benefit to NSW of around $174.3 million in net present value (NPF) terms, consisting of $116.9 million in direct benefits to the State, $57.5 million in indirect benefits and indirect costs of $19,158. The Revised Project will also provide a net benefit of $14.3 million in NPV terms to the Wollongong area, consisting of approximately $8.7 million to employees and $5.5 million to local suppliers.

In addition, WCL has identified a range of local employment and procurement opportunities through an internal review process and is committed to providing the local community with access to these opportunities as they arise.

Results of the economic assessment also estimate that there will be $33.2 million paid in royalties, $3.4 million payroll tax and $2.1 million council rates and taxes; with $38.5 million being company tax attributable to NSW as a result of the Revised Project. Further to this, WCL contributes to a range of community programs, and this is expected to continue if the Revised Project is approved. Based on the outcomes of the assessment, it is *likely* that the Revised Project will result in a *moderate* social impact to the livelihoods of employees, local business and service providers in the Wollongong LGA and investment in local/regional/state communities, and has therefore been rated as a *high* positive social impact (unmitigated and mitigated).

Table 5.17 Summary – employment and procurement opportunities

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operations	Way of Life Community Personal and property rights	Livelihood impacts	Wollongong LGA residents Regional residents	Project Life	WCL Employees Local and regional businesses and service providers Local/Regional/State Communities	**Medium (Positive)**	**High (Positive)**	**High (Positive)**

5.2.5 Social Licence to Operate – Trust and Engagement Social Licence to Operate (SLTO)

Stakeholders participating in the engagement activities also identified social licence to operate as a key issue in relation to the RRP, particularly the governance and viability of the Revised Project, as well as engagement and information provision relating to the Revised Project. This matter has the potential to impact sense of community in the locality given the perceived lack of trust and level of uncertainty associated with company and the Revised Project.

In total 12 participants in the first phase of engagement raised management related concerns that comprised perceptions of poor management and governance (n=9), uncertainty regarding continued operations (n=5) and general economic viability of the company and the project in the short to long-term (n=5). A review of traditional and social media indicate that a proportion of the broader community also share these concerns; with WCL having been in the media as a result of occupational health and safety concerns at the Wongawilli mine site; issues relating to delays in removing a stockpile from the Revised Project site; and issues around ASIC restrictions relating to over-valuation of mining assets.

Furthermore, interviewees from both the IRRM and the KNAG raised similar concerns during the second phase of engagement. Consequently, issues in relation to SLTO have been categorised as a *high* perceived social impact.

It is therefore *likely,* based on previous company performance, that the impact of company management and governance could result in a *moderate* social consequence, resulting in a *high* (unmitigated) social impact ranking.

To address SLTO issues, it is recommended that the company develop a comprehensive social impact management and engagement plan, that details how they will monitor social impacts and engage with local residents and key stakeholders as part of the implementation of the RRP. The desire to see improved company engagement and information provision, was frequently raised by those consulted, including public release of environmental monitoring data. In addition, the state government and the wider community has also called for greater transparency from WCL in relation to their operations in the region.

With the commitment in place for the development and implementation of a dedicated social impact management plan, including a detailed community engagement plan, for the Revised Project; a mitigated social impact ranking of moderate (*possible* and *minor*) could be achieved.

Table 5.18 Summary – Social Licence to Operate

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operations	Fears and Aspirations Decision Making Systems Personal and Property Rights Sense of Community	Social Licence to Operate - Trust - Uncertainty - Engagement and Information Provision	Russell Vale Residents Wollongong LGA	Project Life	Russell Vale Residents Wollongong LGA State Government	High	High	Moderate

5.2.6 Property

This section provides a summary of the property related social impacts identified as a result of the Revised Project Revised Project, with perceptions relating centrally to devaluation of property values and increased property maintenance as a result of the Revised Project. These matters impact people's way of life and personal and property rights. Specifically, stakeholders in the first phase of engagement raised concern that the value of their properties would be reduced as a result of their proximity to the operations (n=9), with some stakeholders also concerned that there would be an increase in the degree of maintenance that they would need to undertake as a result of dust impacts from the operations. Consequently, the perceived social risk has been categorised as *medium*.

As demonstrated in **Figure 3.31** and **Figure 3.32** property values in both Russell Vale and Corrimal have increased steadily and in line with the broader market since 2009.

Consequently, the likelihood of property prices decreasing as a result of the presence of the operations and the Revised Project, given the historical presence of the operation in the community is considered *possible* but *minimal*, resulting in an unmitigated social impact ranking of *low* and a mitigated ranking (given the implementation of environmental controls) also of *low*.

Table 5.19 Summary – Property Values and Maintenance

Project Aspect	SIA Category	Social Impact Matter	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Social Impact Ranking (Mitigated)
Construction and Operations	Personal and Property Rights Sense of Community	Decline in property values impacting resident livelihoods	Russell Vale Residents	Project Life	Russell Vale Residents	**Medium**	**Low**	**Low**

5.3 Social Impact Assessment Summary

Table 5.20 Social Risk Summary Table

Project aspect	SIA Category	Social impact matter	Extent	Duration	Affected parties	Perceived social impact/sensitivity	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Describe the aspect of the project that is causing the impact e.g. Construction of operation, operational workforce	*Health and wellbeing Sense of Community Livelihoods Social Amenity Population change*	*Describe the potential social impact matters. What does the project mean for people? Consider findings from community and key stakeholder engagement, tech studies and baseline*	*Geographical extent i.e. suburbs affected, local government areas or State etc.*	*Length of time the potential social impact is anticipated for e.g. Months, Years, Project life, Permanent*	*Stakeholders affected e.g. Landholders, residents, service providers, government agencies etc.*	*Assess the impacts based on community perceptions using table Social Risk Matrix (consequence/ likelihood) Fill box with colour that reflects assessment*	*Assess the impact given consideration to the technical studies Fill box with colour that reflects assessment*	*Assess the impact given consideration to the technical studies Fill box with colour that reflects assessment and the mitigations being applied*
Population and Community Infrastructure and Services (Construction Workforce)								
Construction workforce influx	Way of Life Community Surroundings	Population change – influx of construction workers	Wollongong LGA	12 to 24 months	Russell Vale and LGA residents	**Low**	**Low**	*NA*
Construction workforce influx	Way of Life Community Surroundings	Population change – influx of construction workers	Wollongong LGA	12 to 24 months	Local Businesses and Service providers	**Low (Positive)**	**Low (*Positive*)**	*NA*
Population change impacts (Operational workforce)								
Operational workforce influx	Way of Life Community Surroundings	Population change – influx of operational workers	Wollongong LGA Workforce Scenarios 3 and 4	Project Life	Russell Vale and LGA residents	Low (*Positive*)	Moderate (*Positive*)	*NA*
Operational workforce influx	Way of Life Community Surroundings	Population change – influx of operational workers	Wollongong LGA Workforce Scenarios 3 and 4	Project Life	Local Businesses and Service providers	Low (*Positive*)	Low (*Positive*)	*NA*

Project aspect	SIA Category	Social impact matter	Extent	Duration	Affected parties	Perceived social impact/sensitivity	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Air quality/dust from construction and operations								
Construction of the Project	Way of Life Community Surroundings Health and Wellbeing	Social Amenity	Russell Vale Residents Wollongong LGA	Construction	Russell Vale and LGA residents	**High**	**High**	**Low**
Operation of the Project	Way of Life Community Surroundings Health and Wellbeing	Social Amenity	Russell Vale Residents Wollongong LGA	Operation	Russell Vale and LGA residents	**High**	**High**	**Low**
Construction and Operation of the Project	Way of Life Health and Wellbeing	Health and Wellbeing	Russell Vale Residents	Construction Project Life	Russell Value Residents Russell Vale Pre-school	**High**	**High**	**Low**
Noise from construction and operation impacts								
Construction of the Project	Way of Life Surroundings Health and Wellbeing	Social Amenity Health and Wellbeing	Russell Vale Residents	Construction	Russell Vale residents Aspect South Coast School	**High**	**High**	**Moderate**
Operation of the Project	Way of Life Surroundings Health and Wellbeing	Social Amenity Health and Wellbeing	Russell Vale Residents	Project Life	Russell Vale Residents Aspect South Coast School	**High**	**High**	**Low**
Traffic and road safety impacts								
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Social Amenity (access to roads)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**High**	**High**	**Moderate**

Project aspect	SIA Category	Social impact matter	Extent	Duration	Affected parties	Perceived social impact/sensitivity	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Public Safety (traffic incidents)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**High**	**Moderate**	**Low**
Product transport from site to the Port	Way of Life Surroundings Health and Wellbeing	Social Amenity Public Safety (Road conditions)	Residents/ businesses along the Transport route	Project Life	Russell Vale Residents Wollongong LGA Residents	**Medium**	**Moderate**	**Low**
Access to water and water quality, flooding and run-off								
Underground mining operations (First workings method only)	Surroundings Way of Life Personal and property rights Health and Wellbeing	Access to water Quality of water – drinking, recreation	Sydney Water Catchment	Permanent	Russell Vale Residents Wollongong LGA Residents Water Catchment users	**High**	**Low**	**Low**
Pit Top Operations	Surroundings Way of Life Personal and property rights Health and Wellbeing	Flooding impacts Water Quality	Local Creeks Sydney Water Catchment	Project Life	Russell Vale Residents Wollongong LGA Residents Water Catchment users	**High**	**Moderate**	**Low**
Greenhouse Gas Emissions								
Construction and Operations	Surroundings Way of Life Health and Wellbeing	Intergenerational equity Fears and aspirations	Project area	Project life	Key environmental groups Wollongong LGA residents	**High**	**Moderate**	**Moderate**
Biodiversity								
Construction and Operations	Surroundings Way of Life	Intergenerational equity Fears and aspirations	Local National	Permanent	Local, regional and national residents Key stakeholders (IRRM, KKAG, CCC, other key environmental groups)	**Medium**	**Low**	**Low**

Project aspect	SIA Category	Social impact matter	Extent	Duration	Affected parties	Perceived social impact/sensitivity	Social impact ranking (unmitigated)	Social impact ranking (mitigated)
Local Employment, Procurement and Community Investment								
Construction and Operations	Way of Life Community Personal and property rights	Livelihood impacts	Wollongong LGA residents Regional residents	Project Life	WCL Employees Local and regional businesses and service providers Local/Regional/State Communities	**Medium (Positive)**	**High (Positive)**	**High (Positive)**
Social Licence to Operate								
Construction and Operations	Fears and Aspirations Decision Making Systems Personal and Property Rights Sense of Community	Social Licence to Operate Trust Uncertainty Engagement and Information Provision	Russell Vale Residents Wollongong LGA	Project Life	Russell Vale Residents Wollongong LGA State Government	**High**	**High**	**Moderate**
Property Values and Maintenance								
Construction and Operations	Personal and Property Rights Sense of Community	Decline in property values impacting resident livelihoods	Russell Vale Residents	Project Life	Russell Vale Residents	**Medium**	**Low**	**Low**

6.0 Management and Mitigation

This section provides a summary of the potential strategies that may be implemented in response to the predicted social impacts associated with the Revised Project, as outlined in **Section 5.0**.

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.

In addition to mitigation measures WCL has implemented, and the mitigation measures adopted through the Revised Project re-design, residents and key stakeholders identified several strategies to address potential social impacts associated with the Revised Project. These strategies are summarised in **Table 6.1** below.

6.1.1 Mitigation and Enhancement Summary

Table 6.1 Summary of mitigation and enhancement strategies

Impact theme	Impact	Community and SIA Suggested mitigations	Proposed measures to be implemented as part of the Revised Project	Relevant section where this has been addressed
Operational Impacts	**Population Change**	None proposed.	Approximately 22 employees during construction; Approximately 205 employees during operations.	Refer to **Section 5.2.4** of this report.
	Air quality	Clean trucks prior to leaving site. Selection of contractor with modern trucks and covers 24 hour air quality monitoring and provision of results	WCL will review and update the existing Russell Vale Colliery Air Quality and Greenhouse Gas Management Plan and implement the updated plan for the Revised Project. This will detail the monitoring and management controls to be implemented to manage air quality impacts associated with the Revised Project including implementation of proactive and reactive management protocols in response to air quality trigger levels defined in the plan. Specifically, the proactive air quality management approach will include: • implementation of a system to provide the operation with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the weather conditions and dust considerations at daily pre-shift meetings • modifying or suspend the planned activities, as appropriate, to minimise dust impacts. In addition, WCL will implement a range of air quality mitigation measures and controls during operation of the Revised Preferred Project: • Enclosure of conveyors and material transfer points • Enclosure of Coal Processing Plant • Water sprays on ROM stockpile • Water carts on unsealed haul routes • Water sprays on stockpiles and exposed areas triggered during periods of high winds • Water sprays on the bunds during construction • Trucks will be covered before leaving the site • Trucks will be washed before leaving the site • Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes • Revegetation/rehabilitation of exposed disturbed areas.	See Section 5.7, Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full air quality impact assessment provided in Appendix 6.

Impact theme	Impact	Community and SIA Suggested mitigations	Proposed measures to be implemented as part of the Revised Project	Relevant section where this has been addressed
		Clean dust at nearby houses	The air modelling results indicate that with the air quality management measures in place the Revised Project is not predicted to result in any exceedance of air quality criteria at any residences off site.	See Section 5.7, Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full air quality impact assessment provided in Appendix 6.
	Noise	Limit transport hours and hours of operations to business hours	• WCL will limit coal beneficiation, truck loading and coal transport to typical daytime hours only, i.e. between 7.00am and 6.00pm Monday to Friday and 8.00am and 6.00pm Saturday. • No coal beneficiation, truck loading and coal transport is proposed to occur on Sundays or Public Holidays. • Coal beneficiation, truck loading and coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closure or supply interruption, however such circumstances would be rare and as a result of unexpected events.	See Section 5.6, Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full noise impact assessment provided in Appendix 5.
		Provision of double glazing	• WCL will implement a range of feasible and reasonable construction noise management measures and operational noise mitigation measures as described in Section 5.6 of Part A of the Revised Preferred Project and Response to PAC Second Review Report. • The updated noise assessment predicts that the project design changes and additional noise control measures to be implemented as part of the Revised Project will significantly reduce the predicted noise levels of the Revised Project in comparison to both historical operations, and to the previously proposed site configurations.	
		Consider moving entry to Mount Ousley	The updated noise assessment indicated that noise from trucks transporting coal complies at residences along Bellambi Lane and surrounds. However, this option could potentially be considered in further mining beyond the current proposal.	
		Provision noise monitoring data	• WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project, including quarterly website updates and annual community information sessions. • WCL will continue to implement the existing community complaints response and management program.	Section 6.0, Part A of the Revised Preferred Project and Response to PAC Second Review Report.

Impact theme	Impact	Community and SIA Suggested mitigations	Proposed measures to be implemented as part of the Revised Project	Relevant section where this has been addressed
Heavy Vehicles	**Traffic**	Consider alternate transport routes	The proposed transport route via Bellambi Lane and Memorial Drive is the route that has historically been used for transport of coal from the Russell Vale Colliery. This route is therefore consistent with previously approved operations and is also an approved 25/26 metre B Double route, as is the remainder of the transport route to Port Kembla.	See Section 5.8, Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full traffic impact assessment provided in Appendix 7.
	Driver Behaviour	Monitor truck speed	WCL will maintain, monitor and enforce the voluntary speed limit along Bellambi Lane of 50km/hr for all trucks accessing the Colliery, with the continued aim of achieving 95% compliance with the voluntary speed restriction	
	Road maintenance	Contribute to road maintenance Resurface roads	WCL will seek to reach agreement with WCC for a road maintenance contribution for the maintenance of Bellambi Lane within 12 months of the approval of the Revised Project.	
	Heavy vehicles and traffic generally	Educate community via Stakeholder Engagement Strategy	WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project, including quarterly website updates and annual community information sessions. WCL will continue to implement the existing community complaints response and management program.	Section 6.0, Part A of the Revised Preferred Project and Response to PAC Second Review Report.
Environment	**Pollution of waterways**	Provision of water use and quality monitoring data	• The existing subsidence monitoring program will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. The monitoring program will be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mining below subsidence sensitive infrastructure. • WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project, including quarterly website updates and annual community information sessions. • WCL will continue to implement the existing community complaints response and management program.	See Section 5.8, Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full traffic impact assessment provided in Appendix 7.

Impact theme	Impact	Community and SIA Suggested mitigations	Proposed measures to be implemented as part of the Revised Project	Relevant section where this has been addressed
	Contamination of water supply	Provision of water use and quality monitoring data	• The Revised Project will use non-caving first workings mining techniques only which have been designed to be long term stable with minimal risk of subsidence and pillar failure to address potential subsidence-related impacts on biodiversity and water resources within the Cataract Reservoir catchment. • The subsidence and groundwater impact assessments concluded that due to the change in the mine design, the Revised Project is not expected to adversely impact on stored water quantity or quality in the Cataract Reservoir.	See Sections 5.2 and 5.3 in Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the subsidence assessment and groundwater assessment provided in Appendix 1 and 2 respectively.
	Subsidence	Adjust mine design further back from the dam	No mining is proposed beneath the full supply level of Cataract Reservoir as part of the Revised Project.	See Section 2.0, Part A of the Revised Preferred Project and Response to PAC Second Review Report.
	Greenhouse gas emissions	Provision of monitoring data	• WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project, including quarterly website updates and annual community information sessions. • WCL will continue to operate the Russell Vale Community Consultative Committee following relevant DPIE guidelines. • WCL will continue to implement the existing community complaints response and management program.	Section 6.0, Part A of the Revised Preferred Project and Response to PAC Second Review Report.
	Biodiversity	Provision of information regarding biodiversity offsets		
	Environment generally	Provision of environmental monitoring data		
Economic	**Local employment and procurement**	Provide training and apprenticeships to locals	WCL will undertake to provide training to locals including graduates with no mining experience; apprenticeships will form part of training opportunities. WCL has identified the following opportunities for skills development and training: • Graduates will be sourced and employed (i.e. environmental scientists, mechanical, electrical and mining engineers) from Wollongong University. • In-house development of personnel trained in Place Change skills.	See **Section 5.2** of this report, including Section 5.13 in Part A of the Revised Preferred Project and Response to PAC Second Review Report, with the full economic impact assessment in Appendix 10.
		Local employment quotas	The economic impact assessment indicates that the Revised Project is expected to generate total indirect benefits of $57.4 million in Net Present Value terms, comprised of $43.6 million of worker benefits and $13.8 million of supplier benefits. WCL will undertake to source staff locally where possible to enhance the local effects of the employment quotas.	
	Community	Contribute to	• WCL has over the past three years supported a range of community-based	Refer to **Section 7.0** in this

Impact theme	Impact	Community and SIA Suggested mitigations	Proposed measures to be implemented as part of the Revised Project	Relevant section where this has been addressed
	contribution/ investment	community	organisation and activities in the local area. • Further review of current development of the program to identify and address key community needs in the locality	report.
SLTO - Management	**Trust in management**	Development of Stakeholder Engagement Strategy	• WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the Revised Project, including quarterly website updates and annual community information sessions. • WCL will continue to operate the Russell Vale Community Consultative Committee following relevant DPIE guidelines. • WCL will continue to implement the existing community complaints response and management program	Refer to **Section 7.0** in this report.
SLTO - Provision of Information	**Transparency and information sharing**	Development of Stakeholder Engagement Strategy	• WCL will conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the Revised Project, including quarterly website updates and annual community information sessions. • WCL will continue to operate the Russell Vale CCC following relevant DPIE guidelines. • WCL will continue to implement the existing community complaints response and management program.	Refer to **Section 7.0** in this report.
Property	**Decreased property values**	Monitor property values	• Development and execution of a social impact management plan for the ongoing monitoring and management of social impacts.	Refer to **Section 7.0** in this report.
		Compensate for losses	• -	-

7.0 Social Impact Monitoring and Evaluation

A key aspect of any SIA is the development of a framework to monitor a project's impact over time – often referred to as a social impact management plan (SIMP). A number of aspects, relating to the monitoring and evaluation of social impacts, are detailed in the SIA guideline (DPE, 2017) and include development of:

- A program that monitors predicted impacts against actual impacts detailing how and when this will be achieved - including community participation.
- A process for reporting incidents and providing information to the community.
- A process for reviewing the above processes.
- A process for provision of monitoring results to the public.

Where possible, a SIMP should also include:

- Mechanisms to facilitate data sharing.
- Independent monitoring.
- Community based monitoring.

The outcomes of the SIA provide a basis for the development of a social impact management plan (SIMP) to monitor social impacts and commitments made as part of the Revised Project.

It is considered best practice in social outcomes measurement and monitoring to draw upon a range of methods, data sources, indicator and data types (e.g. objective vs. subjective, qualitative vs. quantitative; leading versus lagging indicators). Therefore, the proposed monitoring framework should draw upon multiple methods, which may include:

1. *Monitoring socio-economic trends* that will provide context and provide an appreciation of community change.
2. *Monitoring organisational inputs and outputs* which will provide an understanding of what WCL is contributing to the community e.g. in relation to employment, expenditure, local procurement.
3. *Monitoring outcomes of inputs and outputs* which will provide an understanding of what impact community projects and investments are having in the community. WCL has a current community support program that provides contributions to local community groups and organisations, these programs will be further developed to address key community needs.
4. *Monitoring objective indicators of impact* which will ensure WCL is monitoring key risks and trends in relation to key impact areas identified through the SIA process e.g. monitoring of key impacts such as noise and air quality.
5. *Monitoring community perceptions of impact* (e.g. feelings of trust towards the company, resident experience of social impacts), which will ensure regular engagement with the community and ensure emerging issues and impacts are identified proactively.

The SIMP should be developed in consultation with key stakeholders and should also include a process for evaluating engagement efforts. The development of a SIMP that accords with the above principles with regard to the Revised Project will be developed to ensure that reasonable and feasible mitigation measures are implemented to minimise ongoing impacts on the community.

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APPENDIX A

Media Review 2014 – 2019 (Umwelt, 2019)

Media Review 2014 – 2019 (Umwelt, 2019)

Date	Source/Headline	Summary	Link
16/05/2019	Trucks arriving at Wollongong Coal before dawn are waking Russell Vale residents	Residents living near Wollongong Coal's Russell Vale mine claim the company has broken a promise about early morning truck movements.	https://www.illawarramercury.com.au/story/6127635/miners-coal-trucks-waking-russell-vale-residents-before-dawn/
14/05/2019	'Worse than expected': WaterNSW calls for mining curbs in Sydney's catchment	NSW's top water agency has called for curbs on two big coal mines in Sydney's catchment, saying millions of litres of water are being lost daily and that environmental impacts are likely breaching approval conditions.	https://www.smh.com.au/environment/sustainability/worse-than-expected-waternsw-calls-for-mining-curbs-in-sydney-s-catchment-20190514-p51n3m.html
09/05/2019	Wollongong Coal appoints Srivastava to its board	Srivastava has more than 25 years of experience in the coal and mineral business, working for the largest steel and aluminium companies of India in various functional roles.	https://www.miningmonthly.com/investment/international-coal-news/1362501/wollongong-coal-appoints-srivastava-to-its-board
17/04/2019	Millennium Post JSPL rejects charges of not disclosing info on Oz mines	New Delhi: Jindal Steel and Power Ltd (JSPL) Tuesday refuted allegations of not reporting to the investors issues related to its mines in Australia and termed the charges as "false facts". " Arun Kumar Jagatramka erstwhile promoter of Gujarat NRE Coke Ltd, has made an extremely shallow attempt by writing a flimsy defamatory piece and the allegations made are incorrect and frivolous in its entirety and hence not to be believed," JSPL said in a BSE filing.	http://www.millenniumpost.in/business/jspl-rejects-charges-of-not-disclosing-info-on-oz-mines-349174
11/04/2019	Mining and Technology Second and final Wollongong project closed over safety violations	Mine closure at Wongawilli and speculation around the UEP proposal	https://www.mining-technology.com/mining-safety/second-and-final-Wollongong-project-closed-over-safety-violations
10/04/2019	Illawarra Mercury Wollongong mine will be closed down, 45 jobs to go	About 45 Wollongong coal miners are likely to lose their jobs after Wollongong Coal made the decision to close its Wongawilli colliery.	https://www.illawarramercury.com.au/story/6016190/wollongong-mine-will-be-closed-down-45-jobs-to-go/

Date	Source/Headline	Summary	Link
25/03/2019	Mirage News ASIC restricts Wollongong Coal from issuing any reduced-content prospectus	ASIC has given notice to Wollongong Coal Limited (Wollongong Coal) restricting the company from issuing any reduced-content prospectus until 11 March 2020.	https://www.miragenews.com/asic-restricts-wollongong-coal-from-issuing-any-reduced-content-prospectus/
22/03/2019	Illawarra Mercury Chance of work for Wollongong miners stood down after roof falls	About 100 workers stood down because of safety concerns at Wollongong Coal's Wongawilli mine are hoping they can be redeployed to other sites during the enforced shutdown of the operation by the NSW Resources Regulator.	https://www.illawarramercury.com.au/story/5968838/chance-of-work-for-wollongong-miners-stood-down-after-roof-falls/
21/03/2019	Green Left Weekly Sydney's drinking water under threat from coalmining	You may not know that coking coal, used in steel making, is mined in the Greater Sydney drinking water catchment. Long-wall extraction of coal has been used in the mines under the Sydney Water Special Areas since the 1960s. There is no doubt about coking coal's financial value to the mining companies and royalties for the NSW government. However, not enough people know that the mines jeopardise water security for approximately 5 million people living in Greater Sydney, the Illawarra and the Blue Mountains.	https://www.greenleft.org.au/content/sydneys-drinking-water-under-threat-coalmining
20/03/2019	Illawarra Mercury Wongawilli closed, now Wollongong Coal faces fight on another front	Wollongong Coal, with its Wongawilli mine shut down over serious safety concerns, has also been hit with the news that it has failed to satisfy the corporate regulator it hasn't massively overvalued its mine assets. The company will spend weeks trying to satisfy the Resources Regulator its mine can be made safe to re-open, after a series of roof collapses. (Posted on social media by IRRM)	https://www.illawarramercury.com.au/story/5964943/wollongong-coal-faces-fight-on-another-front/?cs=300&fbclid=IwAR0qvTeDfZ-rFS0Hy8ue5EYORHLY9U9O4kjam5fMoiknHEG92mobgEwNZLY

Date	Source/Headline	Summary	Link
19/03/2019	Illawarra Mercury Wongawilli coal mine shut down due to 'serious safety issues'	The state's chief mine inspector has stopped work at Wollongong Coal's Wongawilli mine amid a major investigation into what the NSW Resources Regulator says are "significant safety issues". The stop work order comes after the mining compliance regulator slapped the mine's operators with four separate prohibition notices last week. (Posted on social media by IRRM)	https://www.illawarramercury.com.au/story/5962850/wongawilli-coal-mine-shut-down-due-to-serious-safety-issues/?cs=300&fbclid=IwAR1ilur4a3Zs1JgRETTbtoKvSDEoyRGfo9S8WKW0cvNYX-WiITSuySe89L4
18/03/2019	Australia's Mining Monthly Prohibition notice at Wongawilli over conveyor fire risk	In response to a series of recent reported roof falls, resources regulator inspectors attended the mine last week to review the risk controls in place to protect workers from roof failure. During the investigation, inspectors identified significant safety issues on underground conveyor equipment, relating to fire risk. "As a result, the mine operator was directed to shut the conveyors down until corrective actions are completed," the regulator said.	https://www.miningmonthly.com/development/international-coal-news/1358730/prohibition-notice-at-wongawilli-over-conveyor-fire-risk
18/03/2019	Illawarra 9News Protesters have spun a yarn about the impacts of longwall mining	Knitting Nannas protest at local MP office about water safety concerns	https://www.facebook.com/9NewsIllawarra/videos/328267031138257/
1/03/2019	Illawarra Mercury Big win for little preschool in Dombarton	Knocked back twice before, the small not for profit preschool in Dombarton will receive $325,000 under the NSW Government's latest Capital Works Grants program. Ms Horsey said the money will be used for stage 1 of the redevelopment and re-purpose of the old mine manager's cottage in Wongawilli Village that has been leased to the preschool by Wollongong Coal Limited for $1 a year for the next 10 years with a further option of 10 years.	https://www.illawarramercury.com.au/story/5931690/big-win-for-little-preschool-in-dombarton/

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11/02/2019	Illawarra Mercury Wollongong forum to highlight 'risky' mining of water catchment	A "Protect Our Water" forum in Wollongong on Wednesday night coincides with the drop in levels of drinking water reservoirs and the activation of the desalination plant. Illawarra Residents for Responsible Mining spokesperson Gavin Workman said the plant is a facility Illawarra residents will pay for but not benefit from	https://www.illawarramercury.com.au/story/5899199/wollongong-forum-to-highlight-risky-mining-of-water-catchment/
29/11/2018	Illawarra Mercury Wollongong Coal finally removing 200,000-tonne Russell Vale stockpile	Wollongong Coal starts removing the unlawful stockpile of 200,000 tonnes of waste coal from its Russell Vale mine. Residents were concerned the stockpile had still not been cleared up after years on site, and went further, saying many didn't want the mine re-opened at all.	https://www.illawarramercury.com.au/story/5782882/wollongong-coal-finally-removing-200000-tonne-russell-vale-stockpile/
25/11/2018	Illawarra Mercury Russell Vale mine will 'ramp up' in 2019, says Wollongong Coal	Coal production at the Russell Vale mine is expected to "ramp up" next year, Wollongong Coal has told investors. In its half-yearly financial report, Wollongong Coal (WCL) said it will complete its application to restart mining by January 2019. The company said it expected to receive approval from the NSW Department of Planning and Environment.	https://www.illawarramercury.com.au/story/5774834/russell-vale-mine-will-ramp-up-in-2019-says-wollongong-coal/
23/11/2018	Illawarra Mercury Wollongong Coal declares $57 million loss for half-year to September	Wollongong Coal has reported another enormous deficit, booking a loss of $57.6 million for the six months to September. This is more than double the size of the loss in the corresponding period last year, and raises further questions about whether the struggling miner can continue.	https://www.illawarramercury.com.au/story/5772870/coal-selling-but-wollongong-coal-declares-57-million-loss/
21/11/2018	Australia's Mining Monthly Russell Vale to resume production in 2019: Wollongong Coal	Wollongong Coal's preparation of its application to restart mining operations at its Russell Vale mine in New South Wales is nearing completion and will be submitted in its final form in January 2019 with production from the mine expected later in the year.	https://www.miningmonthly.com/development/international-coal-news/1351438/russell-vale-to-resume-production-in-2019-wollongong-coal

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21/11/2018	Stockhead Wollongong Coal had a massive half-year loss blowout – and it's blaming the AUD	Struggling coal tiddler Wollongong Coal's half year loss has blown out by 143 per cent, and it says the problem is the weak Aussie dollar. Wollongong (ASX:WLC) said the foreign exchange loss was due to the change in exchange rate between the US dollar and Australian dollar on its US dollar borrowings.	https://stockhead.com.au/resources/wollongong-coal-had-a-massive-half-year-loss-blowout-and-its-blaming-the-aud/
6/11/2018	Illawarra Mercury Wollongong Coal to step up safety at its Wongawilli mine	After a series of injuries at its Wongawilli mine, Wollongong Coal are on the hunt to find a safety and health manager. The role will "assist the mine to operate safely and productively going forward".	https://www.illawarramercury.com.au/story/5741860/wollongong-coal-to-step-up-safety-at-its-wongawilli-mine/
19/10/2018	Illawarra Mercury Wollongong Coal exec Sanjay Sharma paid $330k 'termination', then returned a month later	Wollongong Coal company secretary Sanjay Sharma took a termination payout of more than $330,000 in 2017, but was back in his old job a month later. This status of the "termination payout" was left unclear but appeared to be related to a term in his contract.	https://www.illawarramercury.com.au/story/5707989/mine-exec-got-330k-termination-pay-was-back-a-month-later/
12/10/2018	Illawarra Mercury Wollongong Coal's bid to terminate its workplace agreement slammed by Labor leader	Workers laid off from the Russell Vale mine should be the first taken back on if operations restart, according to a section in the workplace deal Wollongong Coal is seeking to terminate.	https://www.illawarramercury.com.au/story/5698800/a-mine-without-permanent-miners-termination-bid-blasted/
10/10/2018	Illawarra Mercury IPCC reaction: Greens coal ban to spare Wollongong mines	The Greens say their policy to close coal mines does not include the metallurgical coal operations in the Illawarra, as the world digests the "urgent" call on renewable energy from the UN's Intergovernmental Panel on Climate Change. Australian and NSW Coalition governments threw their support behind the coal industry on Wednesday after the IPCC released a new report calling for an end to coal-fired power by 2050. The IPCC's report said global warming could be kept to 1.5 degrees but this would still have profound environmental effects.	https://www.illawarramercury.com.au/story/5694743/ipcc-reaction-greens-coal-ban-to-spare-wollongong-mines/

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10/10/2018	Illawarra Mercury Miner wants workplace agreement axed for more 'efficient' terms	Wollongong Coal is trying to terminate its workplace agreement for the Russell Vale colliery so if it restarts mining there, it will be able to employ a workforce on more "efficient" terms.	https://www.illawarramercury.com.au/story/5697662/miner-wants-workplace-agreement-axed-for-more-efficient-terms/
31/08/2018	Illawarra Mercury Wollongong Coal slag heap tests Bradbery's patience	Residents campaigning for action on Wollongong Coal's 200,000 tonne unlawful stockpile have succeeded in sparking some action, with Lord Mayor Gordon Bradbery demanding maximum "rigour" on the issue. Residents and environmentalists are concerned that a storm would wash part of the stockpile down Bellambi Creek and into the suburbs and waterways below.	https://www.illawarramercury.com.au/story/5619140/mayors-patience-runs-out-over-russell-vale-slag-heap/
24/08/2018	Illawarra Mercury Masked protest against 'secrecy' on Wollongong Coal order	A group of Illawarra environmentalists wore disguises on Friday as they staged a protest in slow motion over Wollongong Coal's Russell Vale slag heap. The protest was staged to coincide with Wollongong Coal's annual general meeting. Illawarra Residents for Responsible Mining (IRRM) said Wollongong City Council (WCC) had known for years about the unlawful 200,000 tonne stockpile, which is partly on public land, but had been too slow to act.	https://www.illawarramercury.com.au/story/5605829/masked-protest-against-secrecy-on-wollongong-coal-order/
27/07/2018	Illawarra Mercury Wollongong miner ordered to shift another unlawful stockpile	Wollongong Coal has another big job on its hands after being ordered to remove an estimated 200,000 tonnes of waste coal which it has stockpiled at its Russell Vale colliery in breach of its development consent.	https://www.illawarramercury.com.au/story/5550041/wollongong-miner-ordered-to-shift-another-unlawful-stockpile/
5/07/2018	Australia's Mining Monthly Russell Vale resources fall after Wollongong Coal review	A Wollongong Coal review of its resources estimates to ensure they complied with the JORC Code has led to an increase of compliant resources for its Wongawilli colliery and a reduction of resources for its Russell Vale colliery, both in New South Wales.	https://www.miningmonthly.com/exploration/international-coal-news/1341822/russell-vale-resources-fall-after-wollongong-coal-review

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16/06/2018	Illawarra Mercury 'Time's up' after coal miner's Bellambi Creek deadline expires	The deadline for Wollongong Coal to complete promised realignment work on Bellambi Creek is today - more than five years after a first deadline expired. But the work has not been done, despite being one of the conditions for approval in 2011 of mining at Russell Vale - because it would reduce pollution downstream.	https://www.illawarramercury.com.au/story/5470046/times-up-after-coal-miners-bellambi-creek-deadline-expires/
12/06/2018	Illawarra Mercury Charities and pre-school winners in Wollongong Coal deal	Illawarra charities and a non-profit preschool will be the surprise winners in a deal struck by Wollongong Coal in response to alleged unpaid debts. According to the regulator part of the deal will see Wollongong Coal lease "property to Little School Preschool Inc for $1 per annum, reduced from $26,000 per annum, until January 1, 2023". The deal also requires Wollongong Coal to make two $5000 donations to local charities each year until 2023.	https://www.illawarramercury.com.au/story/5461978/charities-and-pre-school-winners-in-wollongong-coal-deal/
2/06/2018	Illawarra Mercury Black diamond, red ink: Wollongong Coal loses $73m	Wollongong Coal has declared a $73 million loss after a year in which its total liabilities pushed closer to $1 billion. The company said it was forced to make the declaration of the huge loss because Australian accounting standards required it to class large quantities of its debts as liabilities. This, the miner said, was because of broken covenants to lenders - failures to make repayments by certain dates, which had caused the lender to declare a breach.	https://search-proquest-com.ezproxy.newcastle.edu.au/docview/2048128062/45D908F398DD4644PQ/1?accountid=10499
6/04/2018	Illawarra Mercury Wollongong miner 'can't handle' coal pollution, says EPA	Wollongong Coal has a history of poor management of stormwater management and has demonstrated it can't manage pollution control equipment on its Russell Vale mine site, the Environment Protection Authority has said. Gavin Workman from the Illawarra Residents for Responsible Mining group said it was "unthinkable" for the Planning Department to consider allowing Wollongong Coal to drop its long-neglected commitment on the creek.	https://search-proquest-com.ezproxy.newcastle.edu.au/docview/2021811095/AD54A4D9EB0C4A0CPQ/1?accountid=10499

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08/03/2018	Illawarra Mercury Wollongong miner prosecuted over tardy payment of debts	The Regulator has started prosecutions against two of Wollongong Coal's companies, alleging it persistently failed to pay almost $300,000 in rates and levies owed to the NSW Government. Early last month the Regulator threatened to suspend operations at the two mines if Wollongong Coal did not pay other fees it owed.	https://www.illawarramercury.com.au/story/5273498/wollongong-miner-prosecuted-again-over-tardy-payment-of-debts/
07/02/2018	Illawarra Mercury Wollongong Coal threatened with shutdown over unpaid debts, again	Wollongong Coal is again at risk of having its operations suspended by the Resources Regulator for failing to pay fees it owes to the NSW Government. Wollongong Coal told the stock exchange the decision was "preliminary only" and it was "considering its options".	https://www.illawarramercury.com.au/story/5214135/wollongong-coal-threatened-with-shutdown-over-unpaid-debts-again/
09/12/2017	Illawarra Mercury Wollongong Coal use of council land near golf course may cost ratepayers	Ratepayers could end up footing a rehabilitation bill while mining company Wollongong Coal gets part of a golf course, courtesy of a complex land deal from the past, a new Wollongong City councillor fears. Ratepayers would be left with a chunk of land covered in waste coal, while the part of the golf course which still belongs to the mine would be treated as an asset of Wollongong Coal's.	https://www.illawarramercury.com.au/story/5106889/wollongong-coal-use-of-council-land-near-golf-course-probed/
05/12/2017	Illawarra Mercury Wollongong Coal to sell Wongawilli mine land after $23.7 million loss	Wollongong Coal is looking to improve its troubled finances - which could be further hit by a long list of fines and unresolved legal claims worth more than $40 million - by selling off large parcels of colliery land at West Dapto.	https://search-proquest-com.ezproxy.newcastle.edu.au/docview/1972564481/3534DB6E73AC4B62PQ/1?accountid=10499
2/12/2017	Wollongong Coal suspended from trade on stock exchange	Wollongong Coal has been suspended from trading on the stock exchange for failing to lodge its half-yearly report.	https://www.illawarramercury.com.au/story/5094443/wollongong-coal-suspended-from-trade-on-stock-exchange/
09/11/2017	Illawarra Mercury Wollongong Coal found guilty, fined $40k over debts	Wollongong Coal has been convicted in court over its failures to pay debts to the NSW Government, with the Resources Regulator making clear it is sending a message. The miner was fined $40,000 in the Local Court in Sydney on Wednesday after two of its companies were convicted on charges over failing to pay more than $288,000 in debts.	https://www.illawarramercury.com.au/story/5044882/wollongong-coal-found-guilty-fined-40k-over-debts/

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6/10/2017	Booming property prices convince Wollongong Coal to sell up land for housing	Wollongong Coal has unveiled a plan to convert its coal mine into prime real estate. Wollongong Coal — which owns 455 hectares of land 15 km south-west of Wollongong — says the opportunity to transform almost half of its landholding is too good to pass up.	https://stockhead.com.au/resources/homeowners-move-wollongong-coal-mine-company-seeks-diversify/
6/09/2017	Illawarra Mercury Wollongong Coal fined $30,000 over water pollution	Wollongong Coal has been fined again for polluting a nearby waterway with runoff from its Russell Vale colliery. The fine was levelled by the Environment Protection Authority almost ten months after the November 2016 incident.	https://www.illawarramercury.com.au/story/4905306/miner-fined-30k-over-pollution-again/
9/08/2017	Illawarra Mercury Jindal Founder's Day support for Russell Vale Public School	Russell Vale Public School were the big winners when Wollongong Coal Limited celebrated Jindal Founder's Day on August 7. Jindal companies around the world celebrate the day by giving to worthy or needy organisations. With Wollongong Coal's Russell Vale Colliery close to the school, the Russell Vale Public School P&C Association was this year's worthy recipient. On Monday, Wollongong Coal CEO Millnd Oza presented a $5000 cheque to the P&C.	https://www.illawarramercury.com.au/story/4843770/wollongong-coal-supports-russell-vale-students/
9/07/2017	Illawarra Mercury Wollongong Coal seeks 5 more years for Russell Vale in new plan	Wollongong Coal wants permission to mine at Russell Vale for five more years and has started a limited kind of community consultation about its revised plans. But the residents who were invited to a recent meeting in Corrimal were shocked that a coal washery and processing plant would now be part of the proposal.	https://www.illawarramercury.com.au/story/4776942/wollongong-coal-seeks-5-more-years-in-new-plan/
22/06/2017	Illawarra Mercury Wollongong Coal in court over 'failure to pay rent'	The NSW Resources Regulator has taken two Wollongong Coal companies to court after they allegedly failed to pay rent and levies worth more than $288,000.	https://www.illawarramercury.com.au/story/4747913/wollongong-coal-in-court-over-failure-to-pay-rent/

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4/06/2017	Illawarra Mercury Wollongong Coal admits it needs new, less damaging strategy	Wollongong Coal has a new proposal for its Russell Vale mine, which outlines a less damaging method of mining. Although the company has moved away from mining under the catchment they are still looking to extend under the Cataract Dam's feeder creeks.	http://www.illawarramercury.com.au/story/4704586/wollongong-coal-admits-it-needs-a-new-plan/?cs=300
1/06/2017	Australia's Mining Monthly Wollongong Coal seeks to make Russell Vale a bord & pillar op	Wollongong Coal has decided to amend its Russell Vale Colliery underground expansion project application from a longwall mining plan to a first workings mining plan in a bid to counter community concerns.	https://www.miningmonthly.com/mines/international-coal-news/1308816/wollongong-coal-seeks-russell-vale-bord-amp-pillar-op
31/05/2017	Illawarra Mercury Delta SBD goes into administration, Wongawilli mine threatened	Hundreds of Illawarra coal miners have been stood down from their jobs after mine contracting company Delta SBD went into administration. Delta employed more than 300 coal miners across Illawarra.	http://www.illawarramercury.com.au/story/4700355/300-jobs-at-risk-as-mine-operator-delta-sbd-put-in-administration/
31/03/2017	Illawarra Mercury Wollongong Coal wins $91 million judgment against Gujarat NRE Coke	Struggling miner Wollongong Coal has won a $91 million judgment in a long-running court case against its former parent company, Arun Jagatramka's Gujarat NRE Coke.	http://www.illawarramercury.com.au/story/4566444/wollongong-coal-wins-91-million-judgment-against-former-owner/
23/12/2016	Illawarra Mercury Wollongong Coal fined for breaches at Russell Vale Colliery	Wollongong Coal has been fined $6000 over issues at its Russell Vale Colliery. Around 200,000 tonnes of coal and rock extracted from the underground mine was stored on the site and not removed as required in the conditions, which cost Wollongong Coal $3000. It was stung with a further $3000 fine because it had not replaced the underground pipe section of the Bellambi Gully Creek with an engineered open channel.	http://www.illawarramercury.com.au/story/4374158/wollongong-miner-hit-with-6k-fine-for-breaches/
5/12/2016	ABC News Future of Australia's oldest coal mine in doubt as Wollongong Coal considers next move	It may not be a knockout blow, but last week's legal loss is a major setback for the owners of the oldest continuous coal mine in Australia.	http://www.abc.net.au/news/2016-12-05/wollongong-coal-considers-future-russell-vale-mine/8092524

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02/12/2016	Illawarra Mercury Wollongong Coal court case against Minister for Planning and the Planning Assessment Commission thrown out by Land and Environment Court	Wollongong Coal's legal challenge to its problems getting approval to mine at Russell Vale has been thrown out by the Land and Environment Court, which found no validity in any of the miner's claims.	http://www.illawarramercury.com.au/story/4331721/coal-case-thrown-out/
17/11/2016	Illawarra Mercury Illawarra Coal's Appin mine fans fail again	Miners at Illawarra Coal's Appin Colliery have again been forced above ground amid methane level concerns, after a ventilation system cut out at the weekend – the second fan failure in three weeks.	http://www.illawarramercury.com.au/story/4298055/another-fan-failure-at-appin-mine/
4/11/2016	Illawarra Mercury Appin mine ban lifted, operations to resume	The NSW Resources Regulator has lifted a prohibition notice issued to South32's Illawarra Coal-run Appin Colliery following a ventilation fan failure last week.	http://www.illawarramercury.com.au/story/4273610/appin-mine-ban-lifted-operations-to-resume/
1/11/2016	Illawarra Mercury 'Almost explosive' gas levels force Appin mine shutdown	Underground operations at Illawarra Coal's Appin mine have ceased after a dangerously-high level of methane was detected at the site last week. The union says the gas level reached a near-explosive reading after ventilation fans cut out last Tuesday and the risk was exacerbated by workers not being evacuated immediately.	http://www.illawarramercury.com.au/story/4263296/almost-explosive-gas-levels-force-appin-mine-shutdown/
30/09/2016	Illawarra Mercury Longwall mining at Dendrobium 'causes cracked creek to run dry': video	Water courses within the drinking water catchment have run dry after recent longwall mining underneath them, environmentalists say after a recent visit to Illawarra Coal's Dendrobium mining lease.	http://www.illawarramercury.com.au/story/4199332/longwall-mining-at-dendrobium-causes-cracked-creek-to-run-dry-video/
11/09/2016	Illawarra Mercury Delta to direct Wollongong Coal mine hires	Wollongong Coal has announced it will re-open its Wongawilli mine, creating up to 110 jobs. But the company has engaged contractor Delta SBD to run the operation, going against union and politician demands to re-employ recently laid-off workers.	http://www.illawarramercury.com.au/story/3588807/wollongong-coal-to-reopen-mine-creating-110-jobs/

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11/09/2016	Illawarra Mercury 'Very significant damage' doesn't deter coal mine expansion in Sydney catchment	A controversial coal mine in Sydney's catchment area is seeking to expand despite an independent expert panel finding the operation had led to a "very significant drop" in water levels in an endangered swamp.	http://www.illawarramercury.com.au/story/4156163/very-significant-damage-doesnt-deter-coal-mine-expansion-in-sydney-catchment/?cs=12
12/08/2016	Illawarra Mercury Hume Coal mine proposal opposed by 16,000-strong petition, presented by local MP Pru Goward	A petition signed by more than 16,000 people against the controversial Hume Coal mine proposal has triggered a debate on the floor of NSW parliament.	http://www.illawarramercury.com.au/story/4091947/hume-coal-mine-headed-for-debate-in-parliament/
2/08/2016	Illawarra Mercury Tahmoor mine closure brought forward 12 months	The company has also called for expressions of interest in voluntary redundancies now, and a further call is expected early next year	http://www.illawarramercury.com.au/story/4068622/mine-to-close-in-18-months/
1/07/2016	Illawarra Mercury Wollongong Coal’s Russell Vale plans again found wanting by PAC	Wollongong Coal’s plans to expand its Russell Vale have suffered another blow with the Planning Assessment Commission (PAC) deciding the social and economic benefits are probably outweighed by risk and damage to the environment.	http://www.illawarramercury.com.au/story/3824981/russell-vale-mine-plan-hit-with-another-major-setback/
24/06/2016	Illawarra Mercury Wollongong Coal to re-open its Wongawilli pit, 70 jobs to come	Wollongong Coal is preparing to re-open its Wongawilli coal mine on July 5, creating more than 70 jobs but using casual contractors instead of the workforce laid off last year.	http://www.illawarramercury.com.au/story/3989648/wollongong-coal-to-re-open-its-wongawilli-pit-70-jobs-to-come/
7/04/2016	ABC News Wollongong Coal expansion 'totally stranded' by planning report, mining analyst says	An analyst says a coal company's plan to mine further into the Sydney drinking water catchment appears to be "totally stranded" by the findings of an independent body.	http://www.abc.net.au/news/2016-04-07/wollongong-coal-expansion-stranded-analyst/7304782
4/04/2016	Australian Mining Dragonfly threatened by Wollongong Coal expansion	The Russell Vale Colliery, already closed down due to financial concerns, may soon face a permanent end to expansion plans due to a rare, giant dragonfly.	https://www.australianmining.com.au/news/dragonfly-threatened-by-wollongong-coal-expansion/

Date	Source/Headline	Summary	Link
1/04/2016	Illawarra Mercury Wollongong Coal's Russell Vale plans again found wanting by PAC	Wollongong Coal's plans to expand its Russell Vale have suffered another blow with the Planning Assessment Commission (PAC) deciding the social and economic benefits are probably outweighed by risk and damage to the environment.	http://www.illawarramercury.com.au/story/3824981/russell-vale-mine-plan-hit-with-another-major-setback/
16/06/2016	Illawarra Mercury Wollongong Coal's Russell Vale mine rehab at risk by financial troubles: report	Wollongong Coal's Russell Vale mine has been named as among those most at risk of failing obligations to rehabilitate the site when mining finishes.	http://www.illawarramercury.com.au/story/3969857/doubts-on-mine-rehab/
2/06/2016	Illawarra Mercury Mine closure to hit community hard/ Tahmoor mine set to close in less than 3 years	Hundreds of mine workers in the Southern Highlands have been told their jobs will be gone in less than three years.	http://www.illawarramercury.com.au/story/3943869/mine-closure-to-hit-community-hard/
12/04/2016	STEP Inc. Longwall Mining in Sydney's Water Catchments	In Issue 180 of STEP Matters we wrote about the Planning Assessment Commission's (PAC) report on the application to develop eight new longwalls. Wollongong Coal failed to convince PAC that it can expand the Russell Vale colliery without causing substantial and irreversible damage to Sydney's drinking water supply. As the mining approvals have run out the mine was closed six months ago, and the entire workforce was sacked. But the company seems undaunted and has continued with the expansion application.	http://www.step.org.au/index.php/step-matters-issue-186/item/158-longwall-mining-in-sydney-s-water-catchments
4/04/2016	Creamer Media's Mining Weekly Wollongong receives conditional approval for Russell Vale coal expansion	Embattled coal miner Wollongong Coal has given no assurances about the future of its Russell Vale operation, in New South Wales, despite receiving approval from the Planning Assessment Commission (PAC) to expand the underground operations, subject to conditions.	http://www.miningweekly.com/article/wollongong-receives-conditional-approval-for-russell-vale-coal-expansion-2016-04-04/rep_id:3650
26/02/2016	Illawarra Mercury Man airlifted to hospital after Russell Vale mine incident	A Wollongong Coal employee has been airlifted to St George hospital after being injured while working underground at Russell Vale mine.	http://www.illawarramercury.com.au/story/3754086/man-airlifted-after-russell-vale-mine-incident/

Date	Source/Headline	Summary	Link
21/12/2015	The Sydney Morning Herald Coalminers accused of 'playing Russian roulette' in Sydney's water catchment	Environmental groups say the Baird government is "playing Russian roulette" in Sydney's water catchment by approving coalmining without a full understanding of its impacts, taking a "damage first, fix later" approach. "We have no confidence Wollongong Coal can manage the Russell Vale expansion to avoid the same sort of damage to sensitive areas as have occurred at Dendrobium," Ms Smolski said.	http://www.smh.com.au/environment/water-issues/coalminers-accused-of-playing-russian-roulette-in-sydneys-water-catchment-20151217-glq7d2.html
8/12/2015	ABC News Wollongong Coal ordered to clean up pollution the day before it faces planning body to ask for mining approval	Wollongong Coal has issued a statement to the Australian Stock Exchange admitting a reportable environmental breach at its Russell Vale mine. It blamed a malfunctioning stockpile spray for the coal pollution that found its way into nearby Bellambi Creek.	http://www.abc.net.au/news/2015-12-08/wollongongong-coal-ordered-to-clean-up-pollutin-spill/7010160?site=illawarra
11/11/2015	ABC News Mining project near Sydney and Illawarra drinking water catchment gets green light from NSW Government	Mining company Wollongong Coal says it is confident its plans to mine further into the catchment supplying drinking water to Sydney and the Illawarra will be approved.	http://www.abc.net.au/news/2015-11-11/government-support-for-wollongong-coal-expansion/6932630?site=illawarra
23/10/2015	ABC News Angry Wollongong Coal shareholders, protesters front the company's annual general meeting	Environmentalists and residents holding placards reading "water not coal" protested outside the company's AGM in Towradgi on Friday. A mining economics expert at the protest outside the AGM says Wollongong Coal does not deserve to be listed in the Australia stock market.	http://www.abc.net.au/news/2015-10-23/wollongong-coal-agm/6880744?site=illawarr
15/09/2015	Illawarra Mercury $30,000 fine for coal spill in Bellambi Creek	A $30,000 fine for Wollongong Coal spilling coal pollution into Bellambi Creek has caused the NSW Greens to question whether the Environment Protection Authority (EPA) is serious.	http://www.illawarramercury.com.au/story/4033614/30000-fine-for-coal-spill-in-bellambi-creek/

Date	Source/Headline	Summary	Link
2/09/2015	Illawarra Mercury Wollongong Coal being probed on whether it is 'fit and proper' a first, say Environmental Defenders Office, Department of Industry	The investigation into whether Wollongong Coal is a “fit and proper person” to hold a mining licence is a first for New South Wales, the lawyer who worked on the complaint said.	http://www.illawarramercury.com.au/story/4138269/mine-probe-a-first-for-fit-and-proper-power/
1/09/2015	Illawarra Mercury Approvals delay to blame for Russell Vale job losses	Wollongong Coal blames the six-year delay in approval to extract coal at Russell Vale Colliery for its drastic decision to close the gates and lay off 80 workers.	http://www.illawarramercury.com.au/story/3320981/approvals-delay-to-blame-for-russell-vale-job-losses/
13/07/2015	Illawarra Mercury Expansion plans for Russell Vale mine in limbo	Wollongong Coal's controversial bid to expand underground operations at its Russell Vale mine has been blocked amid calls for better evidence about its potential impact on the drinking water catchment.	http://www.illawarramercury.com.au/story/3008022/russell-vale-mine-stalls/
24/06/2015	Illawarra Mercury Wollongong Coal seeks to extend Wongawilli mine permit	Embattled Illawarra miner Wollongong Coal says it needs more time to extract coal from its Wongawilli works and wants the NSW government to permit mining for another five years, until 2020.	http://www.illawarramercury.com.au/story/3169508/wollongong-coal-seeks-to-extend-wongawilli-permit/
30/03/2015	Construction Hunter Further redundancies to come for Wollongong Coal’s Russell Vale coal mine	More jobs are to be cut from Wollongong Coal’s Russell Vale coal mine. The announcement to cut further jobs comes after 152 redundancies were made from Wollongong Coal’s Russell Vale and Wongawilli mines just last year.	http://www.constructionhunter.com.au/blog/industry-news/redundancies-come-wollongong-coals-russell-vale-coal-mine/
3/02/2015	Illawarra Mercury Community says 'no' to Wollongong Coal plans to expand its Russell Vale mine	The Illawarra community has spoken, voicing a resounding ‘‘no’’ to Wollongong Coal’s bid to expand underground operations at its Russell Vale mine.	http://www.illawarramercury.com.au/story/2858432/community-says-no-to-mine-expansion-plans/
2/02/2015	Illawarra Mercury Russell Vale mine expansion concerns to be aired	The public health risks attached to Wollongong Coal's huge Russell Vale Colliery expansion project will be outlined at a public forum on Tuesday.	http://www.illawarramercury.com.au/story/2856747/health-concerns-on-the-agenda-at-russell-vale-mine-forum/

Date	Source/Headline	Summary	Link
12/01/2015	Watt Electrical News Russell Vale coal mine to get PAC review	Planning Minister Pru Goward has ordered the review of Wollongong Coal's proposed expansion of Russell Vale coal mine. It will see Wollongong Coal mine a 400 metre block of longwall 6 at Russell Vale mine which holds 260,000 tonnes of coal. Environmental groups have previously criticised Wollongong Coal's plans to mine longwall 6, claiming it poses a major threat to the water catchment area.	https://www.wattelectricalnews.com/NEWS/Russell-Vale-coal-mine-to-get-PAC-review/23544
3/11/2014	Illawarra Mercury Sydney Catchment Authority objects plans to expand longwall mining near Cataract Dam	The Sydney Catchment Authority has objected to Wollongong Coal's proposal to expand longwall mining operations near Cataract Dam.	http://www.illawarramercury.com.au/story/2670154/wollongong-coals-mine-plan-a-dam-threat/
28/05/2014	Illawarra Mercury Wollongong Coal's longwall mining application approved for Russell Vale	Department of Planning recommended approval with the mine expansion for one longwall, with assessment processing to the Planning Assessment Commission.	http://www.illawarramercury.com.au/story/2555747/russell-vale-longwall-bid-passes-hurdle/
28/05/2014	Illawarra Mercury Wollongong Coal miners sacked after refusing pay cut	More than 140 workers from Wongawilli mine are expected to be left without a job after voting to reject massive pay cuts and loss of work conditions	http://www.illawarramercury.com.au/story/2314498/wollongong-coal-miners-sacked-after-refusing-pay-cut/
28/05/2014	Illawarra Mercury Wollongong Coal's expansion bid blocked	Wollongong Coal's controversial bid to expand underground operations at its Russell Vale mine has been blocked amid calls for better evidence about its potential impact on the drinking water catchment.	http://www.illawarramercury.com.au/story/3003868/wollongong-coals-expansion-bid-blocked/
13/05/2014	Illawarra Mercury Wollongong council slams Russell Vale mine expansion	Wollongong city councillors have voted to express concerns to the state government over planned changes to longwall mining at Russell Vale Colliery.	http://www.illawarramercury.com.au/story/2279403/wollongong-council-slams-russell-vale-mine-expansion/

APPENDIX B

Strategies identified to meet the objectives of Our Wollongong 2028

Strategies identified to meet the objectives of *Our Wollongong 2028*

Strategy	Actions/Activities
Affordable Accessible Transport	• Work in partnership to deliver the Gong Shuttle Bus as an affordable transport option for our community. • Work with partners to decrease car dependency and facilitate sustainable transport to provide convenient movement throughout the city, with sustainable transport modes such as walking and cycling. • Effective and integrated regional transport, with a focus on road, bus, rail and freight movement (including the port of Port Kembla). • Integrated communities close to public transport and local services and facilities focused around existing train stations and town and village centres are planned for and encouraged. • Reduce travel time between Sydney and Wollongong as well as Western Sydney. • Improve footpath connectivity to unique places and spaces, including marine access along the LGA and accessibility from the CBD to the foreshore. • Maintain the service levels of our roads, footpaths and cycle ways to an acceptable standard. • Plan for effective future changes in transport including the option for disruptive transport technologies in the future. • Availability of late night transport options is improved. • Community transport options for frail older people, people with disabilities and the transport disadvantaged are actively promoted and available.
Connected and Engaged Community	• Provide residents with equitable access to information and opportunities to inform decision making. • High-speed broadband and communication is available across the city. • Continue to partner with our local Aboriginal community. • Support residents, businesses and visitors to be actively involved in diverse community activities helping to connect neighbourhoods • Support and strengthen the local community services sector • Facilitate programs and events that promote civic pride • Build on Positive leadership and governance, values and culture Resources (finance, technology, assets and people) are managed effectively to ensure long term financial sustainability • Excellent customer service is core business.

Strategy	Actions/Activities
Health liveable city	• We work in partnership to build on opportunities to strengthen vulnerable communities. • Improve access to affordable and timely medical services. • Involvement in lifelong learning, skills enhancement and community-based activities is promoted. • Urban areas are created to provide a healthy and safe living environment for our community. • Quality district level services, libraries and facilities are available to communities • Work towards enabling all people in our community to have access to safe, nutritious, affordable and sustainably produced food. • Provide a variety of quality public spaces and opportunities for sport, leisure, recreation, learning and cultural activities in the community. • Healthy, active ageing programs are promoted in partnership with government agencies and community organisations. • Housing choice in the Wollongong Local Government Area is improved, taking into account population growth, community needs and affordability. • Integrated services are provided to residents in need of urgent shelter. • Partnerships continue to strengthen and achieve a safe, accessible and resilient community. • Local crime continues to be prevented and levels of crime reduced. • Public facilities in key locations and transport routes are maintained and clean, accessible and inviting to our community and visitors.
Creative Vibrant City	• Using community art and cultural development practices, our places and spaces reflect the creativity, history and identity of our people. • Opportunities for artists and innovators are provided and celebrated. • Museums and galleries are promoted as part of the cultural landscape. • The arts precinct in the heart of the city is consolidated and further enhanced. • Local groups and communities are actively supported to provide community-based programs, events and festivals that celebrate cultural traditions and contemporary practices. • Provide access for communities to quality local spaces and places to meet, share and celebrate. • Partner with Indigenous and culturally and linguistically diverse communities and schools.

Strategy	Actions/Activities
Innovative and Sustainable Economy	• Support educational and employment opportunities that retain young people and local talent, attract new workers and provide opportunities for the unemployed • Grow the national competitiveness of Metro Wollongong to drive economic growth, employment and diversification of the region's economy. • Cross-sector initiatives are coordinated and implemented to increase and attract business investment, supporting small businesses and encouraging jobs growth. • Innovation through social enterprise and social business opportunities is encouraged and supported. • West Dapto urban growth is effectively managed to balance employment and population growth. • Further diversify the region's economy through a focus on new and disruptive industries and green technology • Organisations work in collaboration to support the development of innovative industries including Knowledge Services, Advanced Manufacturing and ICT. • Revitalise West Crown Street by enhancing the amenity and investment opportunities between the health precinct and the commercial core. • Continue to build Wollongong as a vibrant, modern city with a revitalised city centre and an active evening economy • Build our city as a tourist destination of choice for conferences, events, and a place to live, learn, work and visit • Enable signature events and festivals where communities and visitors can gather and celebrate. • Pathways for research and learning are supported and Wollongong is established as a learning place of excellence and innovation • Technology is utilised to transform Wollongong into a Smart City, where assets and infrastructure are able to supply information that is used to enhance urban planning and service provision to our communities.
Environment	• The community is actively involved in the expansion and improvement of our green corridors and other natural areas connecting the escarpment to the sea. • Manage and effectively improve the cleanliness, health and biodiversity of creeks, lakes, waterways and oceans. • The potential impacts of natural disasters, such as those related to bushfires, flood and landslips are managed and risks reduced to protect life, property and the environment. • Reduce our ecological footprint, working together to mitigate the impacts of climate change and reduce waste going to landfill. • Government and community work together to mitigate and adapt to the impacts of climate change on our environment and future generations. • Manage land uses to strengthen urban areas and improve connectivity close to train stations and key transport routes. • Manage visual and urban amenity resulting from urban development particularly in the CBD and areas with medium to high density. • Programs and projects that achieve proactive heritage management, education and promotion are developed and implemented. • Our Aboriginal community is actively engaged in the management of Indigenous heritage • Participate in the Global Covenant of Mayors and set emissions reduction targets for the LGA.

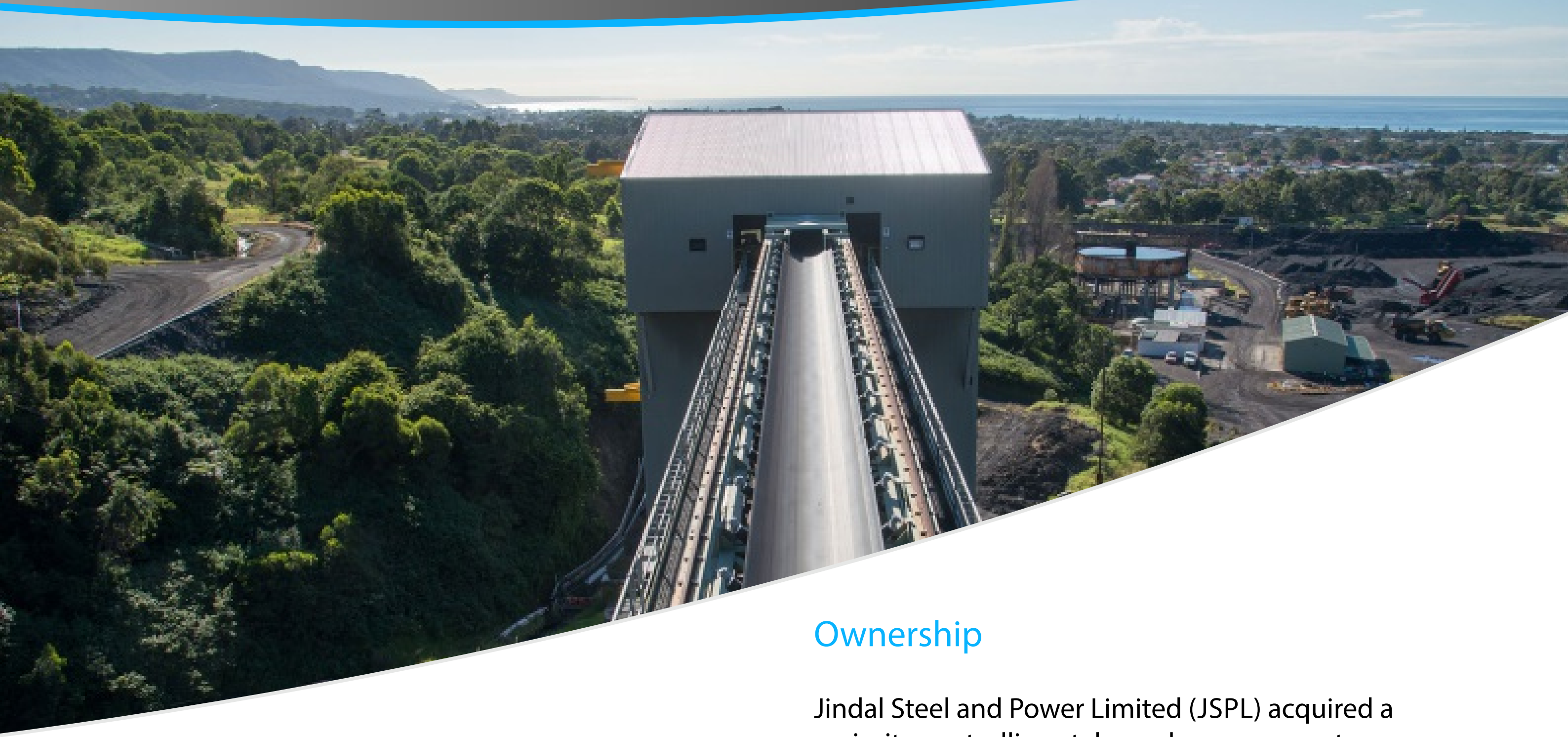
APPENDIX C

Information Sheet 1

WOLLONGONG COAL

Russell Vale Underground Expansion Project

PROJECT INFORMATION SHEET No.1
MAY 2017



This Information Sheet provides information on Wollongong Coal's Russell Vale Underground Expansion Project (UEP)

Wollongong Coal Limited (Wollongong Coal) is an Australian mining business which owns and operates Russell Vale Colliery. Originally known as South Bulli, Russell Vale Colliery is one of the oldest operating coal mines in Australia, with its origins dating back to 1887.

The Colliery is located approximately 10 kms north of Wollongong and approximately 60 kms south of Sydney. The mine has operated in three coal seams, the Bulli, Balgownie and Wongawilli seams. The Colliery is currently in care and maintenance.

Ownership

Jindal Steel and Power Limited (JSPL) acquired a majority controlling stake and management control of Wollongong Coal from the previous owner Gujarat NRE Coking Coal Ltd. JSPL is listed on the Indian Stock Exchange and is an international steel and power company with operating steel capacity of about 10 million tonnes per annum (Mtpa) and power generation capacity is about 5000 megawatts. The majority of Wollongong Coal's production is sold on the export market.

What is the Project?

The Underground Expansion Project (UEP) was originally lodged in 2009. Wollongong Coal have developed a revised mine plan for the Russell Vale UEP, in order to address issues raised by Government agencies, the community and the Planning Assessment Commission (PAC). The revised Project will utilise first workings mining methods which have been designed to be long-term stable and have negligible subsidence impacts.

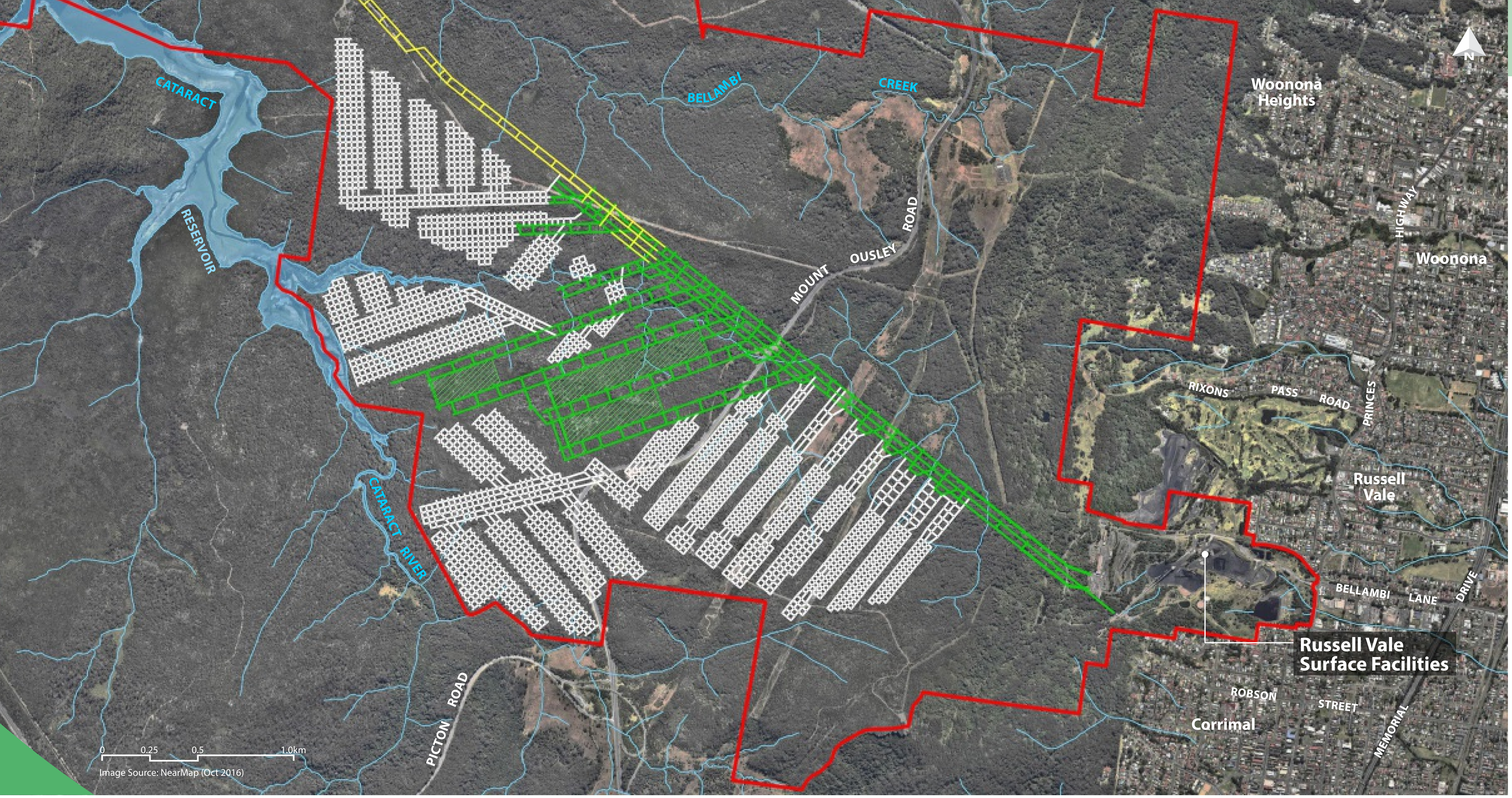


Figure 1 Russell Vale Colliery Key Features

Legend

- UEP Project Application Area
- Approved Mains Headings
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings

What will be assessed?

Comprehensive assessments will be undertaken to identify the potential environmental and social impacts of the Project and to identity how best to manage and/or enhance these impacts. This will include all potentially relevant environmental and community issues, with key focus areas including:

- Socio-economic;
- Subsidence;
- Air quality;
- Noise;
- Groundwater and surface water;
- Flora and fauna;
- Waste;
- Greenhouse gas; and
- Traffic.

It is understood that the report will then be placed on public exhibition, prior to assessment and determination.

How is the revised UEP different from previous mine plans?

The earlier mine plans for the UEP used longwall mining techniques which would have resulted in subsidence impacts. The revised mine plan (refer to **Figure 1**) addresses this issue, incorporating the use of non-caving first workings bord and pillar panels using standard continuous miners.

This in turn reduces groundwater impacts and avoids impacts to biodiversity, heritage and built infrastructure features on the surface above the workings, including the Cataract Reservoir.

The revised mine plan will provide for the extraction of approximately 4 million tonnes of run of mine (ROM) coal from the Wongawilli Seam at a production rate that would not exceed the previously approved ROM production rate of 1 million tonnes of coal per year.

This is significantly lower than the 3Mtpa ROM production originally contemplated in earlier Project applications. The lower production rate will also result in reduced impacts associated with surface operations including reduced trucking rates relative to previously proposed mine plans.

▲ Site ecological monitoring

What is the planning approval process?

Wollongong Coal is currently preparing a comprehensive response to the PAC Second Review Report.

Umwelt (Australia) Pty Ltd (Umwelt), a specialist environmental and social impact consultancy, has been engaged to undertake the environmental and a social assessment and community consultation program for the revised Project.

This Response will include details regarding the revised project and a comprehensive assessment of environmental and social impacts of the revised mine plan.

An outline of the planning and approvals process is provided in **Figure 2.**

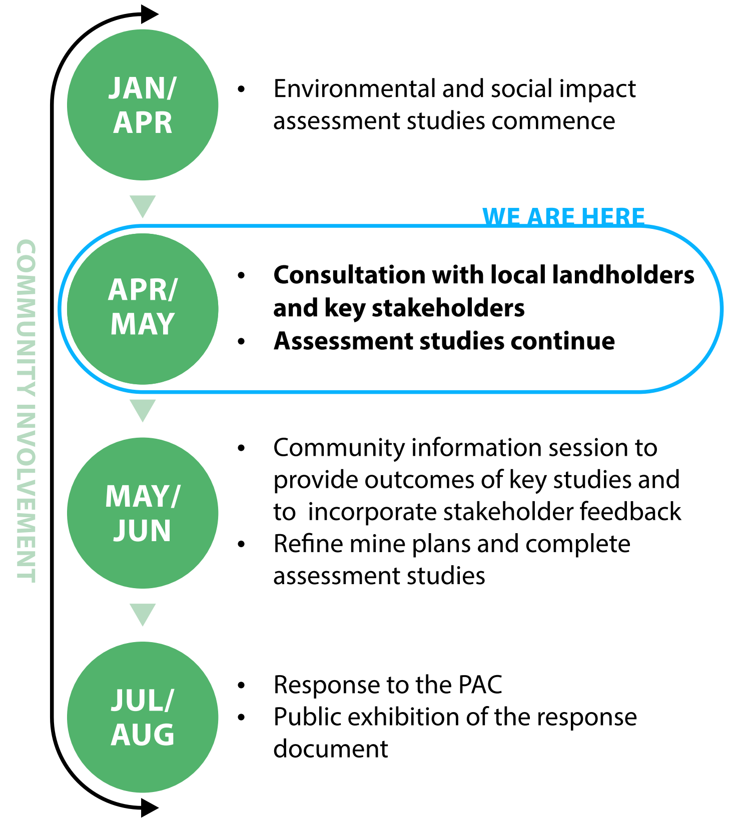


Figure 2 Approvals Process Timeline

How can I get involved?

Conceptual mine planning studies have had regard for the issues raised in relation to previous development proposals at Russell Vale Colliery. Further input from the community will be a valuable part of the Project to ensure that any community concerns are incorporated in Project planning, and considered in the assessments being undertaken on the revised Project plan.

As a priority, Umwelt will be proactively contacting landholders located in proximity to the existing operations to discuss the Project, document community issues and concerns and establish preferred communication channels through the assessment process. Further information will be provided as study findings become available.

A Community Information Session will also be held in mid June to provide an opportunity for the community to meet members of the Project team and discuss key outcomes of the Project studies. The community will also be able to make comments on the revised Project during the exhibition period.

Wollongong Coal will also be consulting with the local community and other stakeholders as part of the ongoing mine planning process for Russell Vale Colliery, and is committed to an ongoing presence in the local community.

We look forward to your involvement in the Project.

Contact Information

If you would like to know more about the Project or be involved in the Social Impact Assessment or consultation program, please contact:

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w. www.umwelt.com.au

umwelt
Environmental & Social Consultants

APPENDIX D

Information Sheet 2

Russell Vale Underground Expansion Revised Project

PROJECT INFORMATION SHEET No.2
MAY 2019

Wollongong Coal owns and operates the Russell Vale Colliery located off the Princes Highway in Corrimal. Originally known as South Bulli, Russell Vale Colliery is one of the oldest operating coal mines in Australia, dating back to the 1880's. The Colliery is currently in care and maintenance.

In 2009 an application to extend operations was lodged with the State government. This proposal was referred to as the Underground Expansion Project (UEP). Since then, the project has been through a number of iterations to minimise its potential adverse impacts and has been reviewed by the Planning Assessment Commission (PAC) on two occasions, most recently in 2016. In response to this most recent review, Wollongong Coal has developed a revised mine plan for the UEP, referred to as the Revised Project, which if approved, will provide the company with 5 years of mining to facilitate further exploration and planning processes.

In May 2017, an initial Project Information Sheet (No.1) was delivered to approximately 1,200 residents in the area around the operation. This information sheet provided details regarding the Revised Project, outlined the assessment process and the program of community consultation and the environmental studies to be undertaken.

This Information Sheet (No.2)

- Provides an update on further project refinements and studies
- Summarises the information collected through the consultation process to date
- Identifies the perceived community issues and impacts in relation to the project, and
- Summarises the results of the environmental studies and proposed mitigation measures.

How has the Project changed?

Wollongong Coal has undertaken a substantial redesign of the UEP (referred to as the Revised Project) in response to concerns from the community and government agencies. These design changes have significantly reduced the potential adverse impacts of the mine on the environment and local community.

Longwall mining is no longer proposed as part of the Revised Project. The revised mine design is based on a non-caving first workings mining system that will result in negligible subsidence. This change significantly reduces the potential impact of the subsidence-related mining impacts on groundwater, surface water and biodiversity, and avoids further longwall mining activity in the Cataract Reservoir water catchment.

The Revised Project will operate at a production rate of 1 million tonnes per year, significantly lower than the 3 million tonnes per year originally contemplated in earlier project applications. The lower production rate will result in reduced impacts associated with surface operations including reduced trucking rates relative to previously proposed mine plans.

In a further response to community concerns, Wollongong Coal is proposing a major redesign of the Russell Vale Colliery Pit Top in order to improve stormwater management, as well as minimise noise impacts from coal handling and transport activities on the surrounding community. These changes include relocating infrastructure, enclosing structures to minimise noise and dust impacts and utilising noise barriers and bunds. This has resulted in a significant reduction in predicted noise levels when compared to both historical operations, and to the previously proposed site configuration.

These design changes, in combination with a range of additional management and monitoring measures, are proposed to enable mining to be undertaken in an environmentally and socially responsible manner.

Key Features of the Revised Project Compared to Previously Proposed Project

	Preferred Project (2014)	Current Revised Project (2019)
Mining Method	8 Longwall mining panels	**No longwall mining is proposed.** Non-caving first workings mining technique with negligible subsidence.
Mining Area	Wonga East only	No change
Production Rate	Up to 3 million tonnes per annum (Mtpa)	Up to 1 million tonnes per annum (Mtpa)
Mine Life	5 years	No change
Total Resource Recovered	Approximately 4.7 Mt ROM coal	Approximately 3.7 Mt ROM coal
Hours of Operation	**Underground Mining** – 24 hours per day, 7 days per week **Surface Facilities** – 24 hours, 7 days per week **Product Transport** - 7.00 am to 10.00 pm, Monday to Friday; 8.00am to 6.00pm Saturday, Sundays and public holidays.	**Underground Mining** – 24 hours per day, 7 days per week **Surface Facilities and Product Transport** 7.00 am to 6.00 pm, Monday to Friday. 8.00am to 6.00pm Saturday. No Sundays or public holidays. Provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions.
Operational Workforce	Approximately 300	Approximately 205
Pit Top Facilities	• Construction and use of two new stockpiles of 140,000 tonnes capacity each with associated reclaim facilities • Construction and use of a new Sizing Plant • Construction and use of new truck loading facilities • Upgrading of existing surface conveyers • Ongoing maintenance and refurbishment of ventilation shafts, water and electrical facilities.	• Establishment of new emergency clean coal and rejects stockpiles within Pit Top disturbance area • Construction of a Coal Processing Plant and ancillary infrastructure to improve product coal quality • Relocation of new secondary sizer and surge bin to more shielded locations • Construction and use of new truck loading facilities • Construction of noise barriers and extension to existing bunds around the Pit Top • Ongoing maintenance and refurbishment of ventilation shafts, water and electrical facilities.
Product Transport	Road transport to Port Kembla via Bellambi Lane and Memorial Drive	

The changes that have been made to the Revised Project are as a result of community issues and concerns being addressed in project planning and design.

Benefits

The Revised Project is predicted to generate:

- Capital expenditure of approximately **$33.5 million** over five years
- Jobs – Up to **22** construction jobs, and up to **205** full time operational jobs
- Royalties / Taxes paid to NSW, including **$32.5 million** in royalties, **$3.3 million** in payroll tax, and **$36 million** in corporate taxes attributable to NSW
- Council revenue – Up to **$2 million** in Council rates and land taxes
- Local Economy – Net benefit of **$30.6 million** to Wollongong local area, associated with local employment and local suppliers.

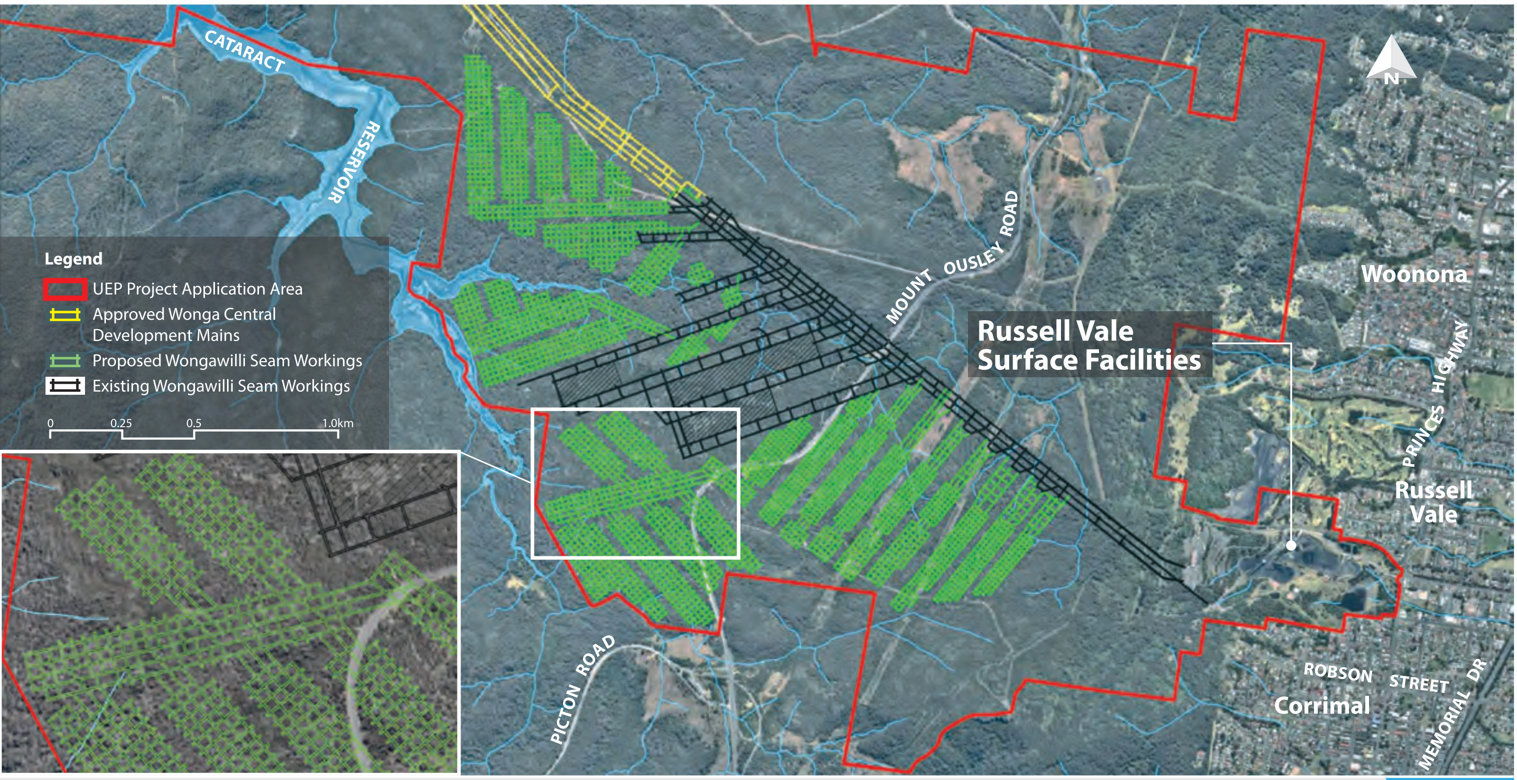


Image Source: NearMap (Oct 2016)

Figure 1 Russel Vale Colliery Key Features

Recent Activity at Russell Vale Emplacement Area

You may have noticed recent activity at the Russell Vale Emplacement Area (RVEA), immediately north of the Pit Top. The RVEA was used as part of earlier mining operations to store oversize material during 2015-2016, up until mining ceased.

In July 2018, the Department of Planning and Environment issued an order to remove approximately 200,000 tonnes of material stockpiled at the RVEA and transport it off site. Removal of this material commenced in early March 2019 and is expected to be completed in July 2019.

Why the delay on the project?

Since the original UEP application was lodged ownership of the company has changed, and as a result, a deeper review of the project plan has been undertaken.

In response to concerns from the community and government agencies, Wollongong Coal has discarded longwall mining and revised the project to significantly reduce the potential adverse impacts of the mine – especially, subsidence. Comprehensive environmental and social assessment of the revised mine design has also been completed.

Wollongong Coal is committed to ensuring that all community and environmental concerns are effectively managed - getting this right takes time.

Will the UEP proceed?

Wollongong Coal is well supported by its ultimate majority shareholder, Jindal Steel & Power Ltd, a major steel and energy conglomerate based in India who sees this project as securing essential raw materials for its steel plants.

Jindal Steel & Power Ltd is a part of the diversified Jindal Group, which supports Wollongong Coal and its ongoing operations, including the Russell Vale Colliery and the Revised Project, if approved.

What are the plans for the future?

Wollongong Coal (and Jindal Steel & Power Ltd) is committed to Russell Vale Colliery and plans to remain a key part of the community, providing long-term stability and employment. Further exploration within the colliery holding is planned to facilitate future mining in an environmentally and socially responsible manner. All future mine planning at the Russell Vale Colliery will be based on non-caving first workings mining methods in order to limit the potential for subsidence related impacts. Wollongong Coal will not be seeking future approval for longwall mining at Russell Vale Colliery.

Any future mining would be subject to a separate assessment and approval process.

Why mine here?

Russell Vale Colliery produces high quality hard coking coal, a product that can help meet the expanding demand for metallurgical coal globally, where it is used for the production of steel. Russell Vale Colliery has a long history in the region and is well located close to coal export facilities at Port Kembla.

Engagement to date?

In 2017, environmental and social studies for the Revised Project commenced, with a detailed round of engagement undertaken with key stakeholders and local residents. This involved:

- **1,200** information sheets have been distributed across the suburbs proximate to the mine operation;
- Contact has been made with approximately **158** stakeholders directly, with **34** interviews conducted with:
  - **27** local landholders and residents;
  - **4** local businesses;
  - **3** community based organisations.
- Review of **88** submissions received during the PAC process in 2015/2016
- Briefings to the Community Consultative Committee for the operation

Environmental and social studies are now nearing completion and further community engagement is underway. Information sessions advertised and held during May 2019 have provided the community with a further opportunity to discuss and provide feedback on the Revised Project.

At what stage is the assessment process?

Community feedback provided as part of the current round of engagement will be considered in the finalisation of the environmental and social studies for the Revised Project. The findings of these studies will be compiled in an assessment of the Revised Project and a response to the 2016 PAC review and will be submitted to the Department of Planning and Environment for public exhibition in the coming months.

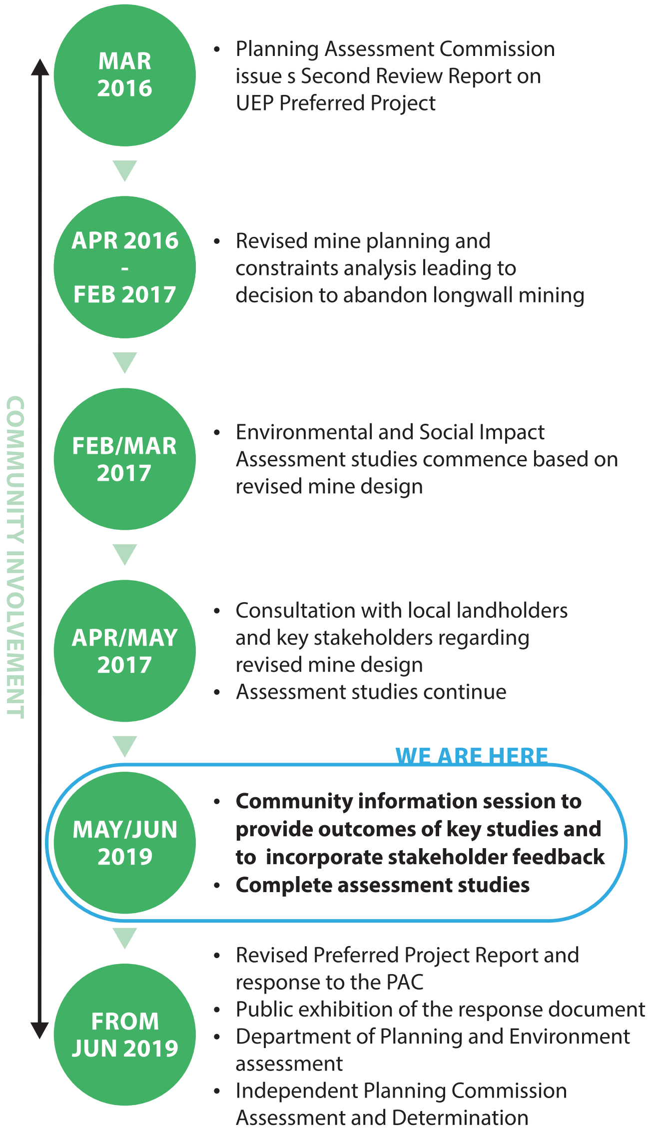
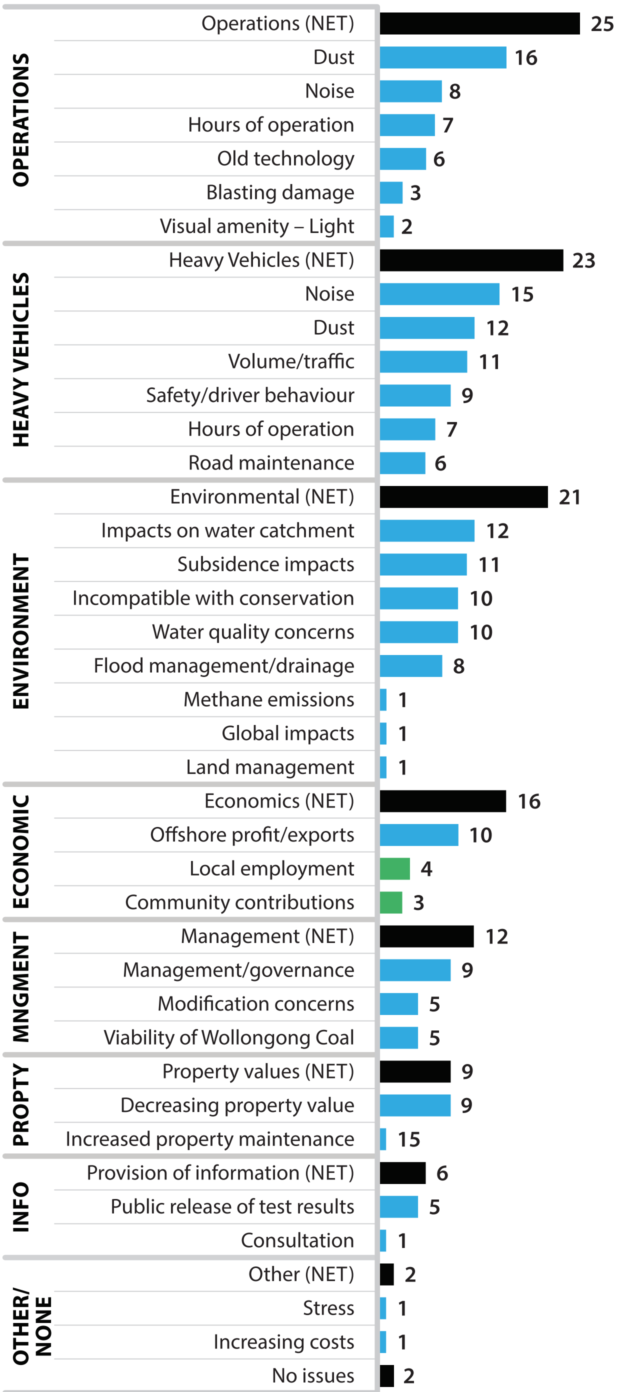


Figure 2 Approvals Process Timeline

What the community has said

The consultation with key stakeholders and local residents identified a number of perceived issues in relation to mine operations, traffic / truck movements, environmental and economic issues. The most commonly raised concerns identified by the community related to dust (surface operations, trucks and health), noise (operations and trucks) and proximity to the Cataract Dam. Concerns about subsidence and the volume of trucks were also commonly raised.



Engagement, communication and trust in the process

Participants were happy to share their thoughts and concerns about the project and welcomed involvement in the Social Impact Assessment program. However, they also expressed a **lack of trust** in the development approval process generally. In this regard it was felt that in earlier project applications, community members had not had the opportunity to raise concerns nor have these issues appropriately addressed.

Residents requested **open and honest communication**, with the majority of those consulted indicating that the **information sheets** were an effective means of communication.

Perceived Benefits

When asked ***"What would be the benefits of the Project?"***, those interviewed identified the following:

Figure 3 Perceived Community Issues/Impacts (n=34)
Note: multiple responses allowed

Impact Category
Negative Impact
Positive Impact

Issues and Opportunities In detail…

The following sections provide more detail on the key issues identified by the community through the consultation process to date and the technical studies and management commitments in relation to these issues.

Quotes obtained through consultation have been used to highlight community views where appropriate.

Air Quality (Dust)

Impact on air quality was the main operational concern, this included dust from coal handling and trucking. The impact of dust on health was also noted with dust exposure a particular concern in relation to long-term health.

"Love Wollongong but not the dust".

"Dust gives me sinus issues".

"The mine needs to use sprays and covers".

Results of the technical review of Air Quality

The Revised Project will operate at a reduced production rate relative to earlier Project designs, resulting in less dust emissions due to less coal being handled and fewer truck movements. A range of dust control measures will also be implemented at the site, including water sprays and enclosures for conveyors and coal transfer points.

An assessment of predicted air quality impacts for the Revised Project has been undertaken in accordance with relevant EPA guidelines. With the proposed dust controls in place, the Revised Project is predicted to comply with all relevant EPA air quality criteria at all residences surrounding the site.

In addition to implementing the proposed dust controls, Wollongong Coal will monitor local air quality and weather conditions so that operations can be modified if required, or additional controls implemented when dust generating conditions are forecast.

Measures to control dust include:

- Enclosure of conveyors and coal transfer points
- Enclosure of new Processing Plant
- Automated water sprays on stockpiles and exposed areas triggered by weather conditions
- Water sprays on the noise berms during construction
- Water carts on unsealed haul routes
- Trials of chemical dust suppressant sprays on long-term stockpiles and unsealed haul routes
- Revegetation/rehabilitation of exposed disturbed areas.

Further pro-active measure will be taken, including:

- Reviewing forecast weather conditions daily so that operations can be modified if required to limit dust generation
- Potential for adverse weather conditions and any required dust control measures will be discussed at daily pre-shift meetings
- Modifying or suspending planned activities, as appropriate, to minimise dust impacts

Reactive measures will also be taken, including;

- Monitoring visual conditions, such as visible dust from trucks above wheel height
- Monitoring weather conditions, such as dry, windy conditions, with winds blowing towards residential areas
- Monitoring ambient air quality conditions

Noise

Noise impacts from the operations and truck movements were also frequently cited as issues of concern to the local community and residents.

"Business hours are Monday to Saturday 8am to 6pm, trucks should be restricted to these hours."

"You should put up walls to reduce the noise."

Pit Top Redesign to Reduce Noise

A major redesign of the Russell Vale Pit Top has been undertaken to minimise the potential noise impacts of the Revised Project. This has included:

- relocation of infrastructure to more shielded locations
- increasing the length and height of existing bunds around the Pit Top
- a new noise barrier along the site access road
- acoustic treatment of coal processing infrastructure
- reduced production and trucking rates

Surface facilities and coal transport will typically be restricted to daytime hours only, with operation between 7.00am and 6.00pm Monday to Friday and 8.00am and 6.00pm Saturday. Surface operations and coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closures or interruptions, however such circumstances would be rare and as a result of unexpected events.

These changes significantly reduce the predicted noise levels of the Revised Project in comparison to both historical operations, and to the previously proposed site configuration.

Results of the technical assessment of Noise

A noise impact assessment has been completed for the Revised Project in accordance with the EPA's Noise Policy for Industry (NPfI). Noise modelling undertaken for the Revised Project shows that with the proposed additional noise controls, the site will generally comply with operational noise criteria at all surrounding residences.

Under adverse weather conditions, there is the potential for minor exceedances (1-2dB) of the criteria during a small percentage (less than 10%) of winter nights at some residences close to the site. The NPfI defines a 1-2 dB exceedance as a negligible impact that would not be discernible by the average listener.

This is a significant reduction in predicted noise levels compared to the previous site configuration, where exceedances (of the then Industrial Noise Policy criterion) of up to 11dB, 13dB and 9dB were predicted during the day, evening and night respectively.

Traffic noise generated by trucks transporting coal was also assessed against EPA criteria and found to comply at residences along Bellambi Lane and surrounds.

During the construction of noise bunds around the Pit Top there are likely to be short periods when noise levels trigger the need for additional management practices, such as:

- scheduling activities to minimise noise impacts,
- notifying impacted residences of the nature and duration of works,
- using quieter equipment and methods where possible, and
- implementing a complaints handling procedure.

Wollongong Coal will continue to operate two continuous noise monitoring stations within the Russell Vale site in order to evaluate the acoustic performance of the operation in real-time and respond to any noise issues as they arise.

Noise control measures:

- Strategic placement of new infrastructure to provide maximum shielding for surrounding residences.
- Restricting surface facilities and coal transport to 7.00am to 6.00pm Monday to Friday and 8.00am to 6.00pm Saturday. No Sundays or public holidays. Provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected Port closures or interruptions.
- Higher noise bunds and new noise barrier to shield noise from Pit Top and truck movements.
- Enclosure and acoustic treatments to buildings and conveyors.
- 24hr real-time noise monitoring to enable rapid operational response.

Proximity to Cataract Dam / Subsidence

Many stakeholders were concerned that subsidence and mining in close proximity to the Cataract Dam would affect the quality and quantity of water in the dam and major creeks in close proximity.

"Better than previous proposal, but why would you mine anywhere near our water supply?"

"They need to move away from the dam."

"I am not confident that the land isn't going to shift."

Results of the technical review on subsidence

The Revised Project will no longer involve any longwall mining. The Revised Project will instead use non-caving first workings mining techniques only, which have been designed to be long term stable with minimal risk of subsidence. This change means that there will be negligible subsidence associated with the Revised Project within the Cataract Reservoir catchment.

A detailed subsidence impact assessment has been completed based on the revised first workings mine plan. The assessment showed that the Revised Project will result in negligible subsidence and negligible subsidence-related impacts on natural and built surface features (including the Illawarra Escarpment, upland swamps, creeks, slopes and built structures), and on biodiversity, surface water and groundwater within the Cataract Reservoir catchment. Additionally, the risk of proposed mining destabilising historical mine workings is low.

Subsidence monitoring will be undertaken to confirm that observed subsidence levels are within predicted negligible levels.

Subsidence control measures include:

- The proposed mining technique will result in negligible subsidence – no longwall mining is proposed.
- Subsidence monitoring will be undertaken to confirm predicted negligible levels of subsidence.
- Mining is limited to the Wonga East area only.
- No mining underneath the Cataract Reservoir.

Traffic and transport

Residents and the local community have raised concerns in relation to the cumulative impacts the project may have on the existing traffic network.

"A lot of trucks could cause damage or seriously injure people if there are accidents."

"Make sure vehicles are safe and roads maintained"

Results of the technical review on traffic and transport

The Revised Project will generate traffic at levels similar to the previous operations at the site. The traffic impact assessment indicated that with the project design improvements and traffic control measures, it is unlikely that the Revised Project will result in an adverse impact on the performance of the road network (including at key intersections), road safety or road users. Traffic conditions on the road network are predicted to remain satisfactory with the Revised Project operating at full capacity.

A designated truck parking area will be established on site, away from residences and in a shielded location, to prevent trucks queuing on nearby streets in the early morning hours (prior to 7.00am). All trucks awaiting loading will park in this area with engines switched off.

Wollongong Coal has also committed to restrict coal transport to day-time hours only. Coal transport will typically occur between 7.00am and 6.00pm Monday to Friday and 8.00am and 6.00pm Saturday. Coal transport may occasionally be required until 10.00pm Monday to Friday in exceptional circumstances such as Port closures or interruptions. No coal transport will occur on Sundays or Public Holidays.

Traffic and transport control measures include:

- Reduced production levels and coal transport typically restricted to daytime only Monday to Saturday. No Sundays or public holidays.
- Truck speeds monitored.
- Road maintenance contribution to be determined with Council for ongoing maintenance of Bellambi Lane.
- Washing of trucks before leaving site.
- On-site roads will be sprayed and cleaned to reduce dust.

Surface water

Operational water use, potential for surface water contamination and changes to the volume of surface water have been raised at various stages during consultation with the community.

Results of the technical review on surface water

Wollongong Coal has recently submitted an application to the Department of Planning and Environment to make improvements to the existing surface water management system at the Russell Vale site, in particular, improvements associated with the Bellambi Gully Diversion Pipeline. These improvements are aimed at reducing flooding and improving the quality of water flowing off site.

An assessment of the potential impacts of the Revised Project on surface water resources was undertaken and considered a range of water quality improvement measures for the Pit Top Facilities, including the Bellambi Gully Diversion Pipeline.

The assessment concluded that the proposed improvements to the stormwater system will reduce the frequency and volume of upslope clean catchment runoff entering the site's water management system during high rainfall events, improve water quality leaving the site during flood events and reduce flood impacts to downstream properties, the Princes Highway, Bellambi Lane and Bellambi Gully.

Water related control measures include:

- No mining beneath the Cataract Reservoir.
- The proposed mining method is the key factor in limiting any adverse impact on surface water or groundwater.
- Improvements to surface water management system at the Pit Top to reduce flooding and improve the quality of water flowing off site.
- Water quality will be monitored on a regular basis and results made publicly available.
- The mine will use recycled water as appropriate to service its needs.

Ground water

Potential loss of surface and ground water due to subsidence related cracking and contamination of groundwater has also been raised by the community.

Results of the technical review on groundwater

The Revised Project has specifically been designed to minimise potential groundwater impacts. The non-caving first workings mining technique limits groundwater depressurisation immediately above the coal seam that would otherwise occur if longwall mining techniques were used.

An assessment of potential groundwater impacts of the Revised Project was undertaken, including assessment of potential interactions with historical multi-seam mining.

The results of the groundwater assessment indicate there is unlikely to be any observable groundwater drawdown effect. There is also predicted to be no observable impact on overall groundwater quality as a result of the Revised Project.

Due to the negligible subsidence associated with the proposed first workings mine plan, the Revised Project is not predicted to result in strata deformation or cracking above the coal seam, with no reduction in Cataract Creek baseflow and no observable change in stream flow or groundwater seepage in the Cataract River (upstream of Cataract Reservoir) and Bellambi Creek catchments. The Revised Project is also not predicted to perceptibly impact upland swamps.

Importantly, the Revised Project is not anticipated to have any adverse impact on stored water quantity or quality in the Cataract Reservoir and is considered to satisfy the Neutral or Beneficial Effect test for the Sydney Drinking Water Catchment.

Wollongong Coal will maintain its existing ground water monitoring network and will regularly review monitoring data and management practices to confirm that impacts on groundwater remain within the range of predicted negligible impacts.

An assessment of water use and availability was undertaken, which indicated that the Revised Project will have a surplus of water and will be able to meet site water demands with little to no import of water from off-site sources.

Greenhouse Gas and Energy

Concerns were raised about the contribution the operation would make to Greenhouse gases and the amount of energy the operation would consume.

Results of the technical review on greenhouse gas and energy

A Greenhouse Gas and Energy Assessment was undertaken to estimate the greenhouse gas inventory and energy use for the Revised Project. The assessment concluded that the forecast greenhouse gas emissions and predicted energy use intensity of the Revised Project falls within the normal operating range for an Australian underground coal mine.

Control Measures for Greenhouse Gas and Energy:

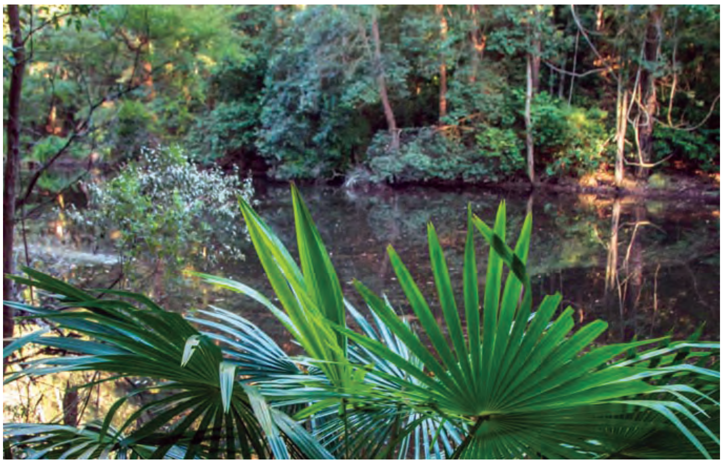
- Wollongong Coal will continue to seek operational energy use efficiencies where commercially feasible.
- Wollongong Coal will review renewable energy opportunities as new technology is developed and becomes viable.

Ecology

Concerns were raised regarding the environmental outcomes for upland swamps and other sensitive environmental features within the Application Area.

Results of the technical review on the ecology

A biodiversity impact assessment was undertaken to determine the potential impacts of the Revised Project on biodiversity values.



The assessment indicated that as a result of the proposed mining method, the Revised Project has removed the risk of subsidence-related damage to sensitive environmental features within the Application Area such as the Cataract River, Cataract Creek and Bellambi Creek, coastal upland swamps as well as rocky outcrops and cliffs. As such, threatened species occupying these sensitive environments (including Prickly Bush-Pea, Giant Burrowing Frog, Red Crowned Toadlet and the Giant Dragonfly) are considered at negligible risk of impact. Additionally, the Revised Project will result in imperceptible impacts to surface water flows and water quality within aquatic environments and therefore negligible impacts are anticipated to the habitat of threatened fish species as a result of mining operations. There is also no proposed change to the disturbed footprint at the surface facilities.

Ecology related control measures

- Mine design changes to minimise subsidence will remove the risk to the sensitive environmental features (creeks, upland swamps and rocky outcrops and cliffs).
- Wollongong Coal will continue to monitor and manage impacts to biodiversity values in accordance with the current Biodiversity Management Plan (2018), including a revised Upland Swamp Management Plan.

Economics

Participants felt that the Revised Project may bring more jobs to the area and opportunities for local businesses. There was some concern, however, that some jobs may be filled from outside the region.

Results of the economic assessment

An Economic Assessment was undertaken which estimated the net benefits of the Revised Project to the State as well as to the Wollongong local area. This assessment comprised a Cost Benefit Analysis and a Local Effects Analysis.

It is estimated that the Revised Project will have a net benefit to NSW of approximately $170 million in net present value (NPV) consisting of $113.9 million in direct benefits to the State, $56.1 million in indirect benefits and indirect costs of $17,850.

The Revised Project will also provide a net benefit of approximately $30.6 million in NPV terms to the Wollongong local area consisting mainly as economic benefits of $21.3 million to employees and $6.7 million to suppliers in the local area.

The revenue, expenditure and employment associated with the operation of the Revised Project will stimulate economic activity in the Wollongong local economy as well as for the broader NSW economy.

With the implementation of the management, mitigation and control measures proposed by Wollongong Coal, it is considered that the Revised Project will result in a substantial net benefit to the local community in the Wollongong area and NSW.

Wollongong Coal in the community

Originally known as South Bulli, Russell Vale Colliery is one of the oldest operating coal mines in Australia, with its origins dating back to 1887. Wollongong Coal is an important part of the community in which it operates and takes pride in the partnerships it develops and the benefits it delivers.

Wollongong Coal is committed to constructively engaging with the local community. Community engagement activities, including key stakeholders and local resident meetings and information sessions, are designed to provide an opportunity to share information about the company's current and planned projects and operations.

Wollongong Coal strives to create opportunities for ongoing growth and development, whether through contributions to charities, sponsorship of local groups and organisations or employment opportunities.
The Revised Project will further enable Wollongong Coal to invest in the locality and the broader Illawarra region.

Over the past 3 years Wollongong Coal has supported the following organisations and activities:

- One Door Mental Health's Light & Hope Clubhouse
- Sponsoring 100 children to attend KidzWish Children's Christmas Party
- Fundraising for technology upgrades at Russell Vale Primary School
- Sponsoring 20 special-needs children to attend a local 'World Festival of Magic' show via the Lion's Club of Woonona
- Provision of swimming lessons for underprivileged children at McKeon's Swim School, Unanderra
- Playground refurbishment at Vista Park, Wongawilli
- Provided space and refurbishment for The Little Pre-School at Wongawilli
- Jerseys for the Wollongong University Football Club
- Donation of money, iPads and books for The Little School Preschool, West Dapto
- Donation of money, grocery vouchers and books to Bellambi Neighbourhood Centre
- Working Bee at Aspect South Coast School, Corrimal
- Collaboration between Jindal University India and Wollongong University.

Thank you

We would like to take the opportunity to thank all community members who have participated in the program so far and look forward to your further input and feedback as the Revised Project progresses.

Would you like more information?

If you would like to know more about the Revised Project, or would like to discuss any aspect of the environmental or social impact assessment with members of the project team, please contact Umwelt or Wollongong Coal using the contact details below.

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APPENDIX 10

Economic Assessment

cadence|economics

ECONOMIC IMPACT ASSESSMENT OF THE RUSSELL VALE COLLIERY

RUSSELL VALE COLLIERY UNDERGROUND EXPANSION PROJECT – REVISED PREFERRED PROJECT

WOLLONGONG COAL PTY LTD

JULY 2019

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General reliance restriction

This report is prepared for Umwelt Australia Limited (Umwelt), on behalf of Wollongong Coal Pty Limited. The purpose of this report is to provide an economic impact assessment of the Russell Vale Colliery Underground Extension Project (Reduced Impact Plan) 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.

Summary Report

This report provides an Economic Impact Assessment (EIA) including a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA) of the Russell Vale Underground Extension Project (the UEP), estimating the net benefits of the Project to New South Wales and the local benefits to the Wollongong region. The EIA will form part of the Response to Submission seeking approval for the Project through the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Russell Vale mine is currently in care and maintenance. For the purposes of the EIA, it has been assumed that the UEP would commence capital expenditure phase in Q1 2020 and run until March 2024. In the initial phase, unprocessed ROM coal would be extracted from the underground workings. On completion of the new processing plant, after March 2021, production will switch to high value, low-volatile hard coking coal. In total the UEP will produce 3.67 million tonnes (Mt) of coal. In the initial phase, production will be 0.78 Mt of ROM coal from underground workings and then 2.31 Mt of hard coking coal.

This EIA is prepared in accordance with the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) and the *Technical Notes supporting the guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (the Technical Notes).

Overview of the CBA

Based on the CBA methodology outlined in the Guidelines and the Technical Notes, and information provided by Wollongong Coal Pty Limited (WCL), the UEP is estimated to provide a net benefit to NSW. This net benefit is estimated to be $174.3 million in net present value (NPV)[1] terms, as shown in Figure 1. This is comprised of $116.9 million and $57.4 million in direct and indirect benefits respectively. Indirect costs of the project are estimated to be $0.019 million.

The ***direct benefits*** of the UEP 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, and the high value of coal extracted underpins the economic viability of the UEP. As a result, the Project is predicted to generate:

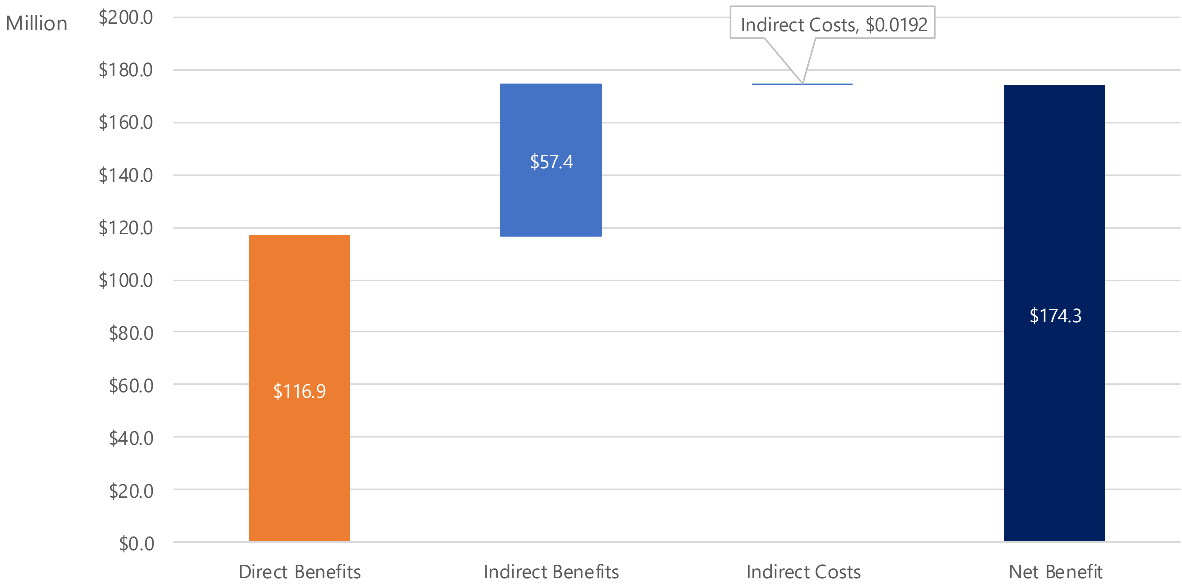
- Total net producer surplus of $112.2 million in NPV terms, of which $39.7 million is attributable to NSW based on a 35.4 per cent NSW ownership share of WCL.
- Total corporate taxes of $120.3 million in NPV terms for Australia, of which $38.5 million is attributed to NSW; and
- $38.7 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $33.2 million with council rates and land taxes of $2.1 million and payroll taxes contributing $3.4 million.

[1] All NPV figures reported are in 2019 Australian dollars, calculated over the period 2019 to 2024, based on a 7 per cent real discount rate (unless otherwise stated).

The ***indirect benefits*** of the UEP 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 $57.4 million in estimated indirect benefits:

- Worker benefits are predicted to amount to $43.6 million in NPV terms; and,
- Supplier benefits are predicted to amount to $13.8 million in NPV terms.

Figure 1: CBA summary of the UEP under central case assumptions, (NPV*)



* Net Present Value in 2019 Australian dollars calculated over the period 2019 to 2024 using a 7 per cent real discount rate.
Source: Cadence Economics estimates based on the EIS and information provided by WCL.

The ***indirect costs*** of the UEP are related to the costs borne on the NSW community through the generation of externalities by the UEP. The UEP, in response to concerns from the public and government agencies, has been substantially revised from the original application to reduce the potential adverse impacts of the mine. As outlined in the report, WCL is spending $4.3 million of operating costs and $1.9 million of capital costs (in NPV terms) to reduce the potential environmental impacts of the operations. These costs are internalised in the project financials and as a result the UEP contributes to a modest incremental indirect cost on the NSW community of $19,158 in NPV terms, which is the cost of greenhouse gas attributable to NSW and the costs of water licenses.

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. The net benefits UEP range from $220.1 million and $117.3 million in NPV terms under the best and worst case assumptions respectively.

Overview of the LEA

The LEA considers the costs and benefits of the UEP on residents of the Wollongong region of NSW. The analysis shows an estimated net benefit of $17.0 million to the region in NPV terms. This is driven largely by:

- Benefits to local workers of $8.7 million in NPV terms based on the assumption that 20 per cent of the mine's direct employees continue to be drawn from the region; and,
- Benefits to local suppliers of $5.5 million in NPV terms based on the assumption that 20 per cent of the inputs to production are supplied from the region.

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 $14.2 million and upper bound estimate of $17.4 million in NPV terms.

1. Introduction

Cadence Economics was commissioned by Umwelt Australia on behalf of Wollongong Coal Pty Ltd (WCL) to undertake an Economic Impact Assessment (EIA) for the Russell Value Underground Extension Project (the UEP).

WCL owns and operates the Russell Vale Colliery and is seeking project approval for the UEP under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The existing and proposed workings are contained within Consolidated Coal Lease 745 (CCL745) and Mining Lease 1575 (ML1575). The Pit Top Facilities for Russell Vale Colliery are located on the edge of the Illawarra escarpment in proximity to the suburb of Russell Vale. The Pit Top Facilities occupy an area of approximately 100 hectares (ha) at the eastern extent of the colliery holdings.

Original application and response

An original application submitted by Gujarat NRE Coking Coal involved a substantial expansion of longwall mining in the Wongawilli Seam across the Wonga East area (a total of 11 longwall panels) and Wonga West area (a total of 7 longwall panels) to extract 31 million tonnes (Mt) of run-of-mine (ROM) coal over a project life of 18 years.

In response to concerns from public and government agencies to the original UEP application, the UEP has been substantially revised to reduce the potential adverse impacts of the mine.

The UEP

In order to address residual uncertainty regarding the impacts of longwall mining raised by the PAC Second Review Report, the Revised Preferred Project has been developed based on a non-caving first workings mining system. The revised mine plan has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence, biodiversity and water impacts within the Cataract Reservoir catchment.

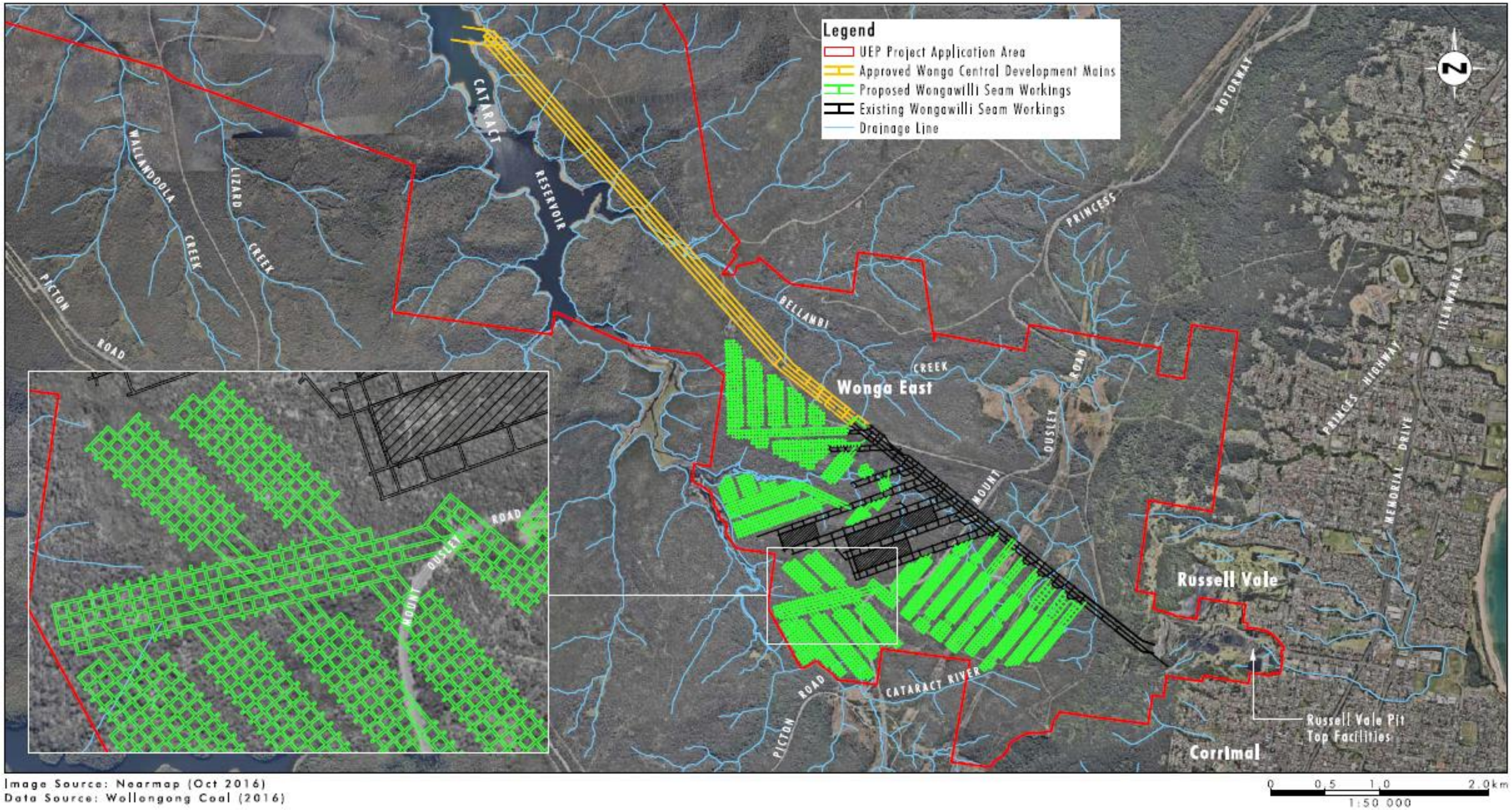
Key elements of the UEP are:

- Mining by means of first working mining techniques only, with the workings designed to be long term stable with minimal subsidence impacts;
- Extraction of approximately 3.7 Mt of ROM coal over 5 years at a production rate that will not exceed 1 Mt of ROM coal per year;
- Construction and use of a new coal processing plant to improve the quality of product coal;
- Substantial redesign of the Pit Top layout to reduce amenity impacts;
- Operation of surface facilities and product transport typically limited to daytime hours only (7am to 6pm Mondays to Fridays, 8am to 6pm Saturdays, no Sundays and public holidays) with provision for occasional operation until 10om Mondays to Fridays to care for unexpected Port closures or interruption;
- Reduced product trucking rates relative to the Preferred Project; and,
- Additional noise mitigation works at the Russell Vale Pit Top Facilities including noise barriers, extension to the height of existing bunds and acoustic treatment of Processing Plant buildings.

The following key objectives have guided the refinement of the UEP as currently proposed in the Revised Preferred Project:

- Develop a mine design that eliminates residual uncertainty regarding subsidence predictions, geotechnical constraints and potential impacts on groundwater, surface water and biodiversity associated with longwall mining;
- Gain access to sufficient resources to enable mining to recommence and occur over a sufficient time frame to undertake the necessary assessments to confirm a suitable mine plan in the Wonga West area that would extend the life of Russell Vale Colliery for a period similar to that sought in the initial UEP application;
- Develop comprehensive mitigation and management strategies to reduce environmental and social impacts associated with the UEP in order to meet relevant criteria where-ever practicable and feasible;
- Conduct mining in an environmentally responsible manner to minimise project specific and cumulative environmental and social impacts;
- Create additional employment opportunities within the community; and
- Co-exist with the local community.

Figure 2: Economic impact assessment – Russell Vale Underground Extension Project UEP



Source: Umwelt

This EIA of the UEP 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.[2] The CBA requires an assessment of the net benefits that accrue to the proponent, government, workers and suppliers of the Project.

In addition, the Guidelines require an estimation of the potential costs generated by the UEP. 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*.[3]

The EIA is based on data inputs for the analysis presented in this report which is derived primarily from:

- Financial information provided to Cadence Economics by WCL, relating to:
    - Coal quality, coal price forecasts, and revenue
    - Operating costs, including the costs
    - Capital costs
    - Other costs, including the costs of environmental abatement
- Various technical reports on the environmental impacts of the Project, including:
    - Subsidence Impact Assessment by SCT
    - Groundwater Impact Assessment by GeoTerra and GES
    - Ecological Impact Assessment by Biosis
    - Traffic and Transport Impact Assessment by Transport and Urban Planning
    - Noise impact assessment by Wilkinson Murray
    - Air Quality Impact Assessment by ERM
    - Greenhouse Gases and Energy assessment by Umwelt
    - Surface Water Assessment and Water Balance study by Umwelt
    - Social Impact Assessment by Umwelt
- The Social Impact Assessment (SIA) by Umwelt
- Various data from the Australian Bureau of Statistics (ABS) including most recent Census data.

The information underpinning this assessment therefore is a combination of the project financials, commissioned expert studies relating to the UEP and publicly available information. Cadence Economics has not verified the information in the project financials and expert 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 inputs.

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[2] New South Wales Government (2015).

[3] Department of Planning and Environment (2018)

2. Cost-Benefit Analysis

The Guidelines set out the CBA framework to measure the net benefits to the NSW community. This approach has been adopted in the economic analysis outlined in this report. Table 1 provides a summary of how these net benefits are measured.

Table 1: 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 project proponent and payments made to government, including the Wollongong Council through rates and the NSW Government through royalty payments. 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.

Baseline case

The starting point for any CBA is the base case, or counterfactual. This scenario considers all costs and benefits if the UEP does not proceed. The Russell Vale site is currently in care and maintenance, with no current extraction, processing or sale operations taking place on the site. In addition, there is some infrastructure at the Russell Vale Pit Top facilities. The Pit Top facilities currently occupy an area of approximately 100 ha.

Under the baseline, WCL is obliged to rehabilitate the site, including underground access points and the Pit Top facilities. WCL has advised Cadence Economics that rehabilitation will cost up to $215 million which would be incurred in 2020 if the UEP does not go ahead. Approval of the UEP will delay rehabilitation costs to 2025.

UEP case (central case assumptions)

The following analysis sets out the financial assumptions underpinning the UEP, including capital expenditure, 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.

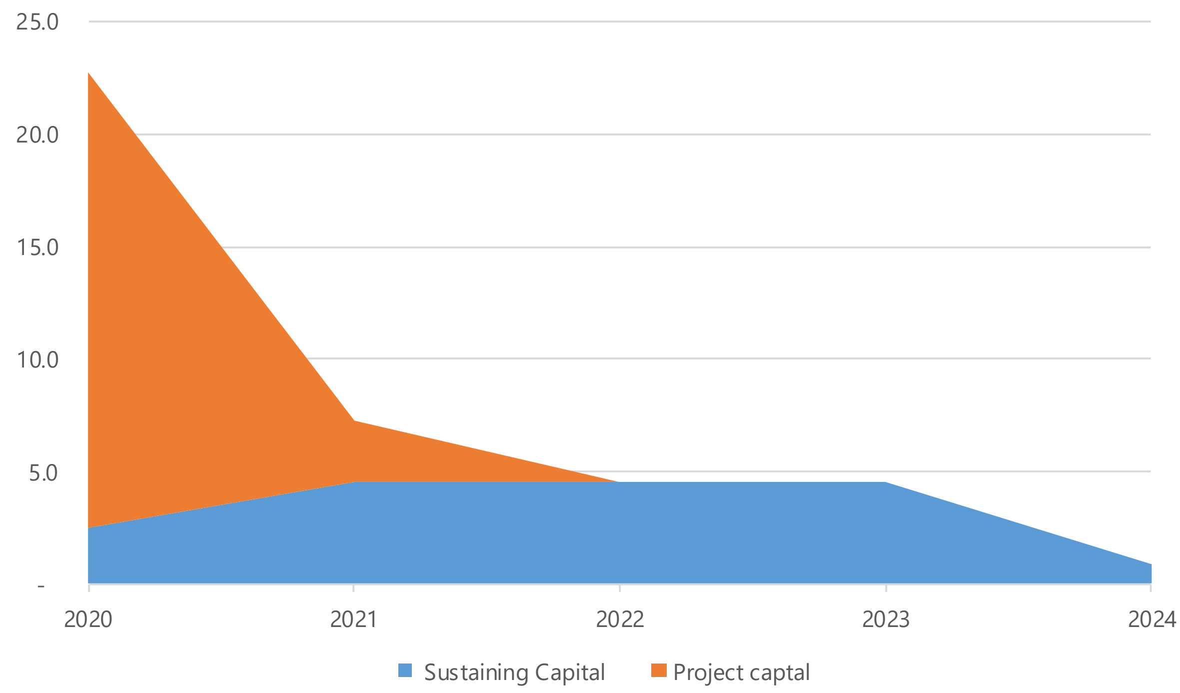
These are central case assumptions from which sensitivity analysis will be conducted and presented later in this report.

Capital costs

WCL provided Cadence Economics with the capital expenditure profile for the UEP. In total, the UEP will require $35.3 million (in NPV terms) of capital expenditure over the period 2020 to 2024, or $39.9 million in undiscounted terms.

Figure 3, provides a summary of capital expenditure, categorised into project capital and on-going capital. The project capital of $21.3 million (in NPV terms) made up of, major works required to develop the underground workings, and surface infrastructure like the processing plant water processing plant and the noise bund (Bund 1). The UEP will also require $14.0 million in NPV terms of additional sustaining capital.

Figure 3: Capital expenditure profile (2019 $ million)



Source: Data provided by WCL

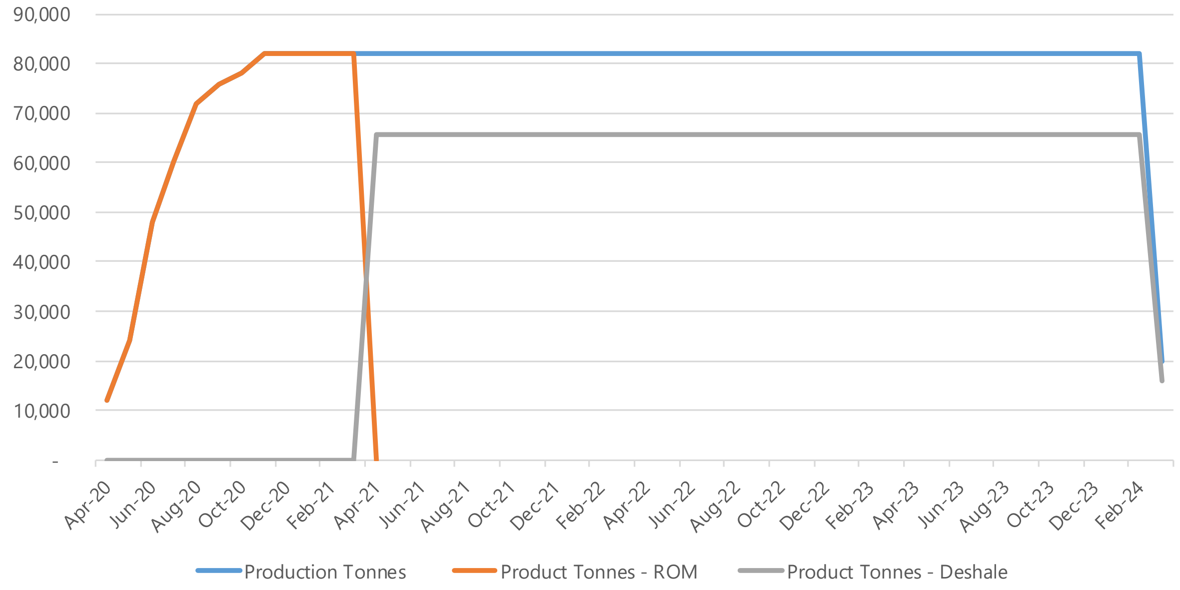
Production assumptions

Based on monthly production, output and sales information provided by WCL, the UEP will produce 3.67 Mt of additional ROM coal over a period of five years staged in two phases:

1. An initial 11-month phase, where saleable output will be unprocessed ROM coal; and
2. A secondary phase, where ROM coal will be processed on site and sold as a refined low-volatile hard coking coal product.

In the initial phase, as outlined in Figure 4, operations are predicted to begin in April 2020 and end in March 2021. In April 2021, on completion of the processing plant, saleable coal from the site will switch to low-volatile hard coking coal product. On average over the secondary phase (except for the last planned month of operations), data provided by WCL suggests coking coal sales of 65,600 tonnes per month.

Figure 4: Russell Vale UEP, output and production tonnes, August 2019 to March 2024



Source: Data provided by WCL

Revenue forecast

Table 2 outlines the projected revenue from the UEP. From a total production of 3.67 Mt ROM coal, the UEP is expected to produce 3.09 Mt of saleable product. This includes, 0.78 Mt of ROM coal and 2.31 Mt of coking coal.

The real price assumptions over the life of the Project were provided by WCL. WCL projections suggest a real price per tonne of $132 dollars for the unwashed ROM output and $197 for coking coal (2019 Australian dollars). Based on the production and real price assumptions, the UEP will generate real revenue of $461.8 million real revenue in NPV terms.

Table 2: Production, price and revenue forecasts for the UEP 2020 - 2024

	Total	2020	2021	2022	2023	2024
ROM Production	3.67	0.53	0.98	0.98	0.98	0.18
Sales	-					
ROM	0.78	0.53	0.25	-	-	-
Coking Coal	2.31	-	0.59	0.79	0.79	0.15
Total	3.09	0.53	0.84	0.79	0.79	0.15
Price (AUD $2019)						
ROM		132	132	132	132	132
Coking Coal		197	197	197	197	197
Revenue	529.9	70.3	148.9	155.4	155.4	29.1
Revenue (NPV)	461.8					

Source: Cadence Economics estimates based on information provided by WCL

* NPV in 2019 dollars based on a 7 percent real discount rate.

UEP financials

A summary of the UEP financials is presented in Table 3. From revenue of $481.5 million in NPV terms, the financial model provided to Cadence Economics by WCL showed operating costs of $213.7 million in NPV terms, and depreciation of $10.2 million in NPV and environmental costs of $4.3 million in NPV terms.

All revenue and operating costs are provided by WCL in a monthly financial model that covers both the initial and secondary phase of the Project. All operating costs, except for royalties, include a ten per cent cost contingency. Depreciation is estimated by Cadence Economics, using a straight-line depreciation method with an assumed 10-year asset life. Based on these figures, the UEP is expected to generate an accounting profit of $257.6 million in NPV terms.

Table 3: Summary of the UEP financials ($ million)

	NPV*	2020	2021	2022	2023	2024	2025
Revenue							
Coal Sales	461.8	70.3	148.9	155.4	155.4	29.1	-
Residual value of capital	19.8	-	-	-	-	27.7	-
Total	481.5	70.3	148.9	155.4	155.4	56.8	-
Operating costs							
Pit-top costs	47.8	8.4	15.4	15.4	15.4		
Surface costs	45.9	-	14.5	19.4	19.4		
Logistics	44.7	11.0	14.6	12.7	12.7		
Royalties	33.2	5.1	10.7	11.2	11.2		
Labour	95.5	19.0	29.6	29.6	29.6		
Environmental	4.3	0.8	1.4	1.4	1.4		
Rehabilitation	-57.7	-215.0	-	-	-	-	215.0
Operating costs	213.7	-170.8	86.2	89.6	89.6	-	215.0
Depreciation	10.2	2.3	3.0	3.5	3.5	-	-
Total costs	223.9	-168.5	89.2	93.1	93.1	-	215.0
Profit	257.6	238.8	59.7	62.3	62.3	56.8	-215.0

Source: Cadence Economics estimates based on information provided by WCL

* NPV in 2019 dollars based on a 7 percent real discount rate.

Direct Benefits

Based on the Guidelines, the direct benefits to NSW of the Project are comprised of three elements:

- The net producer surplus generated by the project that is attributable to NSW;
- The share of company tax payments that are attributable to NSW; and
- Other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

Net producer surplus attributable to NSW

Consistent with the Guidelines, the net producer surplus of the UEP is measured on a cash basis, including capital and operating expenses and revenue.

Based on the financial information summarised in Table 3 above, and the capital costs of $35.3 million in NPV terms, the UEP is estimated to generate a cash operating surplus of $232.5 million in NPV terms. The UEP will generate $120.3 million in NPV terms of additional corporate taxes, leaving a total net producer surplus of $112.2 million as shown in Table 4.

WCL is listed on the Australian Stock Exchange, although a high proportion of the company stock is held by overseas or overseas-controlled entities. For example, Jindal Steel & Power (Mauritius) Limited has a combined holding of 60.4 per cent. Information provided by WCL shows that 35.4 per cent of all shareholders are located within NSW. Based on this NSW ownership share, the net producer surplus that is attributable to NSW is estimated $39.7 million in NPV terms, see Table 4

Table 4: Estimated net producer surplus of the UEP attributable to NSW ($ million^)

Key data	NPV*
Net revenue (sales revenue and asset revenue, minus operating costs)	481.5
Operating costs	213.7
Capital costs	35.3
Cash operating surplus	232.5
Company tax	120.3
Net producer surplus	112.2
Share NSW	35.4%
Net producer surplus attributable to NSW	39.7

Source: Cadence Economics estimates based on information provided by WCL. ^ 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.

Company tax payments attributable to NSW

As outlined in Table 3 above, it is estimated that the UEP will generate an estimated accounting profit of $257.6 million in NPV terms over the life of the Project.

Consistent with the Guidelines, the company tax payments made to the Australian Government are levied on the estimated accounting profits generated by the UEP based in a company tax rate of 30 per cent. This is based on the assumption that all the profit generated by the UEP are 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 5, it is estimated the UEP will generate $257.6 million in total profit in NPV terms over the period 2020 to 2025. At a company tax rate of 30 percent, the company tax estimate is $120.3 million in NPV terms, of which $38.5 million is attributable to NSW.

Table 5: Estimated company income tax from the UEP attributable to NSW ($ million^)

Company tax attributable to NSW	NPV*
Total profit	257.6
Company tax^^	120.3
NSW Share^^^	38.5

Source: Cadence Economics estimates based on information provided by UCL. ^ 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.

Payments to the State government and the local Council

Under the UEP, various payments will be made to NSW Government and the Wollongong City 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 Wollongong city Council.

Over the life of the UEP, a total of $38.7 million in payments are made in NPV terms as shown in Table 6. For the NSW government, the payments are comprised of $33.2 million in royalty payments and $3.4 million in payroll tax. A further $2.1 million is paid in the form of council rates and land taxes.

Table 6: Estimated payments to State government and local Council ($ million^)

Category	NPV*
Total Royalties paid	33.2
Payroll tax	3.4
Council rates and land tax	2.1
Total Payments	38.7

Source: Cadence Economics estimates based on information provided by WCL. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

Summary of direct benefits

Based on the revenue and cost data provided by WCL, the Project is estimated to generate $116.9 million in total direct benefits to NSW in NPV terms as summarised in Table 7. These benefits are comprised of $39.9 million of net producer surplus attributable to NSW, $38.5 million in company tax attributable to NSW and $38.7 million in NPV terms paid to the NSW government in payroll tax and royalties and Wollongong City Council in rates.

Table 7: Summary of the direct benefits of the UEP ($ million)

Net financial benefit	NPV*
Net producer surplus attributable to NSW	39.7
Company income tax attributable to NSW	38.5
Payments to the NSW and local Government	38.7
Total financial benefit attributable to NSW	116.9

Source: Cadence Economics estimates based on information provided by WCL

* NPV in 2019 dollars based on a 7 percent real discount rate.

Indirect Benefits to NSW

Consistent with the Guidelines, the indirect benefits of the UEP accrue to workers, suppliers and land owners.

Benefit to employees

Consistent with the Guidelines, key factors 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); and
- Minus the wage difference due to skills and the disutility to work in the mining industry.

WCL provided Cadence Economics with a detailed list of the workers required as well as the monthly and annual employment costs (which includes a ten per cent contingency) of the UEP. This data is summarised in Table 8. In 2020 employment is expected to be 130.4 full time equivalent (FTE) workers who receive an average wage of $133,234. During the secondary phase of the Project, 2021 to 2023, employment averages 205 FTEs and the average wage is $131,747. In the last calendar year of operations, FTE employment is 51.3 workers and the average wage is $131,747. The average wage in the initial phase is higher than the secondary phase, as there are a greater proportion of higher-skilled workers.

Table 8: Central case – wages paid to those employed under the UEP

	NPV*	2020	2021	2022	2023	2024
Employment (FTEs)		130.4	205.0	205.0	205.0	51.3
Average wage ($ per annum^)		133,234	131,747	131,747	131,747	131,747
Average NSW wage ($ per annum^)	-	66,111	66,111	66,111	66,111	66,111
Estimated worker benefit ($ million^)	43.6	8.8	13.5	13.5	13.5	3.4

Source: WCL, ABS (Table W17) 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.

To measure the ***opportunity cost*** compared to the non-mining sector, the wages earnt by UEP workers are compared with the average wage in NSW. This implies that should the approval not go ahead, those who would have been employed by UEP would find alternative work at the average wage paid in NSW. The average wage across NSW is $66,111 per annum based on the 2016 Census data (updated to 2019 dollars).

As shown, there is a significant premium incorporated in mining wages compared with the average wage paid in NSW. 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) and 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 the UEP compared with any alternate employment. In this context, as the assumption is made that any worker employed in the UEP 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 mine and the measurement difficulties associated with measuring these disutilities generally, we have assumed the disutility for workers under the UEP case is zero. This implies, effectively, that those workers employed by the UEP experience no additional disutility from working in the mine compared with any alternative employment they would have secured in the absence of the project.

Based on this assumption, estimated worker benefit is $43.6 million in NPV terms, over the life of the UEP.

Benefit to suppliers

Consistent with the Guidelines, the economic benefit to suppliers is estimated as producer surplus generated from the sale of intermediate inputs (that is inputs of goods and services into the production process) from NSW firms to the UEP.

As summarised in Table 9, based on the input cost data provided by WCL, the UEP is estimated to require $137.2 million in NPV terms of intermediate inputs over its life-cycle in NPV terms. It is assumed that 50 per cent of the inputs to the mine are sourced from NSW-based suppliers or $68.6 million in NPV terms over the life of the UEP.

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 computable general equilibrium modelling. Using this relatively conservative technique, the total supplier benefits are estimated to be $13.8 million in NPV terms.

Table 9: Central case – estimated supplier benefits

Indirect benefits –suppliers	NPV*
Total intermediate inputs ($ million^)	137.2
Share from NSW	50%
Total intermediate inputs ($ million^)	68.6
Gross operating surplus ratio	0.202
Total benefits to suppliers (NPV*)	13.8

Source: Cadence Economics estimates based on information provided by WCL. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

Land owners

WCL informed Cadence Economics that there are no expected benefits to land owners in relation to the UEP.

Summary of indirect benefits

As summarised in Table 10 the total indirect benefits are estimated to be $57.4 million in NPV terms. The main source of these benefits is the $13.8 million in benefits to suppliers and $43.6 million in benefits to employees in NPV terms. There are no anticipated benefits to land owners as a result of the UEP.

Table 10: Summary of indirect benefits, ($ million)

Indirect benefits	NPV*
Employee benefits	43.6
Supplier benefits	13.8
Land owner premiums (Land sales made above market rates)	0.0
Total Indirect Benefit	57.4

Source: Cadence Economics estimates based on information provided by WCL. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

Indirect Costs to NSW

Consistent with the Guidelines, the indirect costs of the Project are classified as:

- Net public infrastructure costs;
- Estimated loss of surplus to other industries;
- Net environmental, social and transport-related costs; and,
- Net environmental costs.

Regarding the UEP design, as outlined above, WCL have informed Cadence Economics that the management and mitigation of a range of environmental impacts are included in the operating costs of the project, and that this spending constitutes $4.3 million of operating costs in NPV terms. In addition, a capital expenditure of $1.9 million in NPV terms is included in the project financials for the upgrade and extension of existing noise bunds, the installation of a new noise barrier and the installation of a water treatment plant to further reduce the potential environmental impacts of the operations.

Net public infrastructure costs

It is not expected that the UEP will generate additional public infrastructure costs. There is a current obligation to undertake improvements to Bellambi Lane, but this is common to both the Baseline and Project case. In addition, costs associated with the maintenance to Bellambi are included in the environmental management and mitigation costs, these costs are not individually identifiable as they are subject to negotiation.

Loss of surplus to other industries

The UEP may generate loss of surplus in other industries where it competes directly for resources and inputs. The Project may generate these loses through directly competing for land or water rights with other industries, in particular agriculture.

The Project is unlikely to generate significant impacts to other industries. The land used to support new Project-related site infrastructure is considered not suitable for agriculture, as the majority of the surface facilities is already disturbed land and is located in a landscape that is not highly suitable for agricultural purposes. As a result, the loss of surplus to other industries has been assessed as zero. There will be no impact to land use potential as a result of the proposed underground mining.

Net environmental, social and transport-related costs

The analysis below includes a discussion of the residual community impacts of the UEP. The net environmental, social and transport-related costs take into account costs relating to:

- Greenhouse gas;
- Subsidence;
- Groundwater;
- Ecology or biodiversity;
- Noise;
- Air quality;
- Surface water and water balance;
- Traffic and transport;
- Aboriginal heritage;
- Non-Aboriginal heritage;
- Visual amenity; and,
- Residual value of land.

The UEP is expected to generate modest incremental indirect costs on the NSW community of $17,850, which is the cost of greenhouse gas attributable to NSW.

Greenhouse Gas and Energy

A Greenhouse Gas and Energy Assessment (GHGEA) was undertaken for the UEP by Umwelt and estimated:

- Direct (Scope 1) and indirect (Scopes 2 and 3) greenhouse gas emissions associated with the UEP; and,
- Energy use directly associated with the UEP.

The GHGEA findings indicated that:

- The UEP's greenhouse gas inventory is dominated by Scope 3 emissions – third party emissions (approximately 85 per cent);
- Approximately 15 per cent of the greenhouse gases associated with the UEP is related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions); and,
- The UEP is a small scale coal operation that will produce energy commodities over 5 years and the forecast energy use intensity falls within the normal operating range for an Australian underground coal mine.

Managing energy use is the primary greenhouse gas management control option at the Russell Vale Colliery. WCL will continue to seek operational energy use efficiencies where commercially feasible and review and update the Greenhouse Gas Management Plan for the UEP.

Consistent with Guidelines, the level of greenhouse gas (GHG) emissions attributable to the UEP is measured by the:

1. Scope 1 emissions, representing the direct GHG emissions from the Project from, for example, the use of diesel in plant and equipment and fugitive emissions; and,
2. Scope 2 emissions, representing the indirect emissions from the Project purchases of inputs, generally associated with the purchase of electricity.

Table 11 provides the emissions for each year of the Project. In total, the UEP is estimated to emit 1,522,997 CO_2e, mainly Scope 1 emission.

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).[4] The results of this auction yielded an average carbon price of $13.98 per tonne of CO_2e abated (in 2019 Australian dollars). 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 Project are derived by taking the year-on-year emissions and multiplying these figures by the $13.98 carbon price under the ERF over the life of the UEP.

The impact of GHG emissions are global in nature, as a result, apportioning the whole costs of CO_2e associated with the UEP 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 $17.7 million in NPV terms. Attributing the GHG costs based on the NSW population, consistent with the Guidelines, results in an attributed GHG cost of $0.019 million to NSW in NPV terms.

Table 11: Greenhouse gas emissions attributable to the UEP

	NPV*	Total	2020	2021	2022	2023	2024
Tonnes of GHG							
Scope 1		1,419,497	206,543	380,595	380,595	380,595	71,168
Scope 2		103,500	15,060	27,750	27,750	27,750	5,189
Total		1,522,997	221,602	408,346	408,346	408,346	76,357
Price Path ($ per tonne^)			13.98	13.98	13.98	13.98	13.98
Global Impact ($ million^)	17.7	21.3	3.1	5.7	5.7	5.7	1.1
NSW Share of Global impact							
Global population (Million)	-	-	7,794.4	7,874.4	7,953.4	8,031.4	8,108.4
NSW Population (Million	-	-	8.2	8.3	8.4	8.5	8.6
Global population (Million)	0.019	0.022	0.003	0.006	0.006	0.006	0.001

Source: Cadence Economics estimates based on Umwelt. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

Subsidence

The subsidence assessment confirms that the UEP will result in imperceptible subsidence movements and negligible subsidence-related impacts on natural and built surface features (including the Illawarra Escarpment, upland swamps, creeks, slopes and built structures), and on biodiversity, surface water and groundwater within the Cataract Reservoir catchment. Additionally, the risk of proposed mining destabilising historical mine workings is low. Subsidence monitoring will be undertaken to confirm that observed subsidence levels are within predicted levels. In this context WCL will:

[4] The results of this auction are summarised at http://www.cleanenergyregulator.gov.au/ERF/Auctions-results/december-2018 which was accessed in June 2019 for this analysis.

- Review and update existing management plans for the management and monitoring of subsidence based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining.
- Review and update the existing Built Features Management Plans for all surface infrastructures within the vicinity of the proposed first workings to manage any potential subsidence-related impacts on surface infrastructure. The Built Features Management Plans will be prepared in consultation with the asset owners prior to undermining of the surface infrastructure.
- The existing subsidence monitoring programme will be reviewed and updated based on the significantly lower levels of surface subsidence anticipated for the proposed first workings mining method compared to longwall mining. This program will be targeted to confirm the magnitude of subsidence from the proposed first working mining method and provide the opportunity to modify the impact management strategy before proceeding to mining below subsidence sensitive infrastructure.

The costs of undertaking these mitigation and management measures are included in the operating costs of the UEP.

Groundwater

A detailed groundwater modelling based assessment was undertaken to assess the potential groundwater and stream base flow impacts of the UEP.

The first workings mining method proposed for the UEP has been based on a non-caving first workings mining system that will result in imperceptible subsidence movements and negligible subsidence related impacts. The revised mine plan has been specifically designed to minimise potential groundwater impacts by limiting depressurisation immediately above the coal seam. An assessment of potential groundwater impacts of the UEP was undertaken, including assessment of interactions of the UEP with historical multi-seam mining within the UEP Application Area.

Groundwater related impacts

The groundwater modelling results indicated drawdown effects are linked to historic workings and, in particular, long walls (LW) 4, 5 and 6 and there is unlikely to be an observable impacts drawdown effect associated with the proposed first workings mine plan. There are no anticipated subsidence effects on stream bed alluvium or plateau colluvium as there is minimal predicted subsidence or transmitted overburden depressurisation over and due to the proposed first workings extraction.

The proposed workings are not considered to have any potential to perceptibly impact on upland swamps. The UEP is not considered to result in any strata deformation or cracking impacts, with no perceptible reduction in stream baseflow. Modelling shows that the maximum stream flow loss associated with UEP is modelled to be 0.47 ML per year and is made up of:

- 0.0006ML/day (0.22ML per year) in Cataract Creek (upstream of Cataract Reservoir) in 2073
- 0.0002ML/day (0.07ML per year) in Cataract River (upstream of Cataract Reservoir) in 2083
- 0.0005ML/day (0.18ML per year) in Bellambi Creek in 2072.

Cumulative impacts on baseflow due to all previous and currently proposed mining are predicted to peak at 0.027ML/day (9.91 ML per year).

Due to the distance of the previously mined longwall panels (LW 4, 5 and 6) and the proposed first workings from the Cataract Reservoir, and the lack of subsidence impacts from the proposed first workings, no adverse impacts on stored water quantity or quality have been observed, or are predicted to occur, as a result of the proposed first working extraction on Cataract Reservoir.

The maximum total annual groundwater inflow to the workings, including all previous mining impacts from the Russell Vale lease workings, is predicted to be 288ML per year, with the contribution from the proposed first workings (and the continuing gradual increase from previous workings) being up to 36.5ML per year.

The groundwater inflow rate gradually increases during extraction of the proposed first workings as they are dewatered. After the proposed first working mining activities are completed, the model assumes the pumps are turned off and the mine gradually fills up and re-pressurises the overburden until the recovery reaches the 117.5m AHD elevation of the escarpment adit at around 2057. Outflow rates are modelled up to a maximum of 0.3ML per day.

The UEP is considered to satisfy the requirements under the following policies related to the protection of groundwater and surface water flows in the Sydney Drinking Water Catchment, including the:

- NSW Aquifer Interference Policy;
- Neutral or beneficial effect NorBE test under the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011(Drinking Water SEPP); and
- WaterNSW Principles for Managing Mining and Coal Seam Gas Impacts in Declared Catchment Areas.

Groundwater Mitigation and Management Measures

The primary management measure related to groundwater impacts and associated base flows in surface streams is the use of a first workings mine plan to avoid subsidence impacts which have the potential to significantly affect groundwater systems.

Wollongong Coal operates an existing groundwater monitoring network within the Wonga East area. The existing groundwater monitoring network will be utilised for the monitoring of impacts associated with the UEP and historical mining. Existing groundwater management practices will continue to be implemented for the UEP and all monitoring and management practices will be regularly reviewed to confirm they remain appropriate given the scale of observed impacts.

Wollongong Coal will review and update the Water Management Plan and groundwater monitoring program with regards to monitoring of groundwater levels, water quality, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model, as required.

Existing monitoring and management measures associated with the previous mining of longwalls 4 to 6 will remain in place with triggers updated to reflect the predicted groundwater impacts for the UEP and the very low levels of subsidence (less than 100 mm and generally less than 30 mm) predicted for the proposed mine plan.

The costs of undertaking these mitigation and management measures are included in the operating and the costs of the water treatment plant are included in the capital costs of the UEP.

Licensing

Wollongong Coal holds a Water Access Licence (WAL) under the *Water Management Act, 2000* for 515 ML (units)/year (Licence No. WAL36488) which is located within *Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source*. Based on predicted maximum total groundwater inflow to the workings, including all previous mining impacts from the Russell Vale lease workings, of 288ML per year, Wollongong Coal currently holds sufficient units in their WAL. The UEP is within the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* (Unregulated River WSP).

Wollongong Coal will require a WAL for annual cumulative take of up to 10.04 ML/yr. The UEP contribution to the total annual take is 0.47 ML per year, as a result of the reduced flow in Cataract Creek, Cataract River and Bellambi Creek. The annual cost of the UEP contribution to the WAL is $36.66 or $515.20 in NPV terms, as outlined in Table 12.

Table 12: Water accessing licensing requirement for the UEP

WAL (ML per year)	
Cataract Creek	0.22
Cataract River	0.07
Bellambi Creek	0.18
Total	0.47
Volumetric charge ($^/ML)^^	78.0
Annual cost ($^)	36.7
NPV ($)*	515.2

Source: Cadence Economics estimates, based on findings in GeoTerra and GES, 2019.

^ Real 2019 Australian dollars.

* NPV in 2019 Australian dollars based on a 7 per cent real discount rate, estimated using an annual cost of $36.7 over the period 2020 to 2080.

^^ Based on the Sydney Water Volumetric charge 2019-20, updated to 2019 Australia dollars, as outlined in IPART New South Wales, *Review of prices for WaterNSW*, (June 2016)

Ecology

An updated biodiversity impact assessment was undertaken to determine the potential impacts of predicted imperceptible subsidence on biodiversity values. The assessment included:

- A review of potential subsidence impacts and primary impacts arising from the revised mine plan; and,
- Preparation of impact assessments for species reliant on features at risk of impact due to subsidence, including:
  - Threatened ecological communities reliant on perched aquifers; and
  - Threatened species occupying upland swamps, rock environments and aquatic environments.

The biodiversity impact assessment concluded that due to the imperceptible predicted subsidence associated with the revised mine plan, the risk of impacts to the biodiversity values of the UEP Application Area are considered to be negligible. Specifically:

- Impacts to upland swamps from the UEP are predicted to be negligible. Subsequently, threatened species occupying coastal upland swamps (i.e. prickly bush-pea, giant burrowing frog and the giant Dragonfly) are considered at negligible risk of impact;

- The UEP has removed the risk of subsidence-related damage to sensitive rocky environmental features in the UEP Application Area. As such, the UEP is predicted to result in negligible risk of impact to roosting habitat for these species;
- Impacts on surface water flows and water quality area predicted to be imperceptible due to the negligible levels of predicted subsidence, therefore it is concluded that negligible impacts will occur to the habitat of threatened fish species; and
- The Red Crowned Toadlet, which has previously been recorded at two locations within the UEP Application Area, is at negligible risk of impact as a result of the UEP.

Ecology Mitigation and Management Measures

Wollongong Coal will continue to manage and monitor impacts to biodiversity values in accordance with their Biodiversity Management Plan (2019) and Upland Swamp Management Plan (2015). The existing Biodiversity Management Plan will be reviewed and updated to reflect the Revised Preferred Project and associated management and monitoring measures.

Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence impacts as well as primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creek. These will include:

- Continued subsidence monitoring along existing subsidence monitoring lines, and extension of the subsidence monitoring program to include areas within the UEP first workings mine plan;
- Visual inspection of the rock formation that forms the base of upland swamps CCUS4, CCUS5, CCUS10, BCUS4 and BCUS6 during routine monitoring;
- Monitoring of groundwater levels and water quality in upland swamps using the existing network of shallow groundwater piezometers;
- Continued monitoring of surface outflow monitoring in upland swamp CCUS4 using the existing box weir (site CT3a);
- Monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites;
- If subsidence impacts and/or primary impacts in excess of those predicted in this report are detected, the monitoring program will be reassessed.

The costs of undertaking these mitigation and management measures are included in the operating costs of the UEP.

Noise

To reduce noise impacts associated with the UEP, a significant re-design of the Pit Top Facilities and application of additional mitigation measures has been undertaken.

The noise mitigation measures identified through this process to be reasonable, feasible and effective at mitigating noise impacts from the Pit Top Facilities were incorporated into the noise modelling undertaken for the NIA and include:

- Re-positioning new infrastructure to provide maximum topographical shielding from surrounding residences, for example re-locating the surge bin and secondary sizer building from an exposed location to more shielded locations;

- Acoustic treatment of existing and new infrastructure, including acoustically lining the Primary Sizer building and tripper system, enclosing the Processing Plant and Secondary Sizer in an acoustically treated building and acoustic treatments to the Surge bin and conveyors;
- Extension and increase in the height of existing berms in strategic locations surrounding Pit Top Facilities to shield trucks and equipment. The extension to the height of the main northern bund (Bund 1) will be prioritised to be completed prior to the commencement of 'phase-in' operations;
- Construction of a 4 m high noise barrier along the northern side of the site access road to shield trucks accessing the site from adjacent residences;
- Reduced coal truck movements during evening and night-time periods, with no haulage on Sunday and public holidays, to minimise the potential for disturbance;
- establishing a temporary stockpile of ROM coal as early as possible during 'phase-in' operations to provide shielding to northern receivers from potential noise impacts from the dozer operating on the ROM stockpile;
- Voluntary speed limit of coal trucks of 50 km/hr applied to Bellambi lane;
- 40 km/hr speed limit on site; and
- Operational noise mitigation measures such as:
  - Restricting the operation of the dozer, rejects front-end loader, rejects truck, and underground loader to daytime only use;
  - Restricting the operation of reclaim conveyor system, Secondary Sizer, Surge Bin, Processing Plant and truck loading bins to daytime and evening use; and,
  - Dozer movements restricted to near ground level during 'phase-in' operation to maximise shielding provided by temporary ROM coal stockpile.

The proposed mitigation measures and the reconfiguration of the Pit Top Facilities have significantly reduced the predicted operational noise levels in comparison with the pre-existing operation of the site and when compared to the previously proposed site configuration of the original UEP application.

In addition, the construction-phase will incorporate feasible and reasonable work practices to address construction noise impacts, these include:

- Schedule activities to minimise noise impacts;
  - All berm construction works will be undertaken during standard construction hours;
  - Berm construction will be scheduled as early as possible within the 'phase-in' period so that they can operate as noise barriers;
  - Where feasible and reasonable, reduce duration of berm construction works; and
  - Consult with affected neighbours about scheduling berm construction works to minimise noise impacts;
- Notification Before and During Construction of Berms;
  - Provide, reasonably ahead of time, information such as nature of works to be carried out, the intention behind the works (i.e. to reduce long-term operational noise levels emanated from the site), total berm construction duration, what berm(s) are expected to be noisy, their duration, and when respite periods would occur;

    - Provide information to neighbours before and during construction through letterbox drops, meetings or individual contact; and
    - Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, construction hours and regular information updates - this signage should be clearly visible from the outside and include a contact phone number for enquiries during the works;
- Complaint Handling;
    - Give complaints a fair hearing;
    - Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow;
    - Call back as soon as possible to keep people informed of action to be taken to address noise problems;
    - Implement all feasible and reasonable measures to address the source of complaint; and
    - Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, time of verbal response and timeframe for written response where appropriate;
- Use Quieter Equipment and Methods;
    - Provide dump truck access to the berms on the side further away from the closest receivers to maximise distance to receivers and shielding from berm;
    - Where feasible and reasonable, use equipment with less annoying alternatives to the typical 'beeper' alarms (e.g. smart alarms and broadband alarms); and
    - Regularly inspect and maintain equipment to ensure it is in good working order.

To assess the potential noise impacts of the UEP, a detailed noise impact assessment was undertaken for the Revised Project in accordance with the NSW EPA's *Noise Policy for Industry* (NPfI). The NIA considers impacts associated with operational noise, construction noise, night time noise and road traffic noise.

Predicted Noise Impacts

With additional noise controls in place, the site will generally comply with operational noise criteria at all surrounding residences, except under some weather conditions during winter nights. Under adverse weather conditions, there is the potential for minor exceedances (1-2dB) of the criteria during less than 10% of winter nights at some residences immediately adjacent to the site. The EPA considers a 1-2dB exceedance negligible as it would not be discernible by the average listener. In addition;

- Predicted maximum noise levels during the night-time are not predicted to result in sleep disturbance;
- Noise from trucks transporting coal complies at residences along Bellambi Lane and surrounds; and,
- During the construction of noise bunds around the Pit Top, there are likely to be short periods when noise levels trigger the need for additional noise management practices.

Noise Management and Monitoring Measures

To monitor noise performance of the UEP, WCL will continue to operate two continuous noise monitoring stations within the site. WCL will review and update the existing Noise Management Plan for the Russell Vale Colliery to incorporate the UEP and associated additional noise management measures.

The cost of implementing the reasonable, feasible and effective mitigating noise measures, and the monitoring and Noise Management Plan is included in the operational costs. The costs of incorporate feasible and reasonable work practices during the construction phase and the $1 million construction cost for the noise berm has been included in the capital costs.

Air Quality

An assessment of predicted air quality impacts for the UEP was undertaken in accordance with EPA guidelines. The operations of the UEP were analysed and estimates of particulate matter emissions.

The dispersion modelling considered the emissions inventory for each scenario, local terrain factors, local meteorological data and background air quality over a 365 day period in order to predict annual and 24 hour emission levels at selected locations.

A range of air quality mitigation measures and controls have been included in the UEP design and will be implemented by WCL in the ongoing operation of the project. These include:

- Enclosure of conveyors and material transfer points;
- Enclosure of Processing Plant;
- Water sprays on ROM stockpile;
- Water carts on unsealed haul routes;
- Water sprays on stockpiles and exposed areas triggered during periods of high winds;
- Water sprays on the noise berms during construction;
- Consideration of the use of stability polymer veneer coating on long-term unworked stockpiles (>30 days) and unsealed haul routes; and
- Revegetation/rehabilitation of exposed disturbed areas.

The results of the air quality assessment were compared to relevant air quality criteria for PM_{10}, $PM_{2.5}$ and deposited dust and no exceedances of relevant criteria were predicted at any representative sensitive receptor locations off site.

Notably, a review of daily varying cumulative PM_{10} 24 hour concentrations across a full year identified that cumulative PM_{10} 24 hour concentration remains well below the EPA criterion of 50 µg/m^3.

Air Quality Monitoring and Management Measures

WCL will review and update the existing Russell Vale Colliery Air Quality and Greenhouse Gas Management Plan for the UEP. In addition to the dust control measures outlined above, the plan will incorporate a range of proactive and reactive dust control strategies. Proactive air quality management would involve the planning of activities in advance of potentially adverse conditions. Specifically, the proactive air quality management approach will include:

- Implementation of a system to provide the operation with a daily forecast of expected dust conditions in the vicinity of the operation;
- Discussion of the weather conditions and dust considerations at daily pre-shift meetings; and

- Modifying or suspend the planned activities, as appropriate, to minimise dust impacts.

Reactive air quality management will include the modification or suspension of activities in response to the following triggers:

- Visual conditions, such as visible dust from trucks above wheel height;
- Meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors, and/or
- Ambient air quality conditions (that is, elevated short-term PM_{10} concentrations).

The costs of undertaking these mitigation and management measures are included in the operational costs of the UEP.

Surface Water and Water Balance

A Surface Water Impact Assessment (SWIA), including a water balance study, was undertaken for the UEP which assessed the following:

- Flow volumes in downstream watercourses;
- Flooding, including flow rates, velocities and depths;
- Water quality in downstream watercourses;
- Geomorphological and hydrological values of watercourses, including environmental flows;
- Riparian and ecological values of watercourses; and
- Water users, both in the vicinity and downstream of the Russell Vale Colliery Pit Top facilities.

The SWIA concluded that improvements to the existing stormwater system, as proposed through the separate modification application (MP 10_0046 Mod 4), and additional water quality controls proposed for the Pit Top facilities will result in improvements in water quality leaving the site during flood events and reduced flood impacts to downstream properties, the Princes Highway, Bellambi Lane and Bellambi Gully. Specifically, the solutions proposed as part of Mod 4 and the UEP:

- Will reduce the frequency and volume of upslope clean catchment runoff entering the Water Management System during high rainfall events;
- Reduce the frequency and volume of uncontrolled discharges of dirty/mine water from site during high rainfall events and will result in lower concentrations of sediment in licensed off-site discharges;
- Have no negative impacts on riparian and ecological values downstream of the Pit Top facilities as a result of the UEP when compared to the existing care and maintenance scenario;
- Improve water quality downstream of the Pit Top facilities;
- Have no negative impacts on water users downstream of the Pit Top facilities; and
- Have no negative cumulative impacts as a result of the Project when compared to the existing care and maintenance scenario.

The water balance results indicate that the UEP will have a surplus of water in all years and the Project will be able to adequately meet site water demands with little to no import of water from off-site sources. Apart from potable water requirements, there is no predicted demand for water imports for all modelled years with rainfall runoff and extracted groundwater more than adequate to meet the limited UEP water demands for coal mining and surface coal handling, processing and transportation. .

Surface Water Management Measures

The Pit Top facilities Water Management System (WMS) will operate as the key surface water management measure for the UEP. In addition, there will be a series of erosion and sediment control measures utilised during the construction and operational phases of the UEP. The proposed Pit Top facilities WMS will include:

- Installation of debris control structures upslope of the Bellambi Gull Creek diversion pipe inlets and regular maintenance of debris control structures and other stormwater controls to reduce the risk of blockages that could cause upslope catchment runoff to flow across the stockpile area;
- Re-grading of the eastern laydown area to allow the area to be used as a dry sediment basin with a capacity of 2.1 ML and the construction of a channel to direct overflow from the dry sediment basin to the Stormwater Control Dam (SWCD);
- Construction of a flood levee upstream of the stockpile area to direct upslope runoff (from laydown area, car parking and offices) to the Bellambi Gully Creek stormwater diversion pipe and provide stormwater attenuation during high rainfall events;
- Pre-treatment of water flowing to Dam 1 using flocculation blocks to enhance settling in Dam 1 and Dam 2 prior to overflow to the SWCD; and
- Ongoing real time turbidity monitoring of LDP 2 discharge, Bellambi Gull Creek upstream and Bellambi Gully Creek downstream to allow rapid response to deviations above water quality trigger values.

The existing surface water monitoring programs at the Pit Top facilities will be reviewed and updated as required as part of the implementation of the UEP. These programs will be documented in the updated Russell Vale Pit Top facilities Water Management Plan (WMP).

The WMP will be updated as part of the UEP and will include detailed Trigger Action Response Plans to enable WCL personnel to respond appropriately to potential surface water management issues. The updated WMP will include:

- Water balance including details of water supply, use, management and transfers;
- An Erosion and Sediment Control Plan that is consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries, or its latest version;
- Relevant baseline data on water quality;
- Surface water monitoring program;
- Description of the WMS including design objectives and performance criteria; and
- Trigger levels for investigating any potentially adverse impacts.

Monitoring, Licensing and Reporting

Water systems at and surrounding the Russell Vale Pit Top facilities are currently monitored in accordance with the WMP (WCL, 2019) and the site's EPL (EPL 12040). Water monitoring is undertaken to assess compliance against licence and consent conditions and for operational purposes. This includes monitoring of the site water balance, water quality and erosion and sediment controls. Monitoring of the performance of the water management systems and associated erosion and sediment control measures will be set out in the revised WMP, with monitoring typically undertaken monthly and after major storm events.

A record of baseline data has been collected for Russell Vale Pit Top facilities and will be used to inform the ongoing review of monitoring data, allowing any potential impacts of the UEP to be identified and management measures implemented where appropriate.

The following reporting will be undertaken for the UEP:

- Monthly water quality reporting published on the WCL website;
- Real time water quality monitoring results of Bellambi Gully Creek upstream and downstream of the Pit Top facilities available on the WCL website in accordance with EPL 12040;
- Reporting of monitoring data and incidents in accordance with EPL 12040 requirements and conditions of consent; and
- A summary of surface water monitoring results and WMS performance will be provided in the Annual Review.

The costs of reporting, monitoring, and implementing the surface water management measures are included in the operational costs.

Traffic and Transport

A Traffic and Transport Impact Assessment (TTIA) was undertaken for the UEP which assessed the potential changes to existing conditions as a result of the UEP and potential traffic related impacts on:

- Operational capacity of principal intersections;
- Cumulative impacts from existing and proposed developments; and,
- Road condition and road safety.

The UEP will generate traffic at levels similar to the previously approved operations. The TTIA concludes that with the project design improvements and traffic control measures, it is unlikely that the UEP will result in an adverse impact on the performance of the road network (including at key intersections), road safety or road users. Specifically:

- key local intersections will continue to operate at a satisfactory to good Level of Service with the UEP:
    - The Princes Motorway/Bellambi Lane/Colliery Access Road intersection would continue to operate at a good level of service (A/B operation) with low average vehicle delays;
    - The Memorial Drive/Bellambi Lane would continue to operate at a satisfactory Level of service (C/D operation) with average vehicle delays remaining below 43.3 seconds per vehicle; and
- The proposed contribution to the maintenance of Bellambi Lane would further mitigate any impacts of the UEP on the condition of this local road.

Project design improvements and mitigation measures to be implemented for the UEP include:

- Restricting truck transport to 7am – 6pm Monday to Friday and 8am – 6pm Saturday. No Sundays or public holidays. Coal transport may occasionally be required until 10pm Monday to Friday in exceptional circumstances such as Port closures or interruptions;
- Provision of a designated truck parking area on site to prevent queuing of trucks onto the adjoining public road system. All trucks awaiting loading will park in this area with engines switched off;

- Retention of the voluntary speed limit along Bellambi Lane of 50km/hr for all trucks accessing the Colliery, with the continued aim of achieving 95% compliance with the voluntary speed restriction;
- Construction activities, and associated construction traffic, will be undertaken during standard construction hours 7 am-6 pm Monday to Friday and 8 am-1 pm Saturday. No construction works will be undertaken on Sundays or public holidays; and
- A contribution to the maintenance of Bellambi Lane, to mitigate any accelerated pavement degradation, has been proposed and is to be negotiated with Wollongong City Council.

The costs of mitigating against the traffic impacts of the Project are included in the operational costs.

Heritage

Several Aboriginal heritage sites have been previously identified within the UEP area. These sites are mainly associated with rock shelters in sandstone cliff formations and grinding groove sites on upland sandstone outcrops. One of the shelter sites appears to have been impacted by instability to the associated sandstone overhang, either as a result of previous mining in the Bulli Seam or as a result of tree root invasion and natural erosion processes.

The proposed first workings are not predicted to result in any negligible subsidence and are not considered to have any potential to perceptibly impact on natural surface features or surface infrastructure, including Aboriginal heritage sites. The UEP is therefore unlikely to significantly impact Aboriginal cultural heritage and no further assessment has been undertaken. Further it is noted that there is no proposed additional disturbance at the Pit Top Facility, beyond that currently disturbed and approved for development

There are no registered non-Aboriginal heritage items within the UEP area. No direct or indirect impact to non-Aboriginal heritage is anticipated as a result of the UEP and therefore a detailed Heritage Assessment has not been undertaken.

Visual amenity

A visual analysis for the UEP was undertaken to assess the visual impact associated with the UEP as the following has the potential to alter the current visual amenity of the local area:

- Earthworks required to increase the height of existing bunds surrounding the Russell Vale Pit Top
- Changes to the Pit Top layout in order to maximise topographic shielding of plant
- Construction of coal processing infrastructure within the Pit Top area
- Continued use of night lighting at the Pit Top.

Due to the nature of the proposed first workings mining, there is negligible potential for visual impacts associated with subsidence or subsidence remediation works, as a result of the Revised Preferred Project.

Site design and use

The existing bunds surrounding the Pit Top will be raised in order to improve noise mitigation from site operations. This will result in temporary views of earthworks and associated mobile equipment for residences surrounding the site. Once complete, these bunds will act to further limit views of the Pit Top and site operations from surrounding locations in the medium and long term.

Once the final bund heights are achieved, the bunds will be progressively rehabilitated, spread with topsoil and planted with a selection of native species.

The Revised Preferred Project proposes changes to the Pit Top layout to strategically relocate infrastructure to more shielded locations. For example, the existing surge bin will be replaced and relocated from its current exposed location to the toe of a batter. The proposed Coal Processing Plant and associated infrastructure will also be located to maximise shielding provided within the site.

This design work, in combination with the proposed extension to the height of existing bunds, will assist in minimising the visual amenity impacts of the existing and proposed operation.

While coal beneficiation and coal transport activities will not be undertaken during the night-time period, lighting will continue to be required on site to meet maintenance and safety requirements. Lighting will be kept to a minimum, directed away from surrounding residences and will be maintained in accordance with the relevant Australian Standard (*Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*).

Visual Mitigation and Management Measures

Wollongong Coal will implement the following measures to improve the visual amenity of the site and minimise the visual impact of the UEP:

- Bunds surrounding the Pit Top will be progressively rehabilitated, spread with topsoil and planted with a selection of native species as soon as practical once final bund height is achieved
- Existing vegetation outside the Pit Top disturbance area will be regularly maintained and supplemented or replaced if necessary to maintain visual screening
- Areas of disturbance will be kept to the minimum practicable and rehabilitated as soon as practical
- Proposed coal handling infrastructure will be coloured in non-reflective natural tones to minimise contrast against the surrounding environment
- All outdoor lighting will be installed and operated in accordance with Australian Standards, including measures such as directing lighting downwards towards work areas and not toward private residences and roads, and where appropriate, using shields to limit the emission of light off site.

Residual value of land

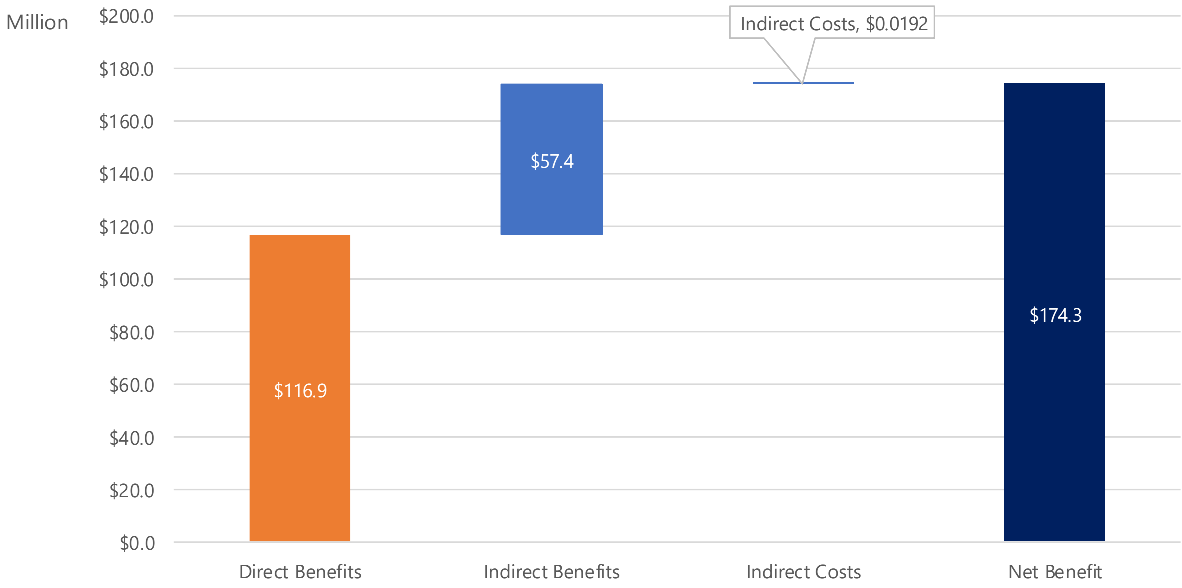
The residual value of land captures any of the benefits associated with an alternate use of the land. That is, where the UEP is not approved, the earmarked land used by the UEP may be used for an alternate benefit-purpose. Any benefits generated by the alternate use, is a cost of the UEP.

The UEP would continue to use the Russell Vale surface infrastructure that was previously used by the approved Mine operations. As result of the current approved use, it is unlikely that further approvals would significantly impact land use. New surface infrastructure, for example the processing plant, will be located on currently disturbed areas.

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 UEP identified above against the baseline scenario. Summarised in Figure 5, the estimated net benefit to NSW is $174.3 million in NPV terms.

Figure 5: Summary of the net benefits of the Project* under central case assumptions ($ million)**



Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario. ** NPV in 2019 dollars based on a 7 percent real discount rate.

Table 13 details the economic benefits of the UEP against that of the Baseline scenario. Direct benefits of the Project are estimated to be $116.9 million in NPV terms. The UEP is also expected to generate total indirect benefits of $57.4 million in NPV terms, comprised of $43.6 million of worker benefits and $13.8 million of supplier benefits.

The UEP is expected to generate modest incremental indirect costs on the NSW community of about $19,158, which is the cost of water licenses and greenhouse gas attributable to NSW (bearing in mind that the majority of mitigation and monitoring costs, $4.3 million in NPV terms, associated with environmental impacts relating to the UEP are incorporated in the capital and operating costs of the project).

Table 13: Estimated net benefits of the UEP ($ million)

Benefits	NPV	Costs	NPV
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	39.7		
2. Royalties, payroll tax and Council rates	38.7		
3. Company income tax apportioned to NSW	38.5		
Total direct benefits	**116.9**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs^**	
1. Net economic benefit to landholders	-	1. Air quality	-
2. Net economic benefit to NSW workers	43.6	2. Greenhouse gas emissions	0.019
3. Net economic benefit to NSW suppliers	13.8	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact	-
		8. Noise impact	0.9
		9. Loss of surplus to other industries	-
		10. Groundwater	0.9
		11. Aboriginal cultural and historical heritage	-
		12 Subsidence	-
Total indirect benefits	**57.4**	**Indirect Costs**	**6.2**
Total Project economic benefit	**174.3**	**Total incremental cost**	**0.019**
NPV of project - ($m)	**174.3**		

Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario. ** NPV in 2019 dollars based on a 7 percent real discount rate. ^ Includes $4.3 million (in NPV terms) of operational costs of the UEP.

Net Benefits – Sensitivity analysis

Consistent with the Guidelines, this section outlines a summary of the systematic sensitivity analysis undertaken for the UEP. 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 Project;
  - 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; and,
- 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 decreased by 10 per cent compared with central case assumptions. Environmental costs are increased by 10 per cent over the central case; and
- ***'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.

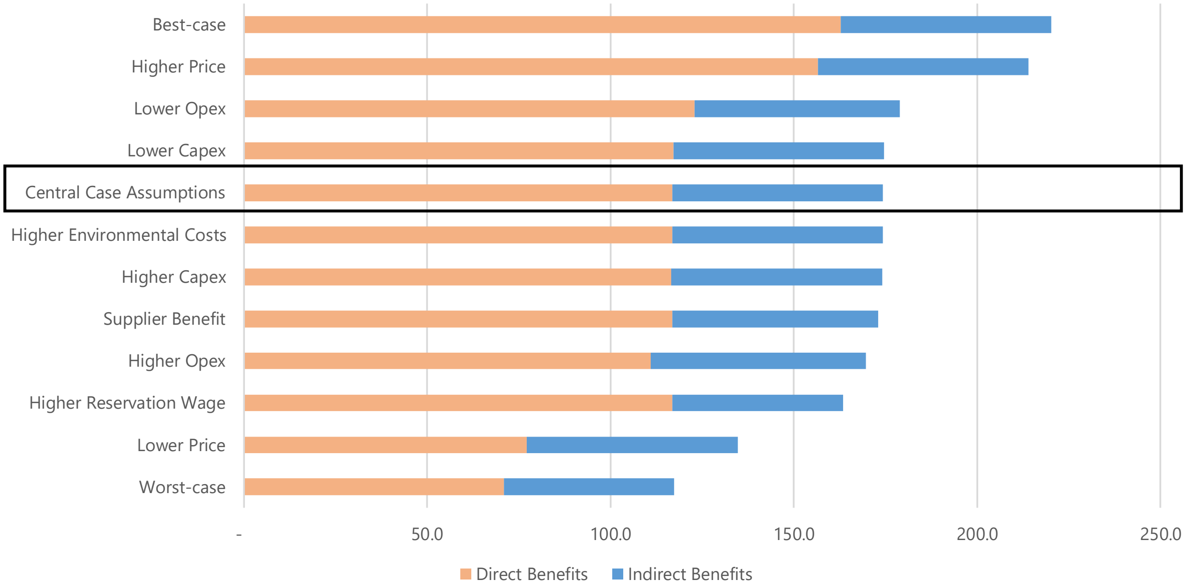
Results of sensitivity analysis

The results of the systematic sensitivity analysis are summarised in Figure 6. 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.

In isolation, the estimated net benefit of the UEP 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 to be $134.7 million in NPV terms.

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 $117.3 million in NPV terms. The upper bound, or best-case, estimate, based on the most optimistic assumptions, is $220.1 million in NPV terms.

Figure 6: 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.

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 project 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 $117.3 million in NPV terms before the UEP would return a net negative return to NSW.

As a result of the relatively short time frame of the UEP (2020 to 2024), the net benefits are not sensitive to the discount rate used for the analysis.

Under the Central case assumptions, the UEP is expected to generate $174.3 million of net benefit using a 7% discount rate. Using a 4% discount rate increases the net benefit to $180.5 million; conversely a 10% discount decreases the net benefit to $168.1 million.

The current mine plan includes a maximum extraction rate of 1.0 Mt of ROM coal per year. Although, WCL may explore options to increase the extraction rate and maintain total ROM coal extracted for the project. Under certain conditions, where the extraction rate increases, the overall length of the project will reduce and bring forward the net benefits of the UEP, increasing the net benefit to NSW in NPV terms.

These conditions include; the total project coal extraction remains the same as the central case assumptions, and, the coal extracted in the initial 11-month phase and the secondary phase (after April 2021, on completion of the processing plant) also remain the same.

3. Local Effects Analysis

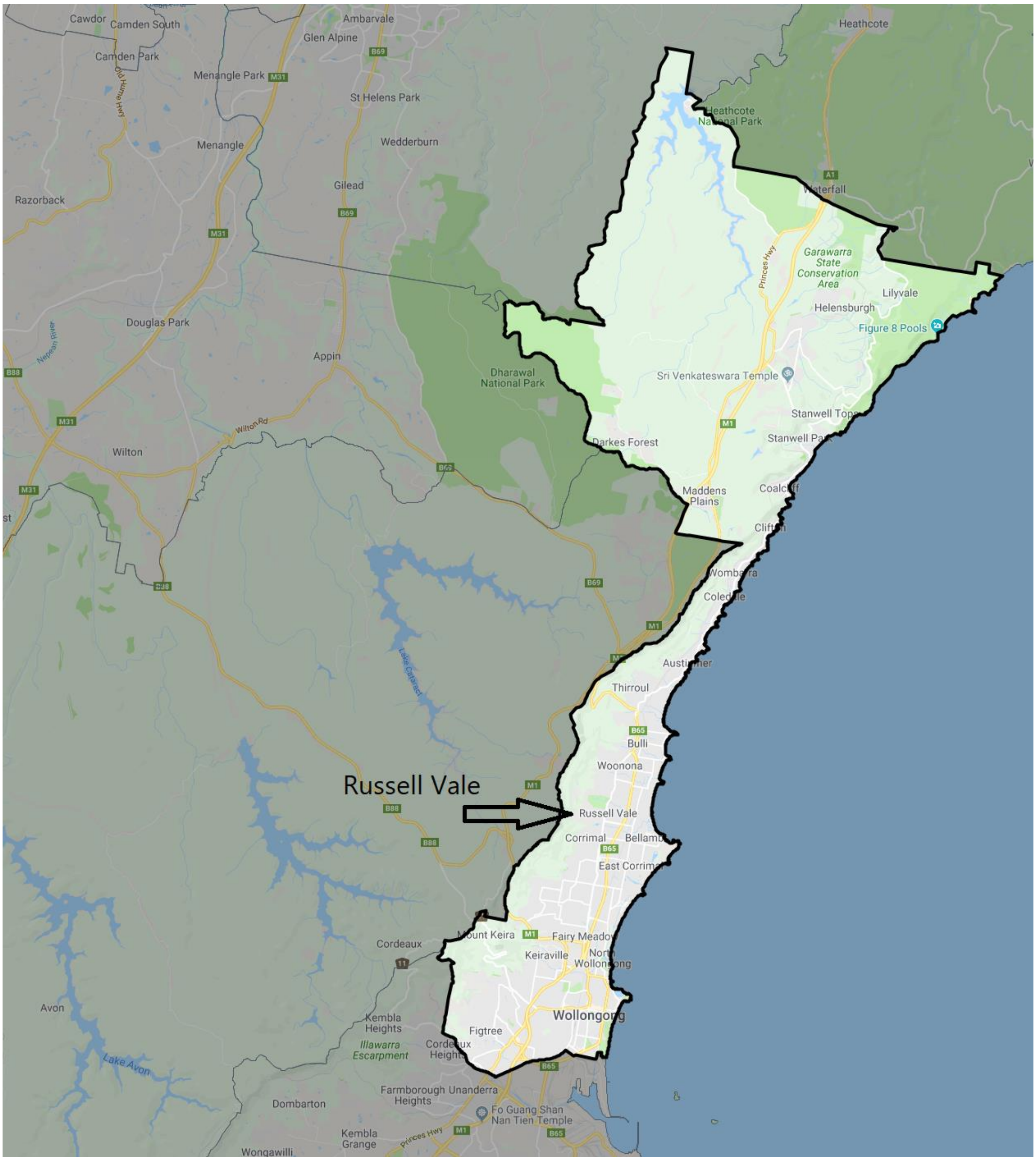
Consistent with the Guidelines, the local effects analysis (LEA) uses a similar framework to the CBA presented in the previous section, but is focussed on the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. In the case of the UEP the Wollongong SA3 area is used for the LEA.

As shown in Figure 7, the Wollongong SA3 takes in a relatively narrow and built up area with the Pacific Ocean to the east and the Illawarra Escarpment to the west. The SA3, includes, the city of Wollongong, north Wollongong and East Corrimal. To the north, the SA3 occupies the area south of the Royal National Park and the Dharawal National Park. Running through the middle of the SA3 is the Princes Highway that takes you to Sydney to the north and to Dapto Port Kembla to the south.

The UEP will extract coal from the Illawarra Catchment Reserve to the west of the SA3, and bring the coal to the pit top located in Russell Vale (see arrow in the figure below). The coal product will be processed on site (when the plant is complete) and trucked the relatively short distance to Port Kembla located directly to the south of the SA3.

The UEP will employ workers and purchase goods and services from suppliers located in the region.

Figure 7: Wollongong SA3 local area



Source: Remplan (http://mapbuilder.remplan.com.au/?link=e1f7954ca97943e79af46bd140cddd17)

Underpinning the LEA are the assumptions that:

- Net producer surplus of 0.5 per cent accrues to the region (based on WCL shareholder information);
- No company income tax accrues to the Wollongong SA3 region;
- As outlined in the SIA, 20 per cent of the workforce requirement of the mine is located in the local area and is used to estimate the local worker benefits; and,

- We have assumed that, the same 20 per cent of intermediate inputs will be supplied from the SA3 region.

As a result of these assumptions, it is expected the UEP will generate indirect benefits to local suppliers and employees of $14.3 million in NPV terms, as outlined in Table 14. The UEP will generate indirect benefits to local suppliers and employees of $5.5 million and $8.7 million respectively in NPV terms. Indirect costs associated with the Project are minor, including greenhouse gas costs attributable to the region of approximately $800 in NPV terms.

Table 14: Estimated Local Effects Analysis of the UEP

Benefits	NPV	Costs	NPV
Direct benefits		**Direct costs**	
1. Net producer surplus	$0.6		
2. Royalties, payroll tax and Council rates	$2.1		
3. Company income tax	$0.0		
Total direct benefits	**$2.7**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs^**	
1. Net economic benefit to landholders	$0.0	1. Air quality	-
2. Net economic benefit to local workers	$8.7	2. Greenhouse gas emissions	0.0
3. Net economic benefit to local suppliers	$5.5	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact	-
		8. Noise impact	0.9
		9. Loss of surplus to other industries	-
		10. Groundwater	0.9
		11. Aboriginal cultural and historical heritage	-
		12 Subsidence	-
Total indirect benefits	**$14.3**	**Indirect Costs**	**6.2**
Total Project economic benefit	**$17.0**	**Total economic cost**	**0.0008**
NPV of project - ($m)	**$17.0**		

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. ^ Includes $4.3 million (in NPV terms) of operational costs of the UEP.

LEA – Sensitivity analysis

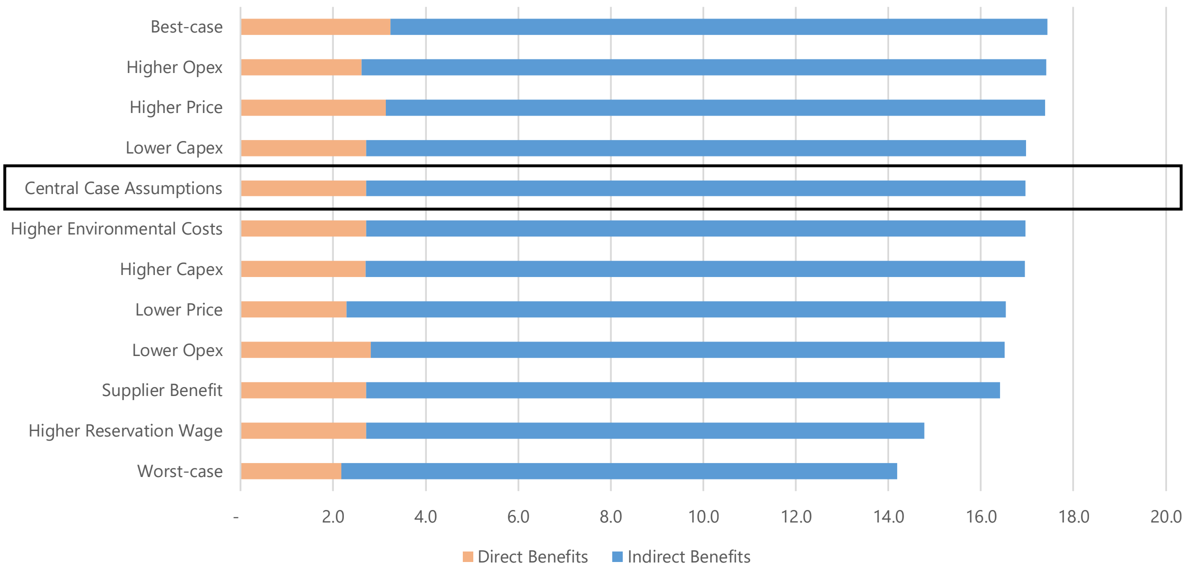
As outlined above the LEA relies on a number of modelling assumptions. Consistent with the Guidelines, Figure 8 provides a summary of the systematic sensitivity analysis undertaken for the UEP. The sensitivity analysis tests the same assumptions outlined in the CBA.

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 8. 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 $14.2 million in NPV terms. The upper bound, or best-case, estimate based on the most optimistic assumptions, is $17.4 million in NPV terms.

Figure 8: 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.

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APPENDIX A: COST BENEFIT ANALYSIS

Table 15: Sensitivity analysis of the net benefits of the UEP Project (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	116.9	156.6	77.2	110.9	122.9	116.6	117.2	116.9	116.9	116.9	71.0	162.9	118.5	114.8
1. Net producer surplus	39.7	68.3	11.1	33.0	46.4	39.1	40.2	39.7	39.7	39.7	3.8	75.5	35.8	42.5
2. Royalties, payroll tax and Council rates	38.7	38.7	38.7	42.1	35.4	38.7	38.7	38.7	38.7	38.7	42.1	35.4	41.9	35.9
3. Company income tax apportioned	38.5	49.6	27.4	35.9	41.1	38.7	38.2	38.5	38.5	38.5	25.1	51.9	40.8	36.4
Indirect Benefits	57.4	57.4	57.4	58.8	56.0	57.4	57.4	46.5	56.0	57.4	46.4	57.3	62.1	53.3
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	43.6	43.6	43.6	43.6	43.6	43.6	43.6	32.7	43.6	43.6	32.7	43.6	47.1	40.5
3. Net economic benefit to Local suppliers	13.8	13.8	13.8	15.2	12.5	13.8	13.8	13.8	12.5	13.8	13.7	13.7	15.0	12.8
Indirect (Environmental costs)	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.021	0.021	0.017	0.021	0.018
Net Benefits	**174.3**	**214.0**	**134.7**	**169.7**	**178.9**	**174.0**	**174.6**	**163.4**	**172.9**	**174.3**	**117.3**	**220.1**	**180.5**	**168.1**

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 16: Sensitivity analysis of the net regional benefits of the UEP (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	2.7	3.1	2.3	2.6	2.8	2.7	2.7	2.7	2.7	2.7	2.2	3.2	2.8	2.6
1. Net producer surplus	0.6	1.0	0.2	0.5	0.7	0.6	0.6	0.6	0.6	0.6	0.1	1.1	0.5	0.6
2. Royalties, payroll tax and Council rates	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.0
3. Company income tax apportioned	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Benefits	14.3	14.3	14.3	14.8	13.7	14.3	14.3	12.1	13.7	14.3	12.0	14.2	15.4	13.2
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	8.7	8.7	8.7	8.7	8.7	8.7	8.7	6.5	8.7	8.7	6.5	8.7	9.4	8.1
3. Net economic benefit to Local suppliers	5.5	5.5	5.5	6.1	5.0	5.5	5.5	5.5	5.0	5.5	5.5	5.5	6.0	5.1
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	**17.0**	**17.4**	**16.5**	**17.4**	**16.5**	**17.0**	**17.0**	**14.8**	**16.4**	**17.0**	**14.2**	**17.4**	**18.2**	**15.9**

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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