


Wongawilli Colliery Modification Report

PA 09_0161 MOD 2 - North West Mains Development
Volume 2 Main Report (Part 2)

Prepared for Wollongong Coal Limited
December 2020


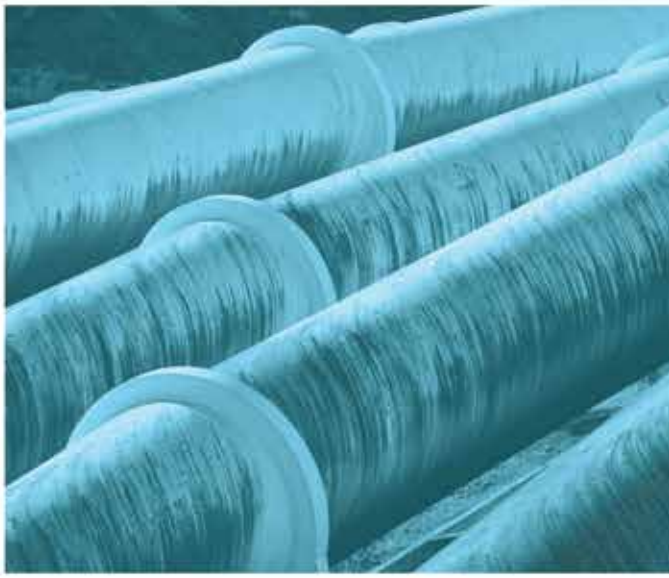

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Table 7.22 Summary of hydraulic conductivity data

Lithology	Location	Hydraulic conductivity (m/day)			Count	Source
		Average	Min	Max		
Wianamatta Formation	Dendrobium	1.2x 10^{-4}	8.6x 10^{-6}	5.0x 10^{-4}	5	HydroSimulations 2019
	Tahmoor		1.2x 10^{-1}		1	SLR 2020
Hawkesbury Sandstone	Appin	-	1.0x 10^{-4}	1.0x 10^{+2}	4+	Heritage Computing 2009
	Dendrobium	2.1x 10^{-2}	8.6x 10^{-10}	2.4	471	HydroSimulations 2019
	Tahmoor	4.2x 10^{-2}	7.6x 10^{-5}	4.5x 10^{-1}	174	SLR 2020
	NWMD		7.3 x 10^{-4}	0.1	9	
Narrabeen Group	Appin	-	1.0x 10^{-4}	1.0x 10^{-2}	4+	Heritage Computing 2009
Bald Hill Claystone	Dendrobium	3.0x 10^{-3}	8.6x 10^{-7}	2.3x 10^{-1}	131	HydroSimulations 2019
	NWMD		9.5 x 10^{-4}		1	
Bulgo Sandstone	Dendrobium	2.5x 10^{-3}	8.6x 10^{-7}	3.2x 10^{-1}	424	HydroSimulations 2019
	NWMD		1 x 10^{-4}	5 x 10^{-4}	8	
Stanwell Park Claystone	Dendrobium	1.5x 10^{-2}	8.6x 10^{-7}	3.2x 10^{-1}	37	HydroSimulations 2019
	Tahmoor	1.1x 10^{-4}	8.6x 10^{-7}	3.5x 10^{-4}	8	SLR 2020
	NWMD		7 x 10^{-5}		1	
Scarborough Sandstone	Dendrobium	1.4x 10^{-2}	8.6x 10^{-7}	2.5x 10^{-1}	84	HydroSimulations 2019
	Tahmoor	3.4x 10^{-4}	4.7x 10^{-6}	2.5x 10^{-3}	34	SLR 2020
Wombarra Claystone	Dendrobium	4.0x 10^{-3}	6.0x 10^{-6}	1.2x 10^{-1}	80	HydroSimulations 2019
	Tahmoor	1.3x 10^{-4}	8.6x 10^{-7}	3.5x 10^{-4}	9	SLR 2020
Coal Cliff Sandstone	Dendrobium	4.0x 10^{-3}	8.6x 10^{-10}	1.3x 10^{-1}	59	HydroSimulations 2019
Bulli Coal	Dendrobium	6.0x 10^{-3}	8.6x 10^{-6}	1.1x 10^{-1}	19	HydroSimulations 2019
	Tahmoor	7.3x 10^{-4}	1.0x 10^{-5}	3.9x 10^{-3}	30	SLR 2020

There is no site-specific data on storage properties, however some estimates are provided below. Results from the neighbouring Dendrobium Mine and Appin Mine have been used to inform the GWA. Consistent with hydraulic conductivity, storage parameters decrease with depth. Estimates of total porosity range between 0.02% and 0.15%.

Direct test data is not generally available for confined storage, namely the specific storage. The specific storage of Hawkesbury Sandstone has been estimated to be approximately:

- $1x10^{-6}$ m^{-1} in the shallower zones where fracture flow is the dominant flow process (Kelly *et al* 2005); and
- $1.5x\ 10^{-6}$ m^{-1}, for intervals between ground surface and 300 m depth based on pumping tests in Hawkesbury Sandstone from Tammetta and Hawkes (2009).

iii Groundwater monitoring network

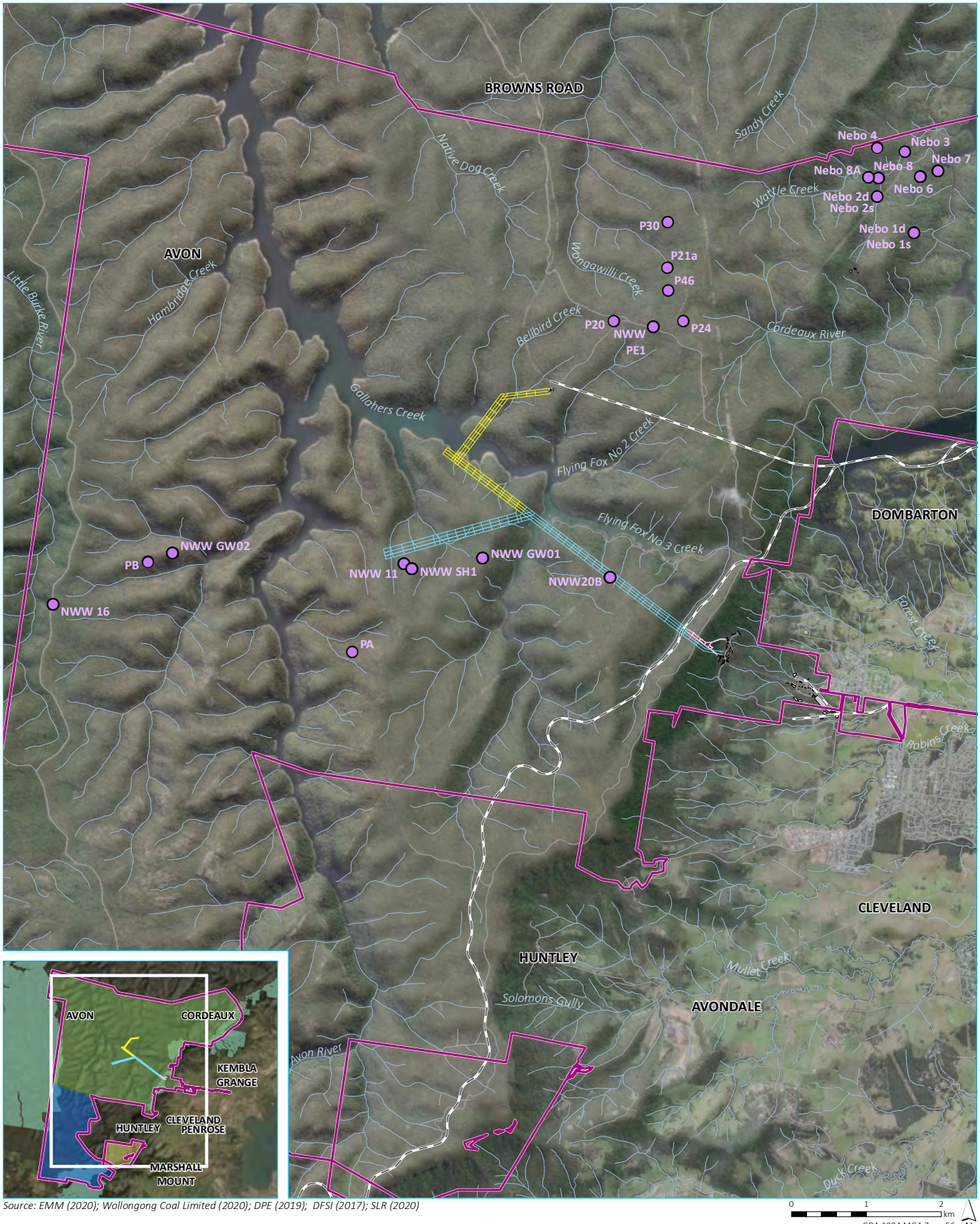
The groundwater monitoring network at the Colliery has been in place since 2009 and includes:

- 6 Nebo open standpipes (Nebo 1 to Nebo 4) within the Hawkesbury Sandstone, Crinanite, Bulli Seam and Wongawilli Seam, with nested bores at Nebo 1 and Nebo 2;
- 7 swamp deposit bores; and
- 11 vibrating wire piezometers (VWP) (Nebo/NWW/NRE) with multiple sensors across various units.

The groundwater monitoring program includes daily readings of pressure head at the VWPs, and manual measurement of water levels at the monitoring bores, as well as water quality sampling and analysis for electrical conductivity (EC), pH, major ions, minor ions and metals.

In addition, a data sharing agreement is in place with South 32, which enables use of extensive site groundwater monitoring data from their network for 149 VWPs with 615 sensors in Areas 3A, 3B and 3C. This network includes 241 sensors positioned within the Hawkesbury Sandstone.

A summary of the groundwater monitoring network is provided in Table 10 of Appendix I and shown below in Figure 7.17.



Source: EMM (2020); Wollongong Coal Limited (2020); DPE (2019); DFSI (2017); SLR (2020)

0 1 2 km

GDA 1994 MGA Zone 56

N

KEY

- Groundwater monitoring location
- Project application area
- Site layout
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment
- Rail line
- Minor road
- Watercourse/drainage line

INSET KEY

- NPWS reserve

Mining title

- ML 1565
- ML 1596
- CCL 766

Groundwater monitoring newtwork

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Figure 7.17

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iv Water quality

a Surface water

A summary of average water quality, as monitored within the 28 surface water monitoring points within the vicinity of the NWMD, is included in Section 7.6.5. An assessment of EC and TDS indicates that Gallahars Creek has higher salinity than the Avon River. Avon River has a long-term EC average less than 100 µS/cm and Gallahars Creek EC average exceeds 100 µS/cm. This surface water quality difference is attributed to the Lake Avon catchment having a high percentage of Hawkesbury Sandstone, which has a high quartz content and low salt content which in contrast to the dominant Bald Hill Claystone lithology of the Gallahars Creek catchment, which has a higher salt content.

The water within the Nepean River surface water is generally fresh (median EC 244 µS/cm) and generally has neutral pH (median pH 7.7).

b Groundwater

Groundwater within the soil is fresh (median EC 273 µS/cm) indicating the water is suitable for drinking, irrigation and stock. pH conditions are relatively neutral (medium pH 6.5). The water is classified as sodium bi-carbonate type water.

Groundwater within the crinanite is fresh to brackish (median EC 946 µS/cm, maximum EC 2,983 µS/cm) and generally has an alkaline pH (median pH of 9.7). The elevated pH is typical of these alkaline intrusive volcanics. Based on salinity the water is generally suitable for short term irrigation and stock water. The water is classified as calcium/sodium bi-carbonate type water.

Groundwater within the Narrabeen Formation is generally fresh (median EC 724 µS/cm, maximum EC 1,404 µS/cm) indicating, based on salinity, the water is suitable for drinking, irrigation and stock. pH conditions are generally alkaline (median pH 8.4). The water is classified as sodium bi-carbonate type water.

Groundwater within the Bulli Seam is brackish (median TDS 2,375 mg/L) and, based on salinity, is suitable for irrigation and some stock (ie sheep and dairy cattle). The water is classified as sodium bi-carbonate type water.

Groundwater quality within the Permian coal measures is typically moderately saline to saline.

v Groundwater receptors

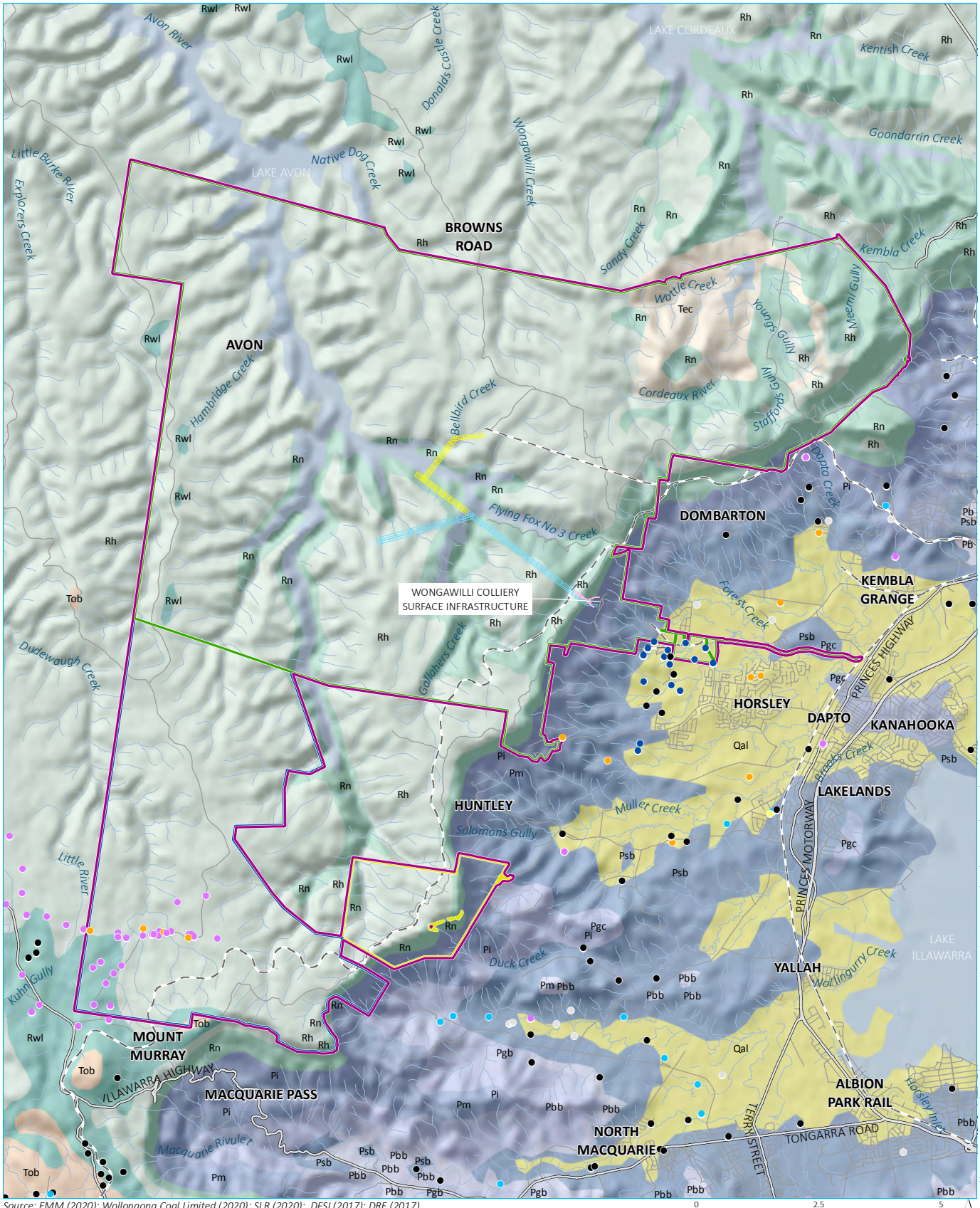
a Third party bores

There are no registered groundwater bores near the proposed modification to the west, south-west and north-west due to lack of population and the areas being reserved as drinking water catchment.

Almost 90% of the groundwater usage in the wider area (refer Figure 7.18) of the proposed modification is from the Hawkesbury Sandstone or from surficial alluvium and basalt aquifers far to the west and south of the Colliery. About 10% of the total entitlement is from the Bulgo Sandstone. This is probably due to generally lower bore yields, poorer water quality, and increased drilling costs for accessing deeper units (HydroSimulations 2019c).

Along the coastal plain to the east of the Colliery, most of the bores extract from the outcropping early Permian strata, ie the Cumberland Subgroup and the older Shoalhaven Group.

A search of the BoM's National Groundwater Information System (NGIS) showed that there are 1,006 registered bores within 5 km of the proposed modification area (to the east and south-east of the Colliery). The search indicated that 512 bores are functional, 454 are unknown, 26 are proposed and 14 have been abandoned, non-functional or removed. The data shows that most bores are used for monitoring (379), followed by water supply (377) and irrigation (139) (refer Figure 7.18). Some less common uses include stock and domestic, commercial and industrial, dewatering and exploration.



Source: EMM (2020); Wollongong Coal Limited (2020); SLR (2020); DFSI (2017); DRE (2017)

0 2.5 5 km

GDA 1994 MGA Zone 56

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KEY

Project application area
North West Mains Drivage completed workings
Proposed additional drivage
Proposed NWMD alignment

Mining title
ML 1565
ML 1596
CCL 766

Existing environment
Rail line
Major road
Minor road
Watercourse
Waterbody

Geological rock unit - group (250k)
Quaternary
Qal
Tertiary
Tec - Cordeaux crinanite
Tob
Triassic
Rh - Hawkesbury sandstone
Rn - Narrabeen group
Rwl - Liverpool subgroup
Permian
Pb - Berkley latite
Pbb - Bombo latite
Pgb - Broughton tuff
Pgc - Dapto-Saddleback latite
Pi - Illawarra coal measures
Pm - Minnamurra latite
Psb - Berry formation

NGIS bore
Exploration
Water supply
Industrial
Irrigation
Monitoring
Stock and domestic
Other

NOTE: Project application area is offset for viewing purposes

Groundwater users

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Figure 7.18

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b Groundwater dependent ecosystems

A review of the WSP for the Greater Metropolitan Regional Groundwater Resources 2011 indicates there are no high priority GDEs within the area of the proposed modification. A review of the BoM GDE Atlas (accessed on 29 August 2020) identified the following potential GDE areas as shown in Figure 7.19:

- Moderate potential for groundwater interaction – localised areas immediately north of the proposed workings and south of the Avon River. Coastal sandstone gully forest, coastal warm temperate rainforest, escarpment foothills wet forest.

- Low potential for groundwater interaction – areas north of the southern extent of the proposed workings including escarpment foothills wet forest, coastal warm temperate rain forest, coastal sandstone gully forest.

Upland swamps have also been mapped within the area, including one swamp area above the proposed NWMD and another one above the approved NWMD (refer Figure 7.19).

The key receptors within the proposed modification area consist of headwater swamps and valley infill swamps, as well as creeks in the vicinity of mining. These swamps are connected to groundwater within valley infill swamps and the sandstone aquifer.

Groundwater modelling has been used to assess impacts to wetlands.

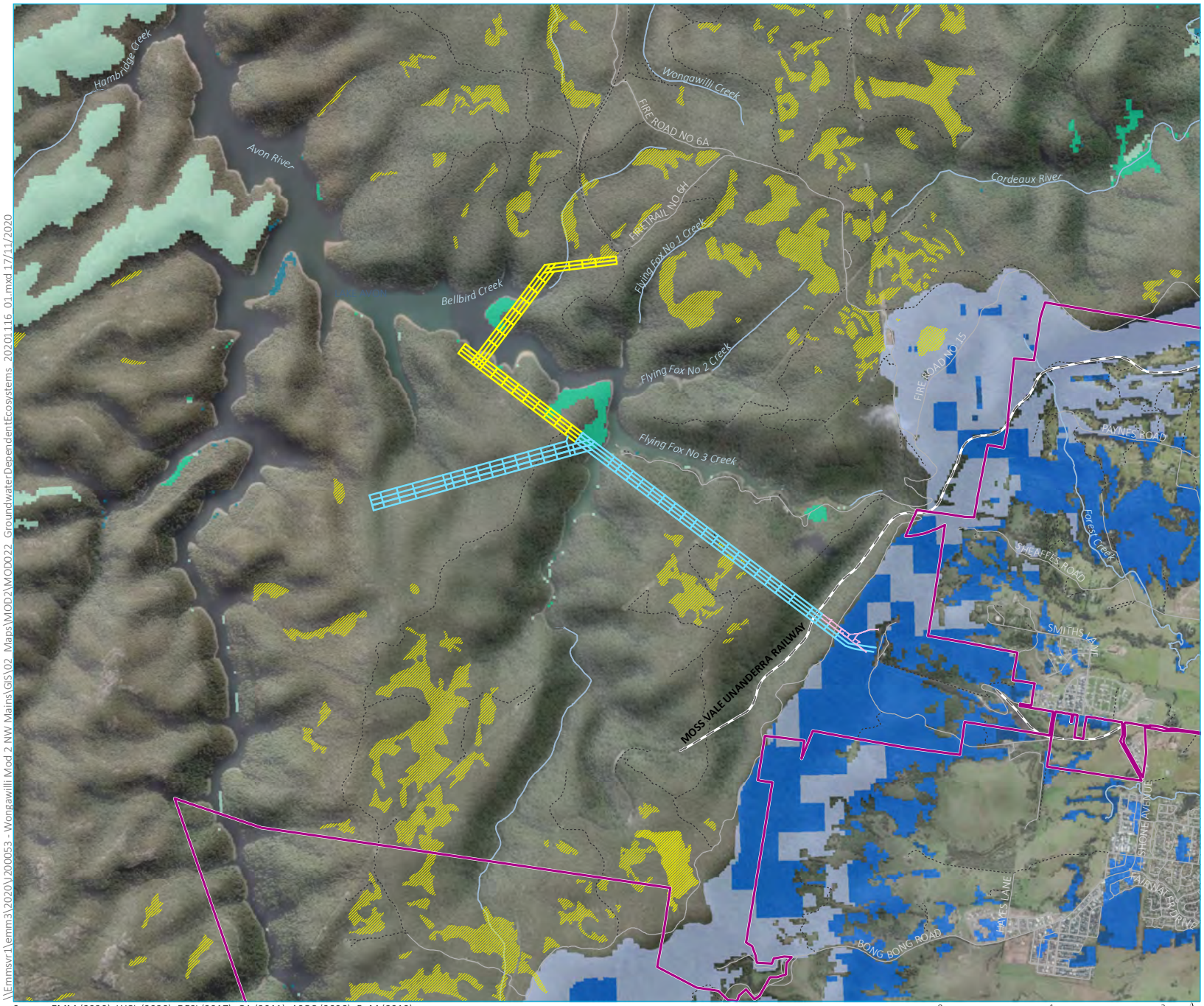
vi Historical mining effects

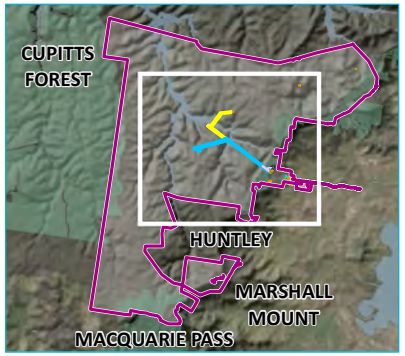
The Southern Coalfields has a long history of mining, including mining in the vicinity of the proposed modification. Blue Panels 2 and 4 were mined approximately 125 m to the north of the proposed NWMD area. Coal was extracted using the bord and pillar method and partial pillar extraction secondary workings has since occurred, which typically results in the partial collapse of the roof structure over the mined void. This has resulted in an increase in void space within the mined areas, as well as increased hydraulic conductivity above the goaf (up to 2-3 orders of magnitude (HGEO 2019) and/or increased cracking.

Furthermore, a number of major dykes have been identified and mapped within the area of the proposed modification. They may provide conduit for groundwater to enter the former workings. It is also possible that inflows can increase where dykes provide a conduit between the workings and aquifer storage.

Longwall mining occurs in the region which can change hydraulic properties of the insitu strata. Subsidence and goaf effect can cause surface cracking, resulting in enhanced vertical conductivity at surface, which varies through natural deposition and infilling, as well as engineered remediation (ie surface grouting).

A subsidence assessment has been conducted for the approved operations and it is predicted that there would be no observable subsidence, strain or tilt, stream bed uplift or bed cracking in Gallahers Creek due to the approved NWMD (MSEC 2010). A subsidence and geotechnical conducted for the proposed NWMD (SCT 2020), supports the 2010 assessment and concluded there is no potential for the main heading development roadway (proposed NWMD) to cause surface ground movement of any consequence.





KEY

- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment
- Swamp

Terrestrial ecosystem (BoM)

National assessment

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Regional studies

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Existing environment

- Rail line
- Minor road
- Vehicular track
- Named watercourse

Source: EMM (2020); WCL (2020); DFSI (2017); GA (2011); ASGC (2006); BoM (2019)

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Groundwater dependent ecosystems

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Modification assessment report
Figure 7.19

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vii Conceptual groundwater model

The GWA describes and considers in detail each of the key hydrostratigraphic units present in the proposed NWMD area, including upland swamps, Cordeaux crinanite, Hawkesbury Sandstone, Narrabeen Group and Illawarra Coal Measures. The conceptual groundwater model presented in Figure 7.20 is based on the information presented in Section 7.6.4 and Appendix I.

The main groundwater units in the area are:

- Upland swamps – saturated alluvial/colluvial sediments and organic matter. Recharged from rainfall as well as surface/subsurface water flow.

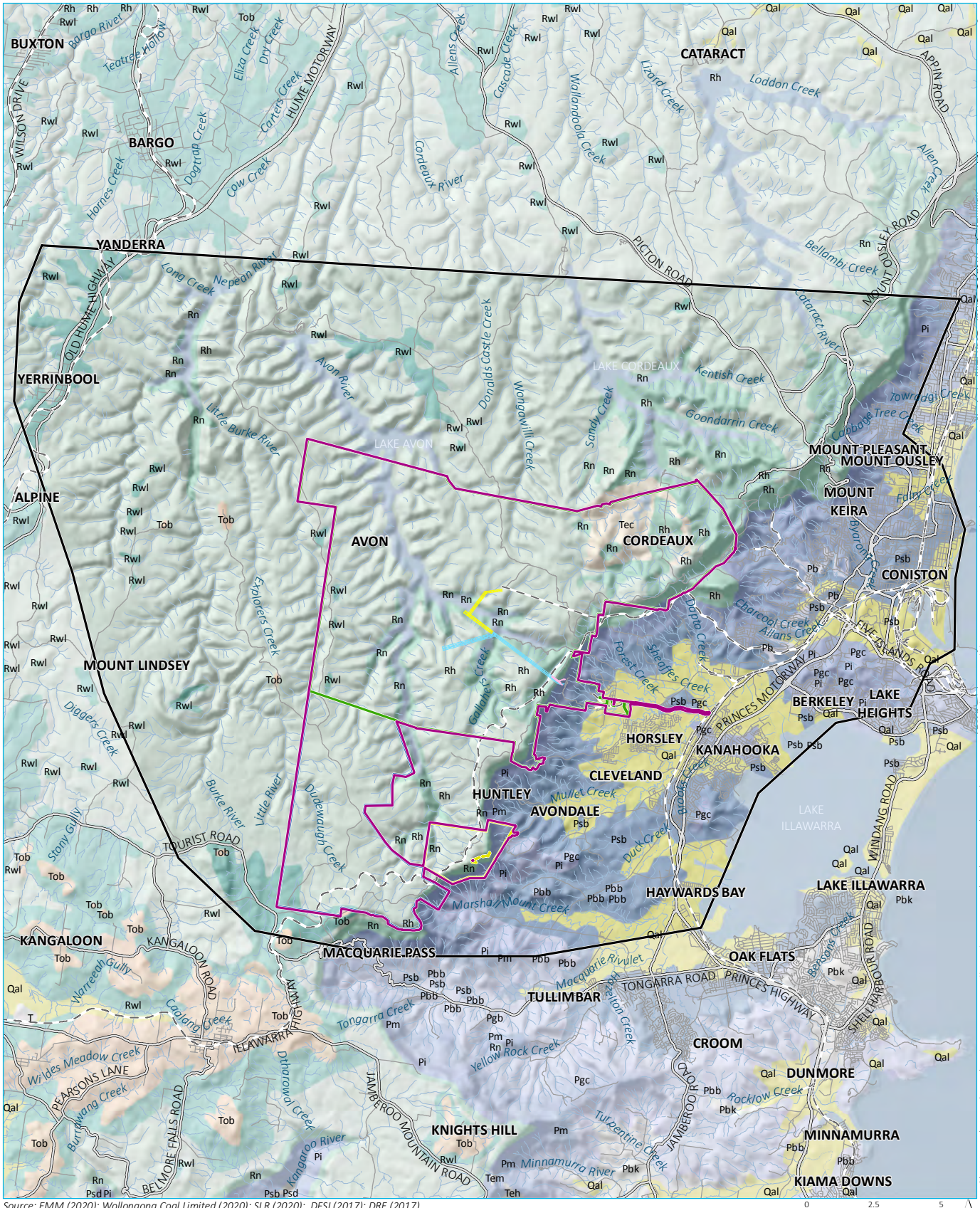
- The Cordeaux Crinanite – present in the Nebo area of the Colliery and has similar characteristics to dolerite intrusions.

- Hawkesbury Sandstone – main groundwater source and widely accessed for groundwater supply regionally and provides baseflow contributions where incised along major rivers (ie Cataract and Nepean Rivers). Groundwater flow is northward, and locally influenced where intersected by rivers and private abstraction bores. Current monitoring data indicates no depressurisation or drawdown within the Hawkesbury Sandstone in response to mining.

- Narrabeen Group – sandstone interbedded with low permeability claystones that generally act as aquitards. Recharge to the Narrabeen Group is from water storage areas where intersected, infiltration of rainfall along the escarpment and downward seepage from overlying Hawkesbury Sandstone.

- Illawarra Coal Measures – with groundwater occurrence largely associated with the more permeable coal seams, with confined groundwater conditions. Groundwater flow generally northward, and locally depressurised due to current and historical mining. Current monitoring shows depressurisation from historical operations, with recovery in levels in localised areas, potentially influenced by underground water storage.

Pre-mining groundwater flow directions are generally north-westward, down dip along the sandstone and coal beds. There is minimal vertical leakage between the hydrostratigraphic units, with the Stanwell Park Claystone and Wombarra claystone acting as aquitards restricting vertical groundwater movement.



Source: EMM (2020); Wollongong Coal Limited (2020); SLR (2020); DFSI (2017); DRE (2017)

0 2.5 5 km

GDA 1994 MGA Zone 56

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KEY

- Groundwater model domain
- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Mining title
- ML 1565
- ML 1596
- CCL 766

Existing environment
- Rail line
- Major road
- Minor road
- Watercourse
- Waterbody

Geological rock unit - group (250k)

Quaternary
- Qal

Tertiary
- Tec - Cordeaux crinanite
- Tob

Triassic
- Rh - Hawksbury sandstone
- Rn - Narrabeen group
- Rwl - Liverpool subgroup

Permian
- Pb - Berkley latite
- Pbb - Bombo latite
- Pgb - Broughton tuff
- Pgc - Dapto-Saddleback latite
- Pi - Illawarra coal measures
- Pm - Minnamurra latite
- Psb - Berry formation

NOTE: Project application area is offset for viewing purposes

Groundwater model extent

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Figure 7.21

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The proposed modification is likely to result in localised depressurisation within the Bulli Seam and Wongawilli Seam associated with direct interception of groundwater and mine progression. The proposed modification involves first workings along the approved NWMD and the proposed extension to connect to the existing vent shaft at Wongawilli 1. There is negligible subsidence predicted due to extraction associated with the proposed modification, due to the design of the proposed NWMD (SCT 2020). With no subsidence impacts predicted, changes in hydraulic properties of the strata overlying the Bulli Seam is unlikely.

The GWA (Appendix I) presents the conceptual groundwater model before, during and after mining.

During mining, groundwater will be pumped from the active mining areas to maintain dry working conditions. Consequently, the Permian sandstone units overlying the mined seams will become depressurised, lowering the potentiometric head within the Permian sequence to below the Bulli Seam. Above the workings where coal is extracted, cracking will be induced due to subsidence effects caused by the mining void. Similarly, cracking is likely in strata above historic bord and pillar mining where secondary extraction has occurred. The cracking is expected to extend into the Scarborough Sandstone, enhancing vertical leakage into the workings. However, the cracking is not expected to extend into the Bulgo Sandstone or Hawkesbury Sandstone.

Locally, groundwater flow directions are altered where there is greater vertical flow towards the Bulli Seam or towards localised cracked strata that provides a conduit into the mine void. Since cracking associated with the proposed modification is not expected to extend into the Bulgo Sandstone, there will be no leakage from surface water features including the Avon Dam. Higher in the stratigraphic sequence, impacts to the potentiometric surface of the Hawkesbury and Bulgo Sandstone are extremely unlikely due to the thickness of the confining units separating the Bulli Seam from these upper aquifers.

Post mining, extraction of groundwater for mining purposes will cease, allowing the mine voids to become inundated and the recovery of potentiometric heads. Recover to pre-mining conditions is expected to take many years. Induced cracking will remain in the strata overlying the flooded voids and there is the potential for minor mixing of groundwater between the hydrostratigraphic units via these cracks. Potentiometric heads within the Hawkesbury and Bulgo Sandstone are expected to remain unchanged from current conditions.

As outlined above, the proposed modification is predicted to result in negligible subsidence and negligible change to the potentiometric surface of the Hawkesbury and Bulgo Sandstone due to the thickness of the confining units separating the Bulli Seam from these upper aquifers. As such, impacts on surface water features and GDEs associated with the proposed modification is extremely unlikely.

7.6.5 Impact assessment

i Modelling approach

The groundwater model used to assess the potential impacts of the proposed modification is an update to the groundwater model developed to assess the potential impacts of coal mining at nearby Dendrobium (HydroSimulations 2019) and modelling conducted in 2010 to support the initial groundwater impact assessment for the Colliery (GeoTerra 2010). The model was developed in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al 2012), aligns with a Class 2 model with elements of Class 3 and is considered fit for the purpose of assessing potential impacts of the proposed modification of groundwater resources.

The model domain, shown in Figure 7.21, is centred over the proposed modification area, with the model boundaries extending 26.4 km from north to south and 35.4 km from east to west.

The model consists of 18 layers to represent the hydrostratigraphy in the area and to allow simulation of the mine development. Layers vary in thickness from a minimal thickness of 0.1 m to 100 m.

Further details regarding model development, including layer definition, boundary conditions, and model calibration is provided in Appendix I.

Uncertainty analysis was conducted to assess how model predictions vary due to uncertainty within the system. Uncertainty is introduced by error in field measurements, conceptual, spatial and temporal simplifications, and limitations with available data. The uncertainty analysis included the scenarios explored in the sensitivity analysis, scenarios assessing variability in hydraulic conductivity, specific yield, recharge and river conductance (boundary condition). Discussion on this analysis is provided in Appendix I.

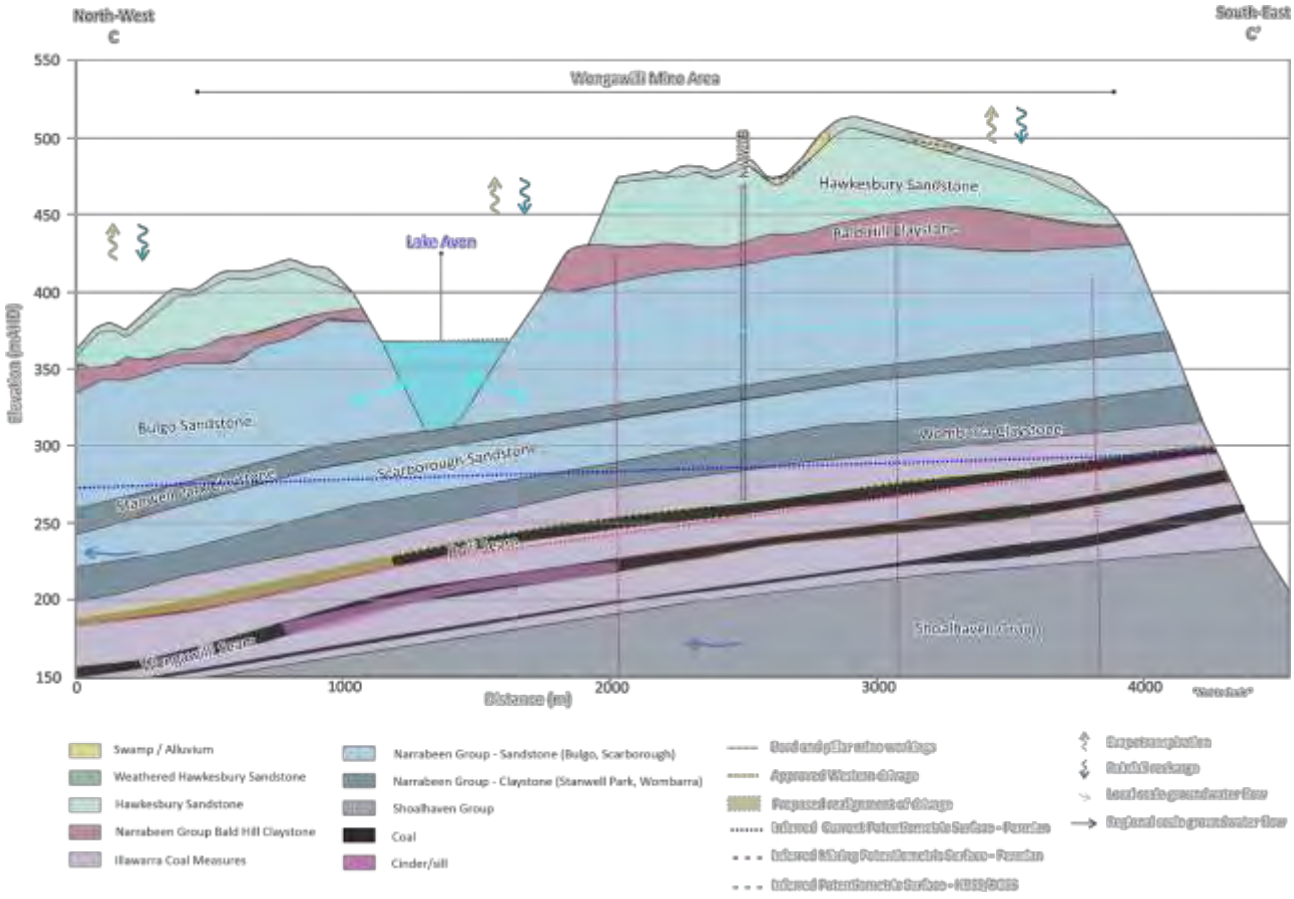
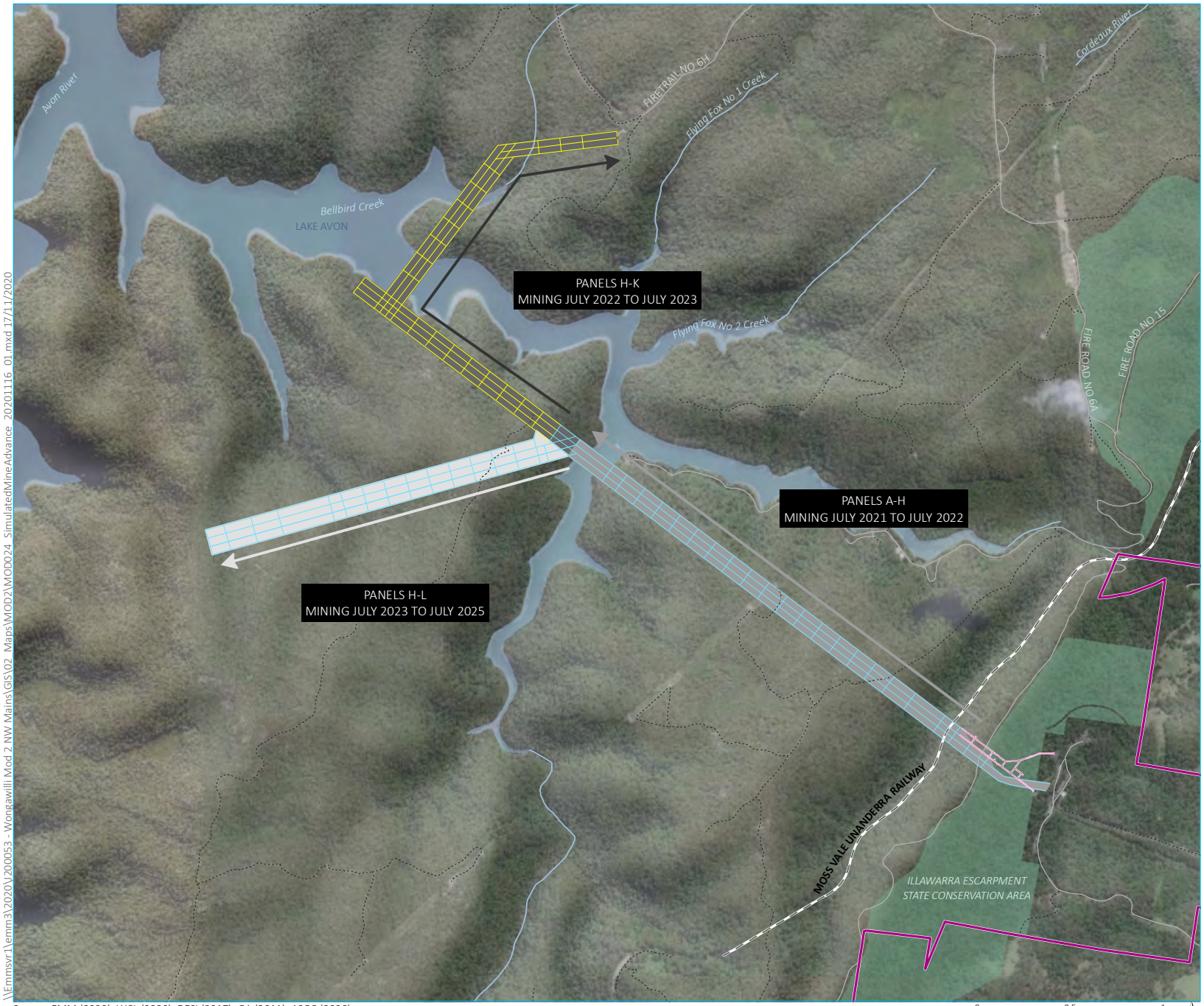


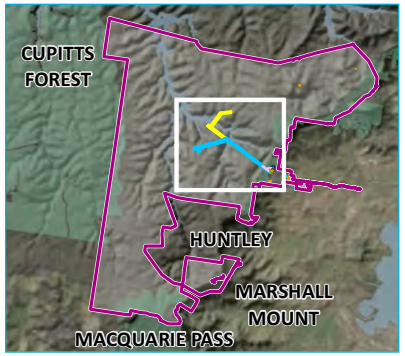
Figure 7.21 Groundwater model extent

ii Groundwater model results

Transient predictive modelling simulating both the mining relevant to the proposed modification and surrounding mines was undertaken as part of the GWA. The predictive transient simulation of mining ran from 1 January 2021 to 31 December 2049. The post-mining, recovery stage of the groundwater model was run for 500 years out to 2550. Details of the predictive simulations are described in Chapter 7 of Appendix I.

The modelled mining progression for the proposed modification is shown on Figure 7.22. Mining is proposed to commence in the current approved A-H area, then advance from H-K in the proposed modification area, with mining finishing in the H-L current approved area (Figure 7.22)





KEY

- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Mining stage

- H-K July 2020 to July 2023
- A-H July 2021 to July 2022
- H-L July 2023 to January 2025

Existing environment

- Rail line
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody
- NPWS reserve

Simulated mine advance

Source: EMM (2020); WCL (2020); DFSI (2017); GA (2011); ASGC (2006)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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Figure 7.22

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In order to assess the potential impact of the proposed medication separately from the current approved mine plan, three model scenarios were performed:

- null run – no mining simulated within the model domain;
- approved project – simulation of the current approved mining area/advance from 2021 with other foreseeable mining in the model domain (eg Dendrobium); and
- modified project – simulation of the current approved mining area, with the proposed modification and other foreseeable mining in the model domain (eg Dendrobium).

a Predicted mine inflows

Predicted inflow to the underground mine is presented on Figure 7.23. The inflow rate is predicted to peak in 2024 at 36.8 ML/year. The predicted inflow for the approved mine plan is predicted to peak at 22.8 ML/year in 2024, and the predicted peak inflow for the proposed modification area is 16.3 ML/year in 2023. The predicted inflow peak in 2024 is greater than the inflows predicted in the EA (9.1 ML/year; GeoTerra 2010) and corresponds to mining progressing into the lower Wongawilli Seam. The predicted inflows can be accounted for within the share entitlements of the current water access licence (WAL) held by Wollongong Coal. This is discussed further in Section 7.6.6 below.

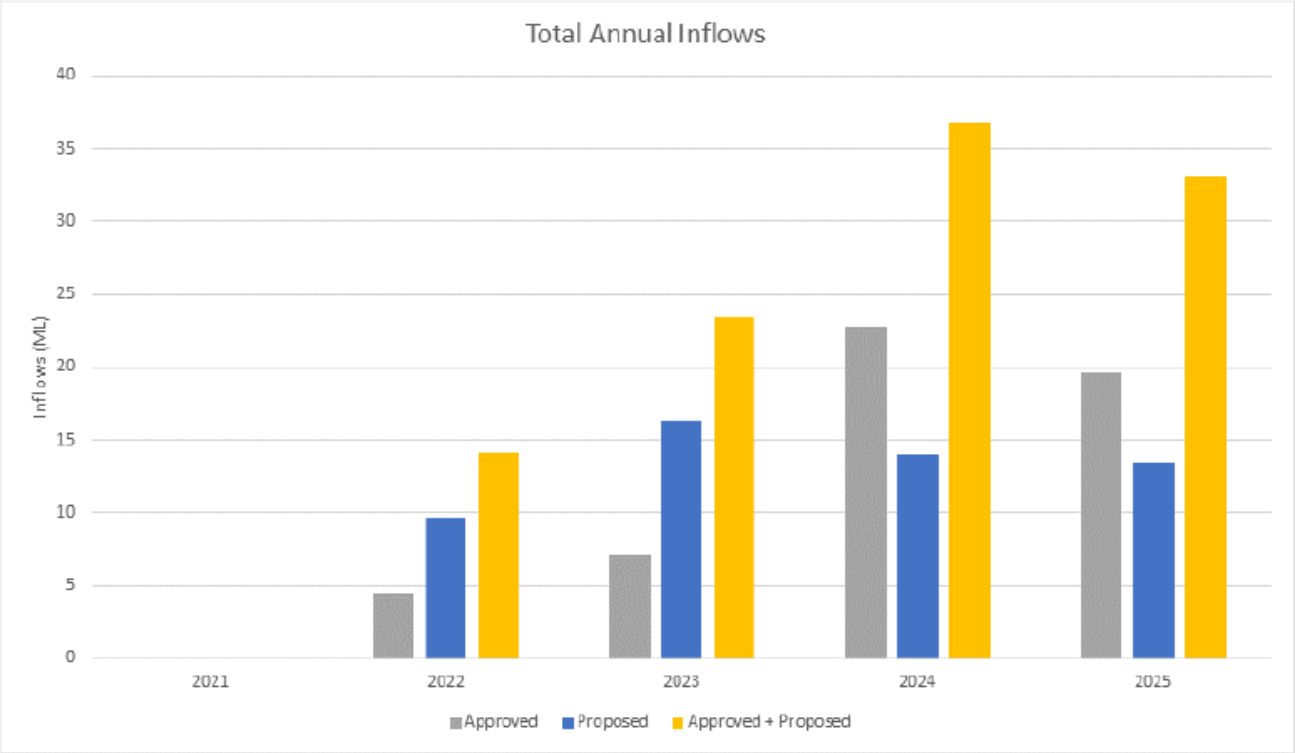


Figure 7.23 Predicted mine inflows

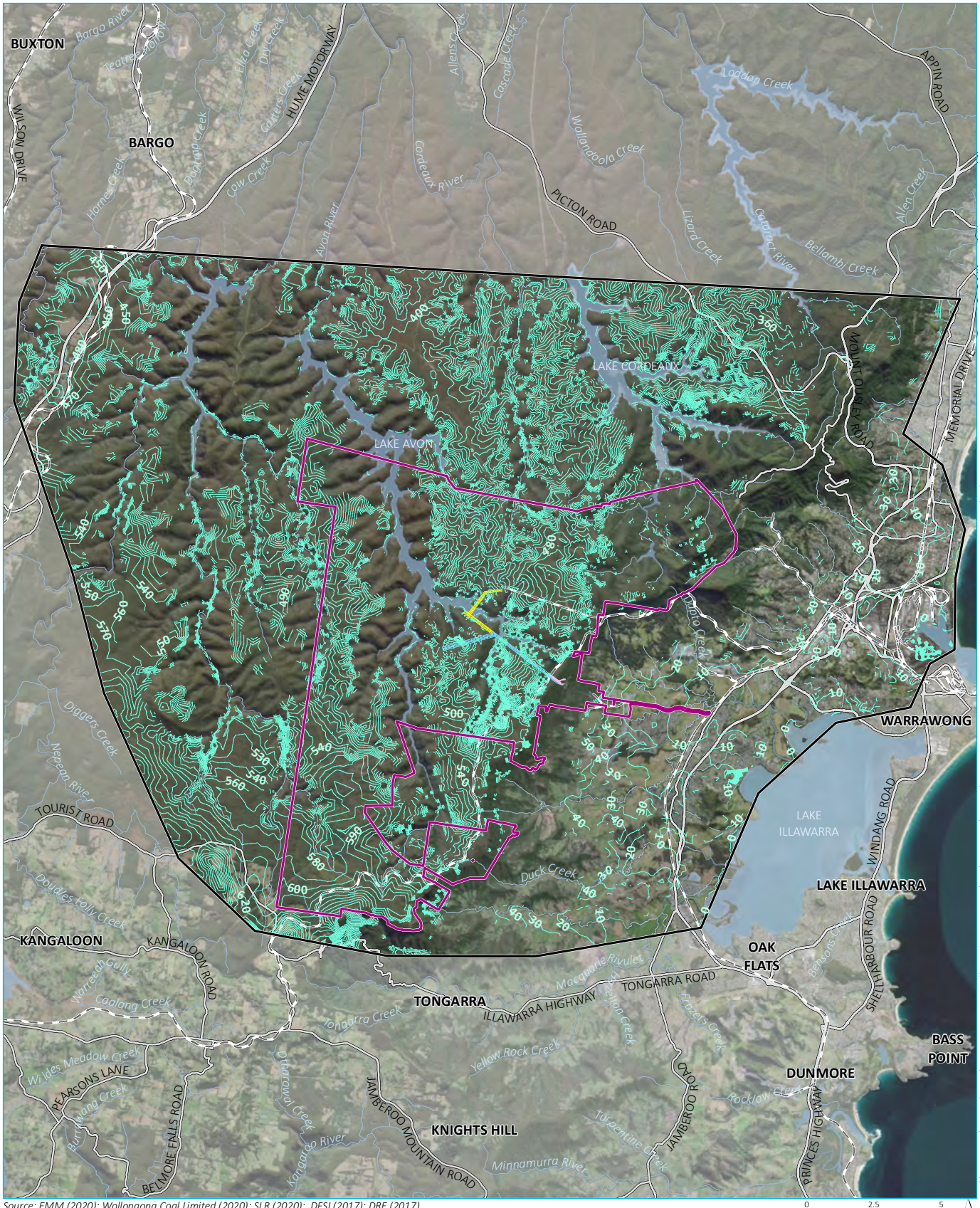
b Predicted groundwater levels

Predicted groundwater levels at the end of mining operations (January 2026) in the alluvium / weathered layer and Bulgo Sandstone for the modified project (approved and proposed) is shown on Figure 7.24 and Figure 7.25. Predicted groundwater level drawdown in the Bulli Seam and Wongawilli Seam at the end of mining (January 2026) is presented in Figure 7.26 and Figure 7.27 respectively.

Additional groundwater elevation contour maps and drawdown maps are provided in Appendix I.

The groundwater model predicts:

- negligible groundwater drawdown (>0.5 m) in the Bulgo Sandstone or watertable during active mining, which is consistent with the predictions reported in the EA (GeoTerra 2010);
- no third-party bores are predicted to be impacted, as defined by the 2 m minimal impact considerations;
- groundwater flow direction in the Bulgo Sandstone will be in a north-easterly direction towards Dendrobium and previously mined areas in the Colliery (Figure 7.25);
- groundwater drawdown in the Bulli Seam up to 50 m (Figure 7.26); and
- groundwater drawdown in the Wongawilli Seam up to 50 m, localised around the L panel (Figure 7.27).



Source: EMM (2020); Wollongong Coal Limited (2020); SLR (2020); DFSI (2017); DRE (2017)

0 2.5 5 km

GDA 1994 MGA Zone 56

N

KEY

- Potentiometric surface (m AHD)
- Groundwater model domain
- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Existing environment

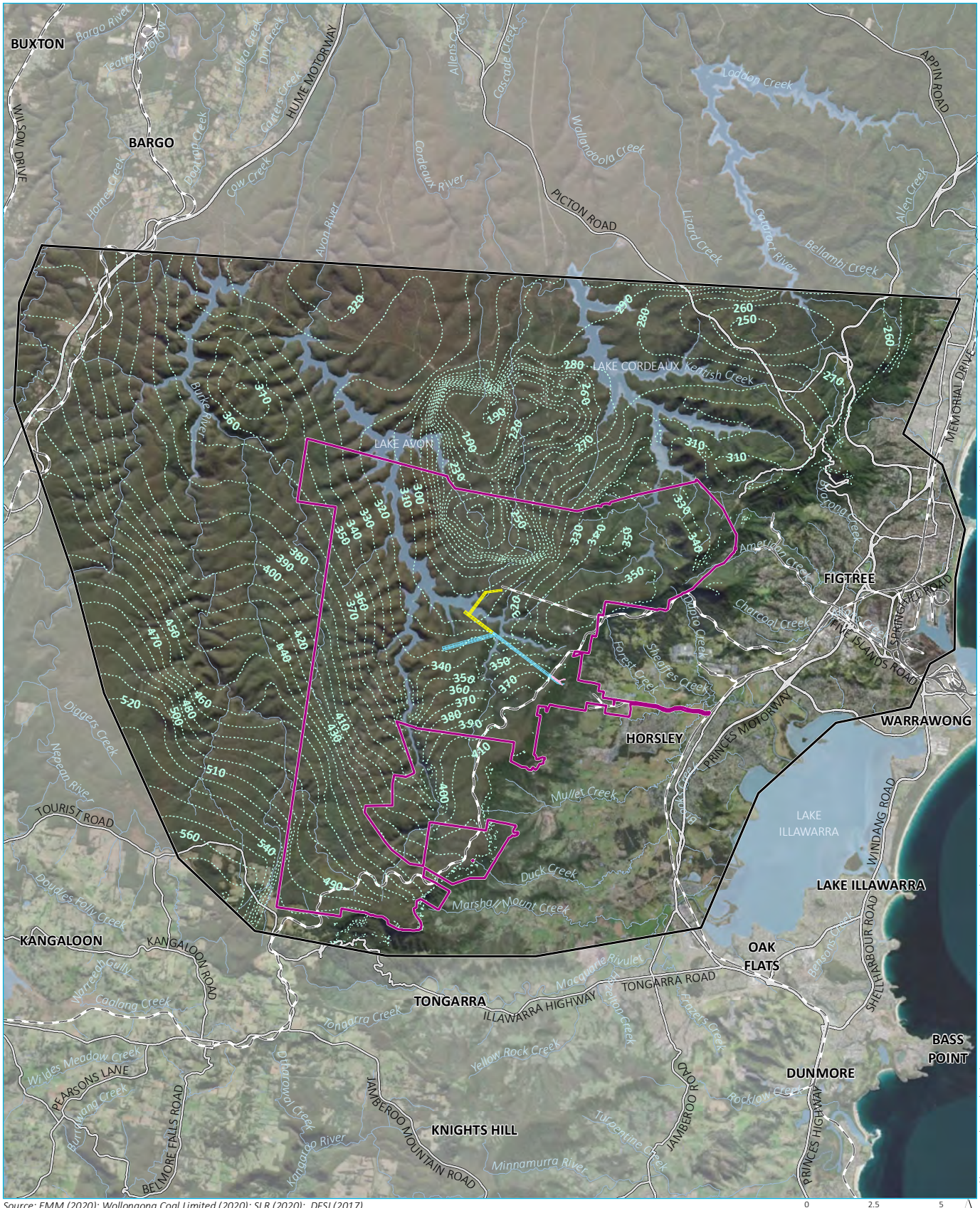
- Rail line
- Major road
- Named watercourse
- Waterbody

Predicted groundwater levels in the alluvium/weathered layer at end of mining

Wollongong Coal Limited
Modification assessment report
Figure 7.24

EMM creating opportunities

\\Emmsvr1\emm3\2020\J200053 - Wongawilli Mod 2 NW Mains\GIS\02_Maps\MOD2\MOD025_PredictedContoursAlluvium_20201116_01.mxd 17/11/2020



KEY

- Potentiometric surface (m AHD)
- Groundwater model domain
- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Existing environment

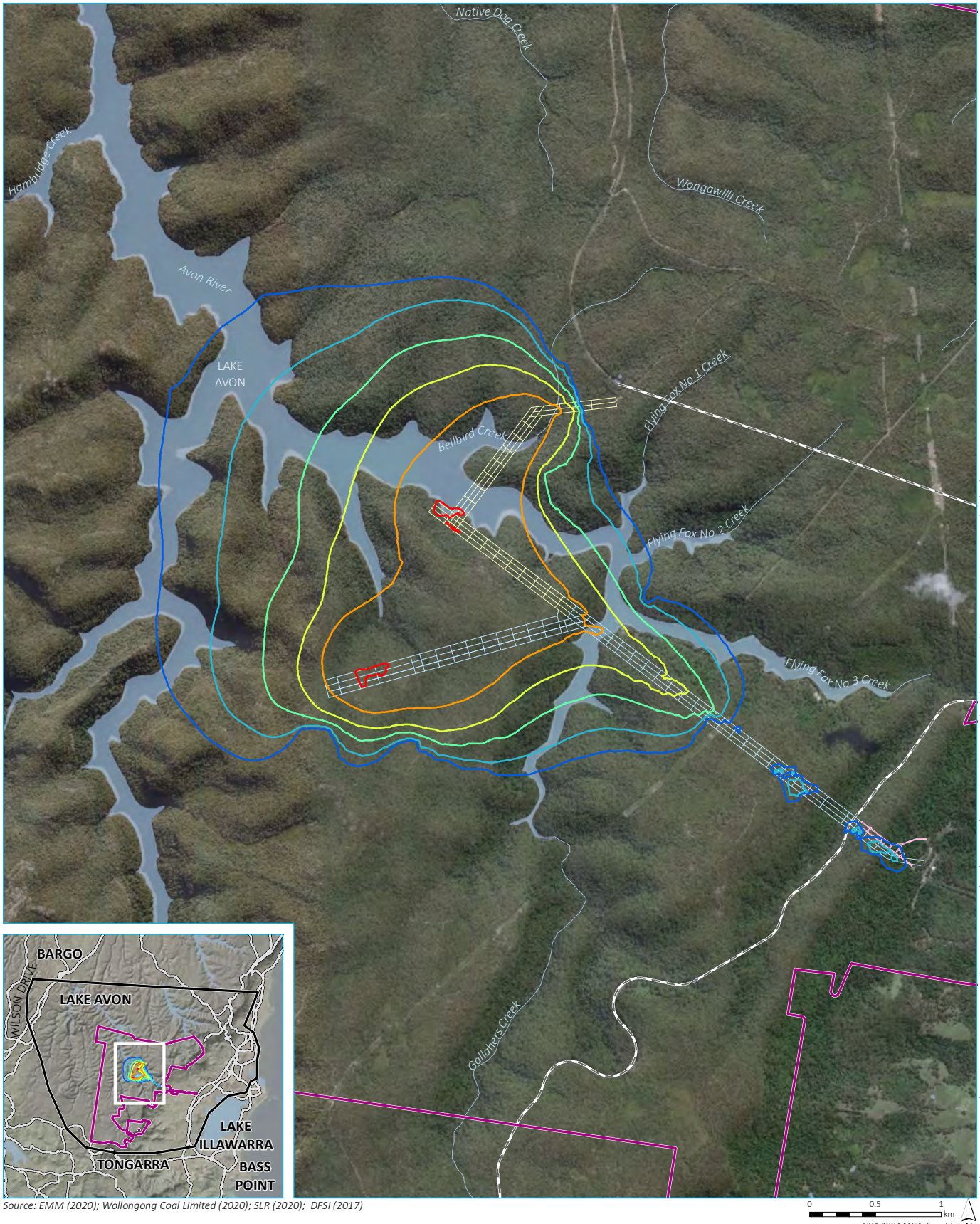
- Rail line
- Major road
- Named watercourse
- Waterbody

Predicted groundwater levels in the Bulgo Sandstone at end of mining

Wollongong Coal Limited
Modification assessment report
Figure 7.25

EMM creating opportunities

\\Emmsvr1\EMM3\2020\200053 - Wongawilli Mod 2 NW Mains\GIS\02_Maps\MOD2\MOD026_PredictedContoursBulgoSandstone_20201116_01.mxd 17/11/2020



Source: EMM (2020); Wollongong Coal Limited (2020); SLR (2020); DFSI (2017)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Groundwater model domain
- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Existing environment

- Rail line
- Named watercourse
- Waterbody

Drawdown contour

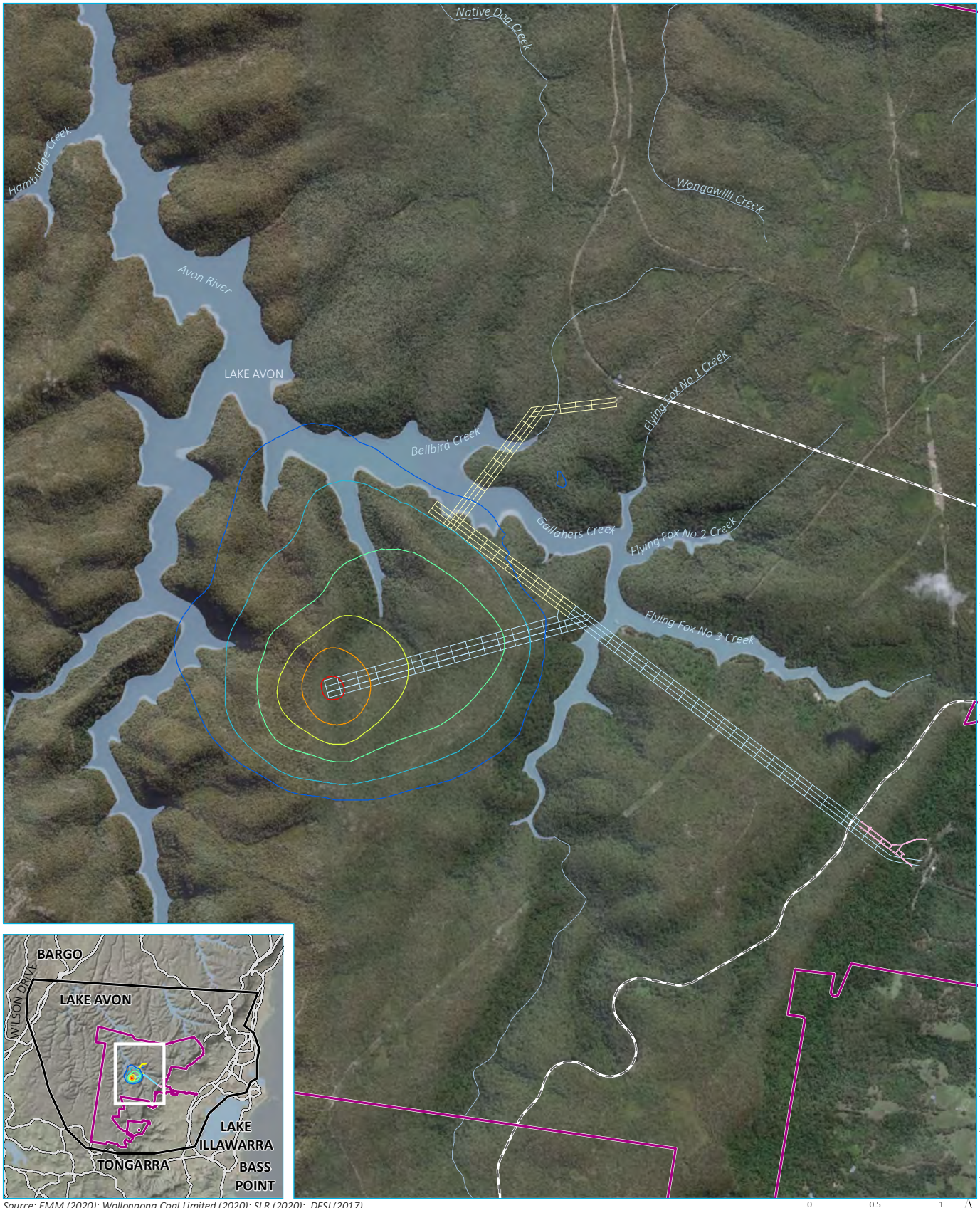
- 1 m
- 2 m
- 5 m
- 10 m
- 20 m
- 50 m

\\Emmsvr1\emm3\2020\J200053 - Wongawilli Mod 2 NW Mains\GIS\02_Maps\MOD2\MOD027_PredictedContoursBullSeam_20201116_01.mxd 17/11/2020

Predicted drawdown in Bulli Seam at end of mining

Wollongong Coal Limited
Modification assessment report
Figure 7.26

EMM creating opportunities



Source: EMM (2020); Wollongong Coal Limited (2020); SLR (2020); DFSI (2017)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Groundwater model domain
- Project application area
- North West Mains Drivage completed workings
- Proposed additional drivage
- Proposed NWMD alignment

Existing environment

- Rail line
- Named watercourse
- Waterbody

Drawdown contour

- 1 m
- 2 m
- 5 m
- 10 m
- 20 m
- 50 m

\\Emmsvr1\EMM3\2020\200053 - Wongawilli Mod 2 NW Mains\GIS\02_Maps\MOD2\MOD028_PredictedContoursWongawilliSeam_20201116_01.mxd 17/11/2020

Predicted drawdown in Wongawilli Seam at end of mining

Wollongong Coal Limited
Modification assessment report
Figure 7.27

EMM creating opportunities

The Independent Expert Panel for Mining in the Catchment Report (IEMPC 2019) recommends that all future mine approvals in the Special Areas should *"include performance measures related to measured changes in groundwater pressure and/or pressure gradients where these have the potential to impact on surface water diversions or losses."* The results of the groundwater modelling predicts there will be negligible groundwater drawdown (<0.5 m) in the upper units of the alluvium/weathered zone or Hawkesbury Sandstone. As such, the potential for losses or diversion to surface water as a result of the proposed modification are extremely unlikely and performance measures are not required.

Groundwater dependent ecosystems

As the model predicts minimal change to the watertable as a result of the proposed modification (<0.1 m), the potential for impacts on GDEs identified in Section 7.6.4(v) is considered unlikely.

In addition, cracking is unlikely to extend into the Bulgo Sandstone and overlying hydrostratigraphic units (SCT 2020), further limiting the potential for hydraulic connection of shallow groundwater systems and surface water to the deeper Permian units.

c Post mining recovery

The groundwater model was run for 500 years post-mining (to 2550) to predict groundwater level recovery and mine water inflows following cessation of mining. The model predicts the groundwater system will continue to recover for greater than 500 years after mining, likely due to the various other mining activities in the area.

Groundwater inflows to the underground post-mining are predicted to range from approximately 10 to 18 ML/year. Further discussion is provided in Appendix I.

iii Sensitivity and uncertainty analysis

The results of the sensitivity and uncertainty analysis are presented and discussed in Appendix I. In summary, the results show that the predicted zone of depressurisation within the Bulli Seam is sensitive to horizontal hydraulic conductivity of the coal seams, however the predicted drawdown from the sensitivity and uncertainty analysis is similar to the base case predictions.

iv Water quality

No impacts to water quality have been identified in the GWA (Appendix I). Wollongong Coal will continue to implement monitoring in accordance with approved management plans as revised on the basis of MOD2. Monitoring data will be reviewed to ensure no adverse impacts and that existing controls are effective in accordance with Wollongong Coal's EPL. Results of monitoring undertaken will be reported in the Colliery annual return.

7.6.6 Licensing

i Summary of entitlements held by Wollongong Coal

WC hold WAL 36487 that has 1,500 shares (equivalent to 1,500 ML) of groundwater in the Management Zone 1 of the Sydney Basin Nepean Groundwater Source managed under the WSP for the Greater Metropolitan Region Groundwater Sources 2011.

ii Summary of required entitlements

The volume of groundwater intercepted and required to be accounted for via shares for the project includes water actively extracted during mining operations and groundwater predicted to flow into the underground following completion of mining.

During mining, the total annual mine water inflow is predicted to peak at approximately 37 ML in 2024. Following completion of mining, the annual mine water inflow is predicted to range from 10 to 18 ML.

Wollongong Coal are required to hold adequate WALs for the maximum water take, which is 37 ML. Wollongong Coal have sufficient WAL entitlement to account for the predicted maximum take and the conditions of WAL 36487 remain relevant for the proposed modification for compliance and annual reporting.

7.6.7 Mitigation measures

No changes to the groundwater monitoring program are proposed. All currently approved management plans would continue to be utilised and maintained throughout the continuation of mining with the existing and groundwater monitoring points remaining in use. Monitoring would be carried out to confirm that the water management system is effective, and that the impacts of mining are consistent with the predictions made in the groundwater assessment. Results of water quality monitoring and water flow monitoring would continue to be reported in the Colliery annual return.

7.6.8 Conclusions

The proposed modification is predicted to have little to no impact on groundwater receptors including third party bores, GDEs and surface water. This is based on the following results of the assessment:

- no groundwater drawdown (>0.5 m) in the Bulgo Sandstone or watertable during active mining is predicted to occur;
- no third-party bores are predicted to be impacted, as defined by the 2 m minimal impact considerations; and
- Wollongong Coal having sufficient WAL entitlement to account for the predicted maximum take with the total annual mine water inflow predicted to peak at approximately 37 ML in 2024 with post mining inflow predicted to range from 10 to 18 ML.

7.7 Subsidence

7.7.1 Introduction

A subsidence and geotechnical assessment (SGA) for MOD2 has been prepared by SCT Operations Pty Ltd (SCT 2020) (Appendix K).

7.7.2 Assessment approach

The SGA takes into consideration and assesses the:

- mining geometry of the approved and proposed NWMD in relation to surface features and topography;
- relevant geological structures and whether these aspects have the potential to create any subsidence effects and impacts; pillar stability assessment, and outlines both anticipated effects and impacts of subsidence as was requested by the DPIE in its correspondence dated 9 April 2020, see Appendix K; and
- outlines expected mining conditions and potential for groundwater inflow.

7.7.3 Assessment assumptions

i Mining geometry

The proposed NWMD main heading developments are planned to be mined in the 1-2 m thick Bulli Seam located approximately 20-30 m above the Wongawilli Seam. The main headings are planned to be mined 2.4 m high. The Bulli Seam coal thickness is a maximum of approximately 1.9 m in the areas of the proposed main headings.

In most areas, the mining section would include the full height of the Bulli Seam including any stone bands or intrusions within the seam, as well as whatever roof and floor strata is required to achieve the nominal 2.4 m mining height.

For the purpose the SGA, SCT have divided the NWMD into three main driveages:

- the NW mains, which refers to the driveages below the Illawarra Escarpment;
- the NE mains, which refers to the north-east driveages; and
- the SA mains, which branch to the south-west.

Four headings are proposed in all, apart from a short section in the north where the NE mains are reduced to three headings as they approach the Wongawilli Ventilation Shaft 1. The divided NWMD driveages and headings as described are displayed in Figure 7.28.

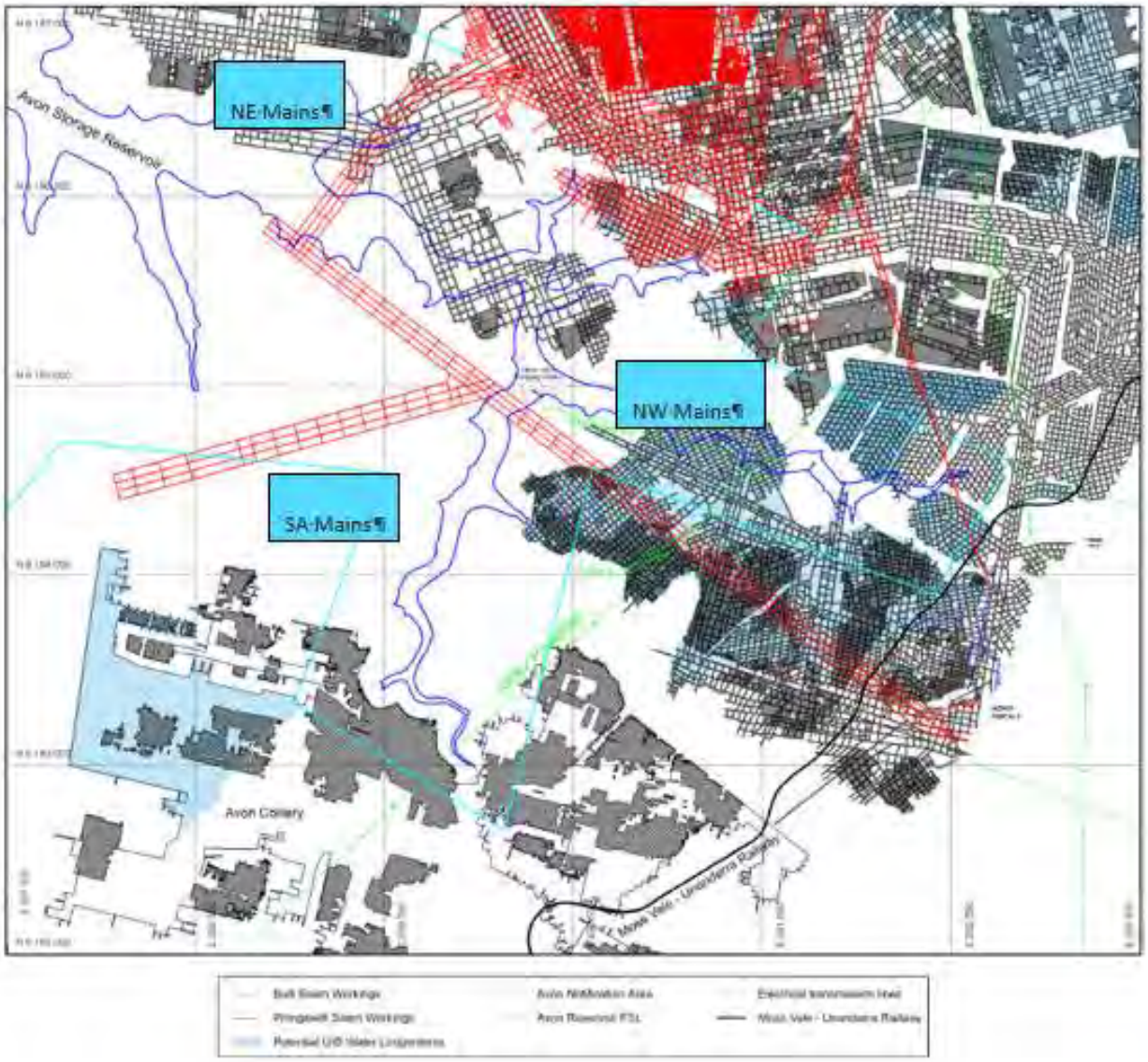


Figure 7.28 NWMD mains driveages

7.7.4 Existing environment

i Surface features

The NWMD is located almost entirely below the Sydney's drinking water catchment (Metropolitan Special Area) of Avon Storage Reservoir, with a small area in the east located below the IECA. Surface features above the NWM include:

- five fire roads numbered 15A, 15H, 15Jand 15G, and 6H;
- the Moss Vale to Unanderra Railway Line;
- Transgrid's Avon to Marulan 330 kilovolt (kV) power transmission line;
- Avon Reservoir;
- Upper Avon Pumping Station; and
- Wongawilli Ventilation Shaft 1.

No other significant surface or sub-surface features have been identified, which could be vulnerable to potential subsidence impacts from MOD2.

ii Surface topography

Figure 7.29 shows the surface topography along the NW and NE mains, which is further described in Section 3.3 of Appendix K.

The main headings are planned to pass 90 m beneath the Moss Vale – Unanderra Railway, 215 m below a 330 kV powerline, twice below Gallagher's Creek (an arm of Avon Storage Reservoir) and once more below the Bellbird Creek arm of the reservoir.

The depth of the headings below the base of the reservoir is 60 m at the first approved NWMD crossing point, 113 m at the proposed second crossing point and 134 m at the third proposed crossing point.

The surface topography rises to a high of RL445 m at the Wongawilli Ventilation Shaft 1 and an overburden depth of approximately 360 m to the proposed mining horizon.

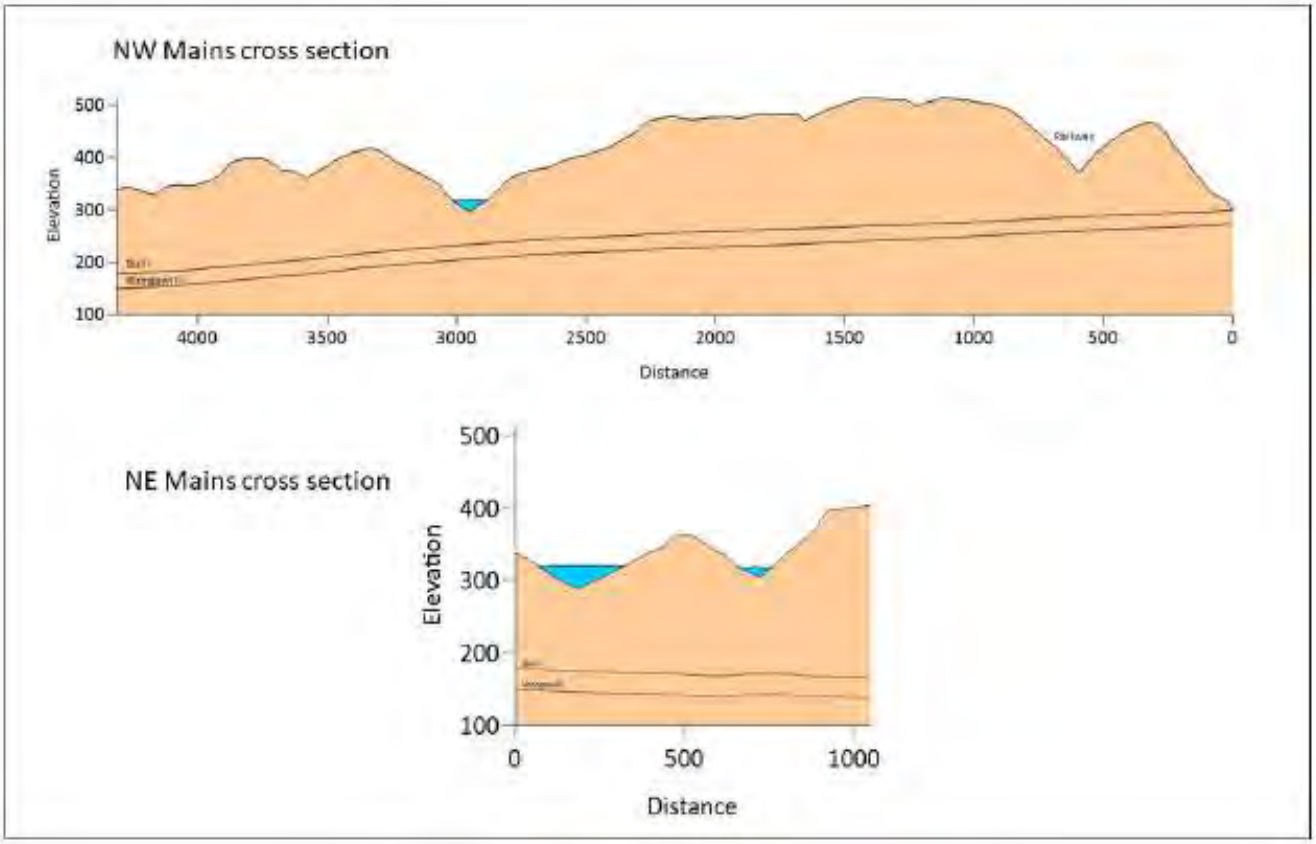


Figure 7.29 Cross sections of NW mains and NE mains

iii Geological structure

The geological structure used for the SGA was mapped during previous mining in the Wongawilli Seam and is shown in Figure 5 of Appendix K.

iv Major geological faults

There are two major geological fault structures in the vicinity of the proposed main heading developments.

The first major fault is located to the north of the proposed NW mains headings, while a second parallel fault is located approximately 750 m to the south of the NW mains between Wongawilli and Avon Collieries.

The SGA notes that Doyle (2017) found, in a review of experience of mining through geological structures in the Dendrobium area of the Southern Coalfields, that geological fault structures are not hydraulically conductive.

v Dykes, sills and seam splits

Dykes are thin vertical 'intrusions' that cut across any layers in the rock they intrude. Dykes tend to be laterally extensive and vertical, and in the Southern Coalfields are generally less than a few metres wide. A sill, on the other hand, moves horizontally between rock layers. Sills commonly develop in coal seams more easily than in the surrounding strata.

Coal quality is degraded by intrusion of hot material (both dykes and sills would have been formed by hot volcanic material), and the harder sill material makes mining more difficult. Thus, areas of silling tend not to be mined.

The extent of mining in the Wongawili Seam below the NW mains is largely determined by the extent of silling. The NW mains are expected to cross five dykes that have been intersected by previous mining in the Wongawilli Seam. Their position, thickness and difficulty to mine can be determined from the records of previous mining and is outlined in Section 3.4.2 of Appendix K.

The estimated extent of silling within the proposed area is well defined where intersected by underground mining. Elsewhere, the extent is estimated from borehole intersections and is therefore subject to interpretation.

The NW mains are not expected to encounter silling in the Bulli Seam but will encounter up to about 1 m of shale (siltstone/claystone) material associated with a seam split within approximately 1,500 m of the existing portals. Mining the shale and upper coal is expected to give better roof conditions because of the Coalcliff Sandstone located above these units.

7.7.5 Impact assessment

The SGA concluded that there is no potential for the proposed NWMD roadways to cause any significant surface ground movement. Any surface subsidence is expected to be so small as to be imperceptible. Any potential impacts to natural and built features are expected to be imperceptible. A summary of the key findings is outlined below.

i Subsidence effects

A previous subsidence assessment undertaken for the Part 3A application for the Nebo Area Project 09_0161 (MSEC 2010) concluded that *"No subsidence is expected as a result of the proposed Western Driveages and, hence, no subsidence predictions have been undertaken for these Western Driveages"*.

SCT's findings for MOD2 are consistent with MSEC's findings. The development of four roadways in the Bulli Seam at 35 m centres in overburden depths ranging from 60 m to 250 m are not expected to cause any perceptible surface subsidence.

The only potential for first workings to cause surface subsidence would be if there was a potential for widespread pillar instability. This potential is assessed as low (refer Section 1.1.5(ii)).

ii Pillar stability assessment

The roadways in the NWMD are proposed to be formed at 35 m centres. The pillars are therefore nominally 29.5 m wide (measured rib to rib). The thickness of the Bulli Seam is expected to range 1–2 m but the mining height is planned to be 2.4 m. A pillar height of 2.4 m and width to height ratio of 12 is used for stability assessment purposes.

The factor of safety calculations used to determine pillar stability, which are outlined in Section 4.2 of Appendix K imply long-term stability. In areas where there has been secondary extraction of pillars in the Wongawilli Seam, vertical loading in the Bulli Seam has the potential to increase. However, the calculations for the pillar stability under such conditions is also expected to be long-term stable.

The SGA concluded that any effects from mining first workings roadways in the Bulli Seam are expected to be generally limited to a few metres around the proposed roadways and not expected to significantly impact workings in the Wongawilli Seam.

Therefore, the long-term stability of the main headings pillars is found to be long-term stable.

iii Subsidence impacts

SGA conducted an assessment of subsidence impacts for specific surface infrastructure within the vicinity of the NWMD. A subsidence assessment of this kind was not undertaken for the Nebo Area Project, as no subsidence was predicted at the time.

a Moss Vale – Unanderra railway line

The Moss Vale – Unanderra Railway Line passes directly above the proposed NW mains. Given that mining has historically taken place within the vicinity of the railway line, a barrier of unworked pillars was left underneath to protect the railway and associated infrastructure from subsidence impacts.

The barrier is generally greater than 80 m wide on each side of the railway centreline, with a total width of more than 160 m. The barrier has been effective in providing protection to the railway line from subsidence impacts.

The SGA considered the dimensions of the coal pillars located in the Wongawilli Seam within the railway barrier, some of which are directly below the railway line. The SGA concluded that mining of the NW mains in the Bulli Seam, approximately 25 m above the barrier pillars left in the Wongawilli Seam, is not expected to cause any significant change in loading conditions at the Wongawilli Seam mining horizon or result in any perceptible impacts to the railway and associated infrastructure.

b Powerlines

Two electricity transmission lines traverse the surface above or adjacent to the NW mains.

The Avon to Marulan 330 kV powerline owned by TransGrid crosses the alignment of the NW mains in a north-south alignment. Two towers on this powerline are located above or adjacent to the NW mains. The northern tower is approximately 210 m and 240 m above the Bulli and Wongawilli Seams respectively. The southern tower is approximately 235 m and 265 m above the Bulli and Wongawilli Seams respectively.

Proposed mining of the NW mains is not expected to cause any perceptible subsidence effects or impacts at the location of the north and the south towers.

A 33 kV powerline, owned by Integral Energy, that supplies the Avon Pumping Station and other water supply infrastructure crosses the Flying Fox No 3 Creek from the north and runs along the edge of the reservoir adjacent to and almost parallel to the direction of the NW mains. The NWMD would not mine below any section of this power line or associated substations/switch yards, and thus MOD2 is not expected to have any perceptible subsidence effects or impacts on these powerlines and associated infrastructure.

No perceptible subsidence effects at, or impacts to, powerline infrastructure are expected as a result of the NWMD.

c Water intake structure

The NW mains are located in proximity to the Avon Water Intake Structure near where the headings pass under the Avon Reservoir. The structure is protected by a barrier and the proposed mining does not extend into this barrier.

The SGA concluded that the proposed four headings have no potential to cause ground movements at the surface that would impact on this structure.

iv Mining conditions

The SGA considers the mining conditions in relation to areas above first workings in the Wongawilli Seam, in areas above secondary extraction in the Wongawilli Seam, dykes, flooded workings, gas and Wongawilli Ventilation Shaft 1. The key findings are summarised as below:

- In areas above first workings in the Wongawilli Seam, where there has been no secondary extraction, mining conditions are expected to be similar to conditions that would be typical of mining in the Bulli Seam at overburden depths of 250 m. The low seam thickness of the 1-2 m thick Bulli Seam, a seam split in the middle, and possible silling west of the Avon Reservoir are expected to make mining more difficult than would be typical. Non-coal material in the roof and floor and within the seam are likely to be harder to cut than coal. These materials are also likely to dilute the coal product significantly. For this reason, fit-for-purpose machinery such as a suitably designed road-header is likely to be required to manage the variable mining conditions and achieve a satisfactory level of productivity.

- The Bulli Seam strata is likely to be significantly disturbed above areas of secondary pillar extraction in the Wongawilli Seam. The SGA found that rib deterioration, open fractures and elevated horizontal stresses may occur in some areas. However, these are expected to be managed with meshing and additional rib support, as well as a program of monitoring and response to match the support requirements to the strata and stress conditions. SCT also recommended drill ahead strategies to confirm the presence of coal on the other side of dykes, and to manage the vertical alignment of the belt road through these areas.

- Difficult mining conditions are expected where dykes cross the NW mains. A fit-for-purpose miner capable of mining Bulli Seam roof and floor material is likely to be able to penetrate the dyke material more effectively than standard continuous miners, but provision should be made in case there is a need to drill and blast through this section of the proposed driveages.

- Historical findings indicate that gas is generally very low within typical contents of around 1 m^3/t, with the composition of the gas consisting of a high percentage of methane (CH_4). While gas is not expected to be a significant issue for the mining of the NW mains, the risk of gas migrating from areas of the Wongawilli Seam workings into the Bulli Seam above needs to be considered. The SGA concludes that this may be an issue for the NW mains where any potential gas accumulation has not been displaced by water in the flooded workings.

- The three main headings that are planned to intersect the Wongawilli Ventilation Shaft 1 are planned to cross the Wongawilli Fault (refer Figure 6 of Appendix K). SCT recommends staying above the existing Bulli Seam workings in this area to avoid all the legacy issues associated with mining through old workings. The roadway conditions surrounding the Wongawilli Ventilation Shaft 1 are described in detail in Section 5.6 of Appendix K and conclude that avoiding the existing Bulli Seam roadways in favour of newly constructed roadways/drifts is recommended. Remaining above the Bulli Seam level provides an opportunity to seal the old workings to prevent gas and water related issues from below. This also removes the requirements of inspections and maintenance of old roadways.

v Potential for inflow

The SGA reviews the potential for inflows to occur where the main headings cross below Avon Reservoir, as well as strategies to identify and manage this potential.

Dam Safety NSW prohibit mining below stored waters at a depth of less than 60 m. Given that the proposed NW mains below the base of Avon Reservoir are close to this minimum, the modification will be referred to the Dams Safety NSW by DPIE for consideration.

The base of the reservoir is interpreted to be RL496 m. The roof of the Bulli Seam is estimated to be RL436 m. Boreholes are located all around the site, with the nearest being 230 m away.

The assessment considered the hydraulic conductivity in various places within the NW workings. The proposed four roadways of the NW mains are planned to pass 60 m below the floor of the Avon Reservoir in the vicinity of a vertical dyke structure that extends through to the surface. Based on SCT's experience in the nearby Blue Panels, the inflow rates expected are estimated to be less than 0.2 ML/day and therefore likely to be acceptable based on Dams Safety NSW guidelines for tolerable loss.

Even though significant inflows are not expected, SCT has recommended a precautionary approach to manage the potential for inflows from the reservoir into these roadways. The full supply level (FSL) of Avon Reservoir is at RL320.2 m, while the existing NW mains portals are at approximately RL260 m. This equates to a 60 m head difference that would need to be managed in the event of any high inflows. The SGA recommends managing the potential for inflows by drilling ahead in the Bulli Seam through the dyke and below the base of Avon Reservoir from the underground roadways once they have been developed (refer Section 6 of Appendix K). This approach would confirm there are no zones of increased hydraulic conductivity that would lead to high potential inflows into the underground roadways from the reservoir.

7.7.6 Management and mitigation measures

Recommended mitigation measures are summarised throughout Appendix K are summarised below:

- Fit-for-purpose machinery such as a suitably designed road-header is likely to be required to manage the variable mining conditions and achieve a satisfactory level of productivity within areas above first workings in the Wongawilli Seam.

- Some areas above secondary extraction in the Wongawilli Seam will likely require meshing and additional rib support to control roadway width. A program of monitoring and response is recommended to match the support requirements to the strata and stress conditions.

- Given that difficult mining conditions are expected where dykes cross the NW mains, a fit-for-purpose miner capable of mining Bulli Seam roof and floor material is likely to be able to penetrate the dyke material more effectively than standard continuous miners. Provision should be made in case there is a need to drill and blast through this section of the proposed driveages.

- The water level in the Wongawilli Seam lodgement, below the proposed NW mains, will need to be drawn down by a minimum of 10 m to avoid water entering the inbye Bulli Seam workings of the NW mains. Additional drawdown is recommended to accommodate inflows into the lodgement after heavy rainfall, for the life of the main headings.

- Staying above the existing Bulli Seam workings in the area close to the Wongawilli Ventilation Shaft 1, to avoid all the legacy issues associated with mining through old workings. This approach will ensure that:

    - there would be no need to intersect the existing Bulli Seam workings which are old, low height and relatively poorly supported;

    - the shaft could be back filled to above the Bulli Seam and sealed to prevent circulation loss into existing workings in the Bulli Seam and Wongawilli Seam; and

    - waste rock material from the stone driveages could be disposed of into the shaft.

- Mining below the Avon Reservoir should be done in a way to manage the potential for inflows, ie being able to drill ahead in the Bulli Seam through the dyke and below the base of Avon Reservoir. This approach would confirm there are no zones of increased hydraulic conductivity that would lead to high potential inflows into the underground roadways from the reservoir.

7.7.7 Conclusion

The SGA concludes that there is no potential for the proposed NWMD roadways to cause any significant surface ground movement. Any surface subsidence is expected to be so small as to be imperceptible. Any potential impacts to natural and built features are expected to be imperceptible.

The main headings are expected to pass at acceptable distances below any significant surface infrastructure identified in the assessment.

Wollongong Coal will implement the proposed mitigation and management measures identified within the SGA to ensure a conservative approach is taken to the mining of the NWMD and reduce the already low potential for subsidence impacts.

7.8 Biodiversity

7.8.1 Introduction

A Biodiversity Development Assessment Report (BDAR) was prepared by Biosis Pty Ltd (Biosis 2020) to address the biodiversity impacts of MOD2 (Appendix L).

7.8.2 Assessment approach

i Overview

The BDAR was prepared in accordance with the *Biodiversity Assessment Method* (BAM; OEH 2017a) and key biodiversity legislation and government policy listed below. The BDAR assess the potential impacts of the proposed modification on biodiversity values. It addresses the BAM and the Biodiversity Offsets Scheme (BOS), and identifies how the proponent proposes to avoid and minimise impacts to biodiversity.

More precisely, the BDAR addresses only the proposed modification components that fall outside of the previously approved footprint, consisting of 28.7 hectares overlying the proposed underground roadways (ie the proposed extension of the NWMD), the proposed coal conveyor and existing mine tunnel entrance at the Wongawilli Pit Top. As direct impacts to native vegetation are only proposed at the Wongawilli Pit Top, this area has been designated the subject land, and makes up 0.03 hectares of native vegetation proposed to impact by MOD2.

Section 1.5 of Appendix L provides a list of key sources of information used for the BDAR, including relevant databases, spatial data, literature and previous site reports.

Numerous field investigations were carried out to undertake flora and fauna assessments across the study area. Field surveys were undertaken on 17, 21, 24 and 29 July, and 4 and 24 August 2020 with methods and results outlined in Section 3.1 and Section 3.2 of Appendix L respectively.

ii Legislation

The proposed modification has been assessed against key biodiversity legislation and government policy, including:

- *Environment Protection and Biodiversity Conservation Act 1999*;
- *Environmental Planning and Assessment Act 1979*;
- *Biodiversity Conservation Act 2016*;
- *Fisheries Management Act 1994*;
- *Biosecurity Act 2015*;
- State Environmental Planning Policy Koala Habitat Protection 2019 (Koala SEPP); and
- *Wollongong City Council LEP 2009*.

iii Assessment terminology

For the purpose of the assessment, the following terminology is used throughout the BDAR and this section:

- 'subject land' defines the total area of proposed disturbance and encompasses the proposed works footprint and all areas that could be disturbed during construction (ie the footprint of the proposed conveyer works, the conveyor belts, drive heads and any buffer zones to account for further vegetation removal); and
- 'study area' encompasses the subject land and includes areas outside of the subject land that could be indirectly impacted by the proposal, including adjacent areas downslope.

7.8.3 Existing environment

i Bioregions, landscape and soils

The study area occurs within the Sydney Basin Interim Biogeographic Regionalisation of Australia (IBRA) bioregion, and both the Illawarra and Sydney Cataract IBRA subregions. The Sydney Basin Bioregion extends from just north of Batemans Bay to Nelson Bay on the Central Coast, and almost as far west as Mudgee. It is one of the most species diverse bioregions in Australia, as a result of the variety of rock types, topography and climates (OEH 2016).

The study area occurs within the Bulli Coast Escarpment Mitchell Landscape, with varied soils types. The high rainfall, averaging approximately at 2,200 mm per year, and high elevation encourage mesophilic vegetation on rich soils with cool temperate rainforest elements.

No vegetated or cleared parts of the study area are mapped as being Acid Sulphate Soils under the Wollongong LEP.

ii Waterways and wetlands

The study area is located within the Hawkesbury Nepean catchment, within the WaterNSW Metropolitan Special Area. The waterways above the proposed extension of the NWMD can be categorised into two broad groups, the large waterbody of Gallaghers Creek (within the upper influence of Lake Avon reservoir), and first and second order tributaries of Lake Avon, shown in Figure 7.12.

Lake Avon occurs within the Lake Avon dam and has a catchment area of 124 square kilometres (km^2) (WaterNSW 2020). The study area intersects with Gallaghers Creek, passing below the lake from the south western to north eastern bank, with the upper extent of Lake Avon dam. The crossing and study area is located downstream of the confluence of the major tributaries of Flying Fox No 1 Creek, Flying Fox No 2 Creek and Flying Fox No 3 Creek with Gallaghers Creek, and upstream of the Bellbird Creek tributary.

Lake Avon, within the study area, is included in the Coarse Key Fish Habitat mapping by NSW Department of Primary Industries (DPI) (DPI 2007). It is also considered TYPE 1 highly sensitive key fish habitat and CLASS 1 major key fish habitat, according to the classification provided in DPIE (2013).

The study area also intersects with five mapped first and second order high slope streams on the south western and north eastern banks of Lake Avon (refer Figure 7.12) The field surveys undertaken as part of the BDAR identified that the stream network on the north eastern bank appears to be more complex than mapped, with a number of additional small waterways and drainage lines identified and shown in photographs taken during field surveys.

There are no wetlands mapped within the study area. Lake Avon is mapped as a reservoir on the NSW Wetlands database (DPIE 2020c).

iii Plant community types

The following plant community types (PCTs) were identified within the study area above the proposed extension of the NWMD, and are shown in Figure 7.30:

- PCT 1804 – Needlebush – Banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin (high condition);
- PCT 1292 – Water Gum – Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion (high condition);
- PCT 1250 – Sydney Peppermint – Smooth-barked Apple – Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion (high condition);
- PCT 1127 – Sandstone cliff-face soak of the Sydney Basin Bioregion (high condition);
- PCT 1083 – Red Bloodwood – scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion (high condition); and
- PCT 878 Gully Gum – Sydney Peppermint – Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion (high condition).

The following PCTs were identified within the study area (and the subject land) at the Wongawilli Pit Top, and are described in detail in Table 2 and Table 3 of Appendix L, and shown in Figure 7.30:

- PCT 906 – Lilly Pilly – Sassafras – Stinging Tree subtropical/warm temperate rainforest on moist fertile lowlands, southern Sydney Basin Bioregion (moderate condition); and
- PCT 1245 – Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (low condition).

Two of the PCTs within the overall study area have been identified as either threatened or endangered ecological communities (refer Section 7.9.3vii(b) below).

iv Biodiversity values map

There are no areas of outstanding biodiversity or biodiversity values mapped within the subject land at the Wongawilli Pit Top. There are, however, areas of outstanding biodiversity value mapped within the proposed extension of the NWMD, encompassing riparian vegetation along Lake Avon and its tributaries.

v Areas of geological significance

There are no recorded karst, caves, crevices, cliffs or other areas of geological significance within the subject land at the Wongawilli Pit Top. However, the subject land occurs on a flat bench on the lower slopes of the IECA. The escarpment rises to the west of the subject land and is composed of cliff areas often exceeding 10 m in height.

Within the proposed extension of the NWMD, the study area contains two cliff lines recorded during field investigations. Both cliffs occur above Lake Avon, with steep slopes leading down to the water body. The surrounding landscape also contains several cliff lines. No karsts or caves were recorded within the study area, however rocky areas and rock crevices are abundant throughout.

vi Vegetation description

The majority of the habitat for flora and fauna mapped within the subject land at the Wongawilli Pit Top consists of rainforest and wet sclerophyll forest. Given that the subject land is located adjacent to the IESC and the Metropolitan Special Area, habitat extends far into the surrounding landscape beyond 100 ha. Native vegetation within the subject land is connected to further vegetation to the west, north and south.

The subject land at the Wongawilli upper pit top supports 0.03 ha of native vegetation with varying levels of disturbance. The results of the field investigations within the subject land identified that the condition of the native vegetation across the study area is varied, with areas of heavy weed infestation and other areas of predominantly native vegetation. Figure 7.30 shows the extent of Lantana infestation at the Wongawilli Pit Top.

Areas adjacent to the vehicle track in the north-west of the study area are primarily underscrubbed and lack native understorey, however they maintain a canopy cover from White Topped Box. Areas with no native cover storey or mid storey cover, and less than 50% cover of native groundcover, met the definition of cleared land and were not mapped as native vegetation. These areas are not considered to provide habitat for threatened species.

vii Threatened species

a Fauna habitat

A fauna habitat assessment was undertaken to determine whether the vegetation to be impacted by the proposed works contains habitats suitable to support threatened fauna species identified in the assessment. The field investigation, however, identified only one hollow-bearing tree within the subject land. The hollow was of medium size.

The field investigations confirmed the following findings:

- the subject land lacked large hollows that would be suitable habitat for roosting owls or larger mammals;
- no aquatic habitat was recorded within the subject land, and thus presence of threatened frog species was considered unlikely; and
- no banksias, bottlebrushes or other high quality feed species were recorded within the subject land that might provide foraging habitat for mammals.

Nevertheless, a few threatened species were assumed to exist within the study area, and are discussed in the following sections. A detailed assessment of the likelihood of occurrence of each potential species credit species is provided in Appendix 2 of Appendix L.

b Threatened and endangered ecological communities

PCT 1804 recorded within the proposed extension of the NWMD meets the listing for the threatened ecological community (TEC) Coastal Upland Swamp in the Sydney Basin Bioregion, which is listed as endangered under both the BC Act and the EPBC Act.

PCT 906, identified in the Wongawilli Pit Top study area and subject land, currently meets the listing for Illawarra Subtropical Rainforest in the Sydney Basin Bioregion, which is an endangered ecological community (EEC) under the BC Act, in accordance with the final determination (NSW Scientific Committee 2008) for Illawarra subtropical rainforest in the Sydney Basin Bioregion – endangered ecological community listing.

The extent of threatened and endangered ecological communities are shown in Figure 7.31.

c Candidate species

A number of ecosystem credit species and species credit species were predicted to occur within the habitat present within the subject land and were assessed using the BAM method (OEH 2017a). The presence or absence of these species in the subject land was determined in accordance with Section 6.4 of the BAM (OEH 2017a). A list of the species is provided in Table 6 and Table 7 of Appendix L respectively.

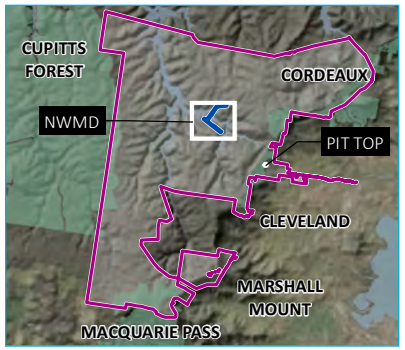
No threatened fauna species were recorded during the field survey, and no threatened fauna were considered likely to occur within the subject land. However, a number of species were assumed to be present, including the Pink Robin, Large-eared Pied Bat, Large Bent-winged Bat and Little Bent-winged Bat. Thus, no targeted threatened fauna surveys were required. Figure 7.32 shows the threatened microbat breeding habitat, within the study area at the Wongawilli Pit Top.

Targeted species surveys for species that have a likelihood of occurring within the subject land were undertaken, as described in Section 4.3.1 of Appendix L. No threatened flora species were recorded during the field survey, as detailed in Chapter 4 of Appendix L.

d Aquatic species

The BDAR considered the likelihood of occurrence of threatened aquatic species within the proposed extension of the NWMD. The Fish Community status within the study area of Gallaghers Creek has been classified by NSW DPI as very poor (DPIE 2020d). Macquarie Perch have the potential to occur within the study area along Gallahers Creek, given the level of connectivity with Lake Avon which has been mapped as the habitat of the fish (DPIE 2020d). Furthermore, several threatened fish species populations are known to occur within Lake Cataract which is located north of Lake Avon. The presence of these species of fish within the study area is possible, but unknown.

No fish community status mapping or indicative threatened fish species mapping is located along the mapped tributaries of Lake Avon within the proposed extension of NWMD study area. These streams are not considered to support suitable habitats for the threatened species listed above given their high slope, small size and more limited connectivity. These tributaries do, however, support habitats for non-threatened aquatic species.



KEY

- BAM plot
- Hollow bearing tree
- Study area
- Subject land
- Survey transect
- *Lantana camara* - Lantana

Plant community type - condition (Biosis, 2020)

- PCT 878 | *Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion* - High
- PCT 906 | *Lilly Pilly - Sassafras - Stinging Tree subtropical/warm temperature rainforest on moist fertile lowlands, southern Sydney Basin Bioregion* - Moderate
- PCT 1083 | *Red Bloodwood - scribbly gum healthy woodland on sandstone plateau of the Sydney Basin Bioregion* - High
- PCT 1127 | *Sandstone cliff-face soak of the Syndey Basin Bioregion* - High
- PCT 1245 | *Sydney Blue Gum x Bangaly - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion* - Low
- PCT 1250 | *Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion* - High
- PCT 1292 | *Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion* - High
- PCT 1804 | *Needlebush - Banksia wet heath swamps on coastal sandstone plateaus of the Sydney Basin Bioregion* - High

Existing

- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- Project application area
- NPWS reserve

Source: EMM (2020); WCL (2020); Biosis (2020); DFSI (2017); GA (2011); ASGC (2006)

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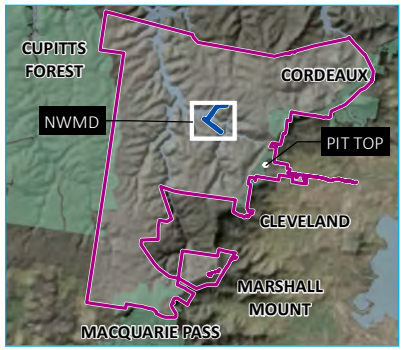
Plant community types within the study area

Wollongong Coal Limited
Modification assessment report
Figure 7.30

EMM creating opportunities



KEY

- Study area
- Subject land
- Minor road
- Vehicular track
- Named watercourse

Threatened ecological

- Coastal Upland Swamp in the Sydney Basin Bioregion (Endangered, BC Act and EPBC Act)
- Illawarra Subtropical Rainforest in the Sydney Basin Bioregion (Endangered, BC Act, Critically Endangered, EPBC Act)

INSET

- Project application area
- NPWS reserve

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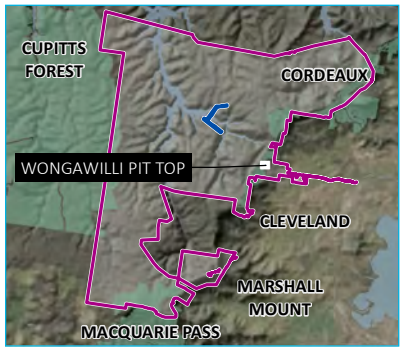
Source: EMM (2020); WCL (2020); Biosis (2020); DFSI (2017); GA (2011); ASGC (2006)

Threatened ecological communities in the study area

Wollongong Coal Limited
Modification assessment report
Figure 7.31

EMM creating opportunities



KEY

- Study area
- Subject land
- Microbat breeding habitat (100 m
- Project application area (refer to inset)

Threatened microbat breeding habitat (Large-eared Pied Bat, Large Bent-winged Bat, Little Bent-winged Bat)

- Existing mine tunnel
- Old gantry and tumbler

Existing

- Minor road
- Vehicular track
- NPWS reserve

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Source: EMM (2020); WCL (2020); Biosis (2020); DFSI (2017); GA (2011); ASGC (2006)

0 50 100 m

GDA 1994 MGA Zone 56

N

Threatened microbat breeding habitat

Wollongong Coal Limited
Modification assessment report
Figure 7.32

EMM creating opportunities

7.8.4 Impact assessment

i Direct impacts

a Wongawilli Pit Top

The BDAR identified that areas of dense understorey rainforest vegetation within the subject land at the Wongawilli Pit Top could provide potential foraging habitat for Pink Robin, which is listed vulnerable under the BC Act. In addition, two human-made structures at the Wongawilli Pit Top could provide potential roosting or breeding habitat for threatened microbat species, which were recorded within 100 m of the proposed works. These are the old gantry and tumble house, and the existing mine tunnel entrance. Neither structure is currently in use by WCL. Several microbat species have previously been recorded utilising these structures including the threatened Large Bent-winged Bat (vulnerable, BC Act), Large-eared Pied Bat (Vulnerable, BC Act and EPBC Act) and the Little Bent-winged Bat (vulnerable, BC Act). Therefore, these four species have been assumed present within the subject land.

Direct impacts arising from the proposed modification within the subject land at the Wongawilli Pit Top include:

- removal of 0.01 ha of modern condition PCT 906 Illawarra Escarpment subtropical rainforest consistent with the TEC Illawarra Subtropical Rainforest in the Sydney Basin Bioregion (Endangered, BC Act, Critically Endangered, EPBC Act);
- removal of 0.02 ha of low condition PCT 1245 Illawarra Escarpment Blue Gum wet forest;
- removal of 0.03 ha of vegetation considered to be foraging and breeding habitat for three threatened microbat species. Large-eared Pied Bat, Large Bent-winged Bat and Little Bent-winged Bat; and
- removal of 0.03 ha of vegetation considered to be foraging habitat for Pink Robin.

These impacts will be permanent. Mitigation measures outlined in Section 7.8.5 will help to minimise the potential impacts to biodiversity values that remain present within the study area.

b NWMD

No direct impacts to biodiversity values will occur as a result of the proposed works within the proposed extension of NWMD.

ii Indirect impacts

A number of indirect impacts have been identified and assessed in the BDAR, and are outlined in Table 13 of Appendix L. Potential indirect impacts are outlined below.

- Inadvertent impacts on adjacent habitat or vegetation, including reduced viability of habitat and loss of breeding habitat:
    - Vegetation within the Wongawilli Pit Top is disturbed, and does not provide high quality fauna habitat. The subject land lacks large hollows that would be suitable habitat for roosting owls such as Powerful Owl or large mammals such as Spotted-tailed Quoll. No aquatic habitat was recorded within the subject land, and thus presence of threatened frog species such as Littlejohn's Tree Frog or Red-crowned Toadlet was considered unlikely. Furthermore, no banksias, bottlebrushes or other high quality feeding species were recorded within the subject land that might provide foraging habitat for mammals such as Eastern Pygmy Possum. A comprehensive assessment of the likelihood of occurrence of each potential species credit species is provided in Appendix L.

- Nevertheless, inadvertent impacts on adjacent habitat or vegetation at the Wongawilli Pit Top may occur as a result of the proposed works, including increases in noise, dust, vibration, light and human traffic during construction and operation.

- The removal of vegetation and construction of a coal conveyer within a larger patch of retained vegetation has the potential to result in reduced viability of habitat in this area. Impacts will be in the form of noise, dust or light spill associated with both the construction and continued operation of the proposed conveyor, impacting habitat quality for resident fauna such as birds, bats and small mammals.

- As the proposed conveyor will be installed adjacent to the old gantry and tumbler house, which provides potential threatened microbat roosting and breeding habitat, there is potential for reduced viability of this habitat due to noise or light spill, both during construction and operation of the proposed conveyor.

- Appropriate mitigation measures are provided in Section 7.8.5. While mitigation measured during construction are detailed in Section 7.8.5, ongoing measures will be required in order to protect the viability of the habitat for the threatened microbat population. Impacts are expected to be minimised through the implementation of a CEMP and an Operation Environmental Management Plan (OEMP) detailing best practice environmental protection measures. Mitigation measures undertaken to reduce some of the impacts will include the installation of noise barriers during conveyor construction, as well as the measures outlined in Table 7.25 and Table 7.26.

- No impacts on habitat or vegetation are predicted as a result of works within the proposed extension of NWMD.

• Reduced viability of adjacent habitat due to edge effects:

  - Vegetation within the Wongawilli Pit Top footprint is disturbed, and contains several weed species including Crofton Weed, Cape Ivy, Lantana, Pellitory and Madeira Winter Cherry. Edge effects can be seen at the eastern and western edge of the study area through presence of Lantana and absence of canopy species (refer Figure 7.31). Due to the removal of 0.03 ha of vegetation in a strip running from the eastern to western edge of the study area, there is potential for reduced viability of the surrounding vegetation due to further edge effects, including weed encroachment and spread. Mitigation measures, such as continued weed treatment and monitoring, have been provided in Section 7.8.5.

  - No vegetation is proposed to be removed from the study area within the proposed extension of NWMD and thus no edge effects are likely.

• Transport of weeds and pathogens from the site to adjacent vegetation:

  - As already noted, there are a number of weed species present within the subject site. As the vegetation to be retained is in similar condition, increased transport of pathogens and weeds is unlikely to occur. Regardless, measures to ensure adequate control of weeds and pathogens will be detailed and managed by biosecurity measures outlined in the CEMP and OEMP.

  - No transport of weeds is predicted as a result of works within the proposed extension of NWMD.

- Increase in pest animal populations:
    - The study area and surrounds likely support several pest animal species including the Red Fox and Feral cats and several species of deer. The OEMP will detail monitoring and management measures to ensure that the presence of such species does not increase due to the ongoing operation of the proposed conveyor. However, overall the removal of 0.03 ha of vegetation within a patch greater than 100 ha at Wongawilli Pit Top is unlikely to increase the presence of pest animal populations within the locality.
- Increased risk of fire:
    - Removal of 0.03 ha of vegetation within the subject land will involve the use of machinery within vegetation. While the risk of fire is considered unlikely, it could be catastrophic if it spread to surrounding bushland. This risk will be managed by implementing appropriate mitigation measures such as spark dampers, water spraying, or the close proximity of fire-fighting gear such as extinguishers.
    - Ongoing operation of the proposed conveyor within the study area after construction may also pose a small fire risk to surrounding bushland if a mechanical issue was to cause a spark. Fire-fighting equipment such as extinguishers will remain in close proximity to the proposed conveyor permanently. This will substantially reduce the fire risk that the proposed works might pose to the study area and surrounds.

iii Prescribed impacts

An assessment of prescribed impacts was undertaken for both the Wongawilli Pit Top and the proposed extension of NWMD. The assessment considered potential impacts to karsts, caves, crevices and cliffs, rocky areas, human-made structures, non-native vegetation, connectivity, movement of threatened species, water quality, water bodies and hydrological processes, wind turbine strikes and vehicle strikes.

Overall, the assessment concluded that other than already identified impacts (refer Section 7.9.4i and Section 7.9.4ii) no other impacts are anticipated from the proposed modification.

iv Impacts to groundwater dependent ecosystems

The study area at the Wongawilli upper Pit Top is partially mapped as supporting Groundwater Dependent Ecosystems (GDEs) on the Groundwater Dependent Ecosystem Atlas (GDEA) (BOM 2019) due to the presence of Subtropical Complex Rainforests (recorded as PCT 906 during the field investigation). However, no changes to groundwater are predicted as a result of the proposed works at the Wongawilli upper Pit Top.

Likewise, the study area within the proposed extension of the NWMD is partially mapped as supporting GDEs on the GDEA due to the predicted presence of PCT 1250 within the vegetated peninsula in the centre of the study area (BOM 2019). However, the field investigation undertaken by Biosis confirmed that the vegetation in this area was not Coastal Sandstone Gully Forest but was instead PCT 1083 - *Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion* and PCT 878 - Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion.

Due to the inconsistency between GDEA mapping and the vegetation mapped during the field investigation, the presence of GDEs was instead determined using the *Risk assessment guidelines for groundwater dependent ecosystems – Appendix 4: inferring groundwater dependency* (DPI 2012). Using this document, it was determined that all PCTs mapped as present within the Additional Driveage are groundwater dependent, with the exception of PCT 1083.

In particular, in the north east portion of the Additional Driveage, PCT 1804 - *Needlebush - Banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin* was recorded, and is consistent with the TEC *Coastal Upland Swamp in the Sydney Basin Bioregion* (Endangered, BC Act and EPBC Act). This PCT is considered to be particularly groundwater dependent.

The project groundwater assessment concluded that there is no potential for any surface water or groundwater impacts as a result of the proposed Additional Driveage (SLR 2020), while the project geotechnical report similarly concluded that there is no potential for any perceptible surface subsidence impacts as a result of the proposed Additional Driveage (SCT 2020). It also concluded that inflows from Lake Avon into the proposed underground roadways is unlikely. As such no impacts to GDEs are expected to occur as a result of MOD2.

Four serious and irreversible impacts (SAIIs) have been identified as having potential to occur as a result of the proposed works. These are:

- removal of 0.01 hectares of *Illawarra Subtropical Rainforest in the Sydney Basin Bioregion* (Endangered, BC Act, Critically Endangered EPBC Act);
- removal of 0.03 hectares of breeding habitat for Large-eared Pied Bat;
- removal of 0.03 hectares of breeding habitat for Large Bent-winged Bat; and
- removal of 0.03 hectares of breeding habitat for Little Bent-winged Bat.

SAII assessments have been prepared for each of these entities, and are provided Appendix 6 of Appendix L.

v Impacts to native vegetation (ecosystem credits)

The offset requirement for the proposal was calculated using the BAM calculator. Table 7.23 provides a summary of the ecosystem credit offsets required for impacts from proposed works at the subject land.

Table 7.23 Offsets required for the proposed works (ecosystem credits)

Vegetation zone	Vegetation	Area (ha)	Impact	Vegetation integrity score	Offset required?	Credit Requirement
VZ1	PCT 906 - moderate	0.01	Clearance	64.8	Yes	1
VZ2	PCT 1245 - low	0.02	Clearance	40.2	Yes	1

vi Impacts to threatened species (species credits)

The offset requirement for the proposal was calculated using the BAM Calculator. Table 7.24 provide a summary of the species credit offsets required for impacts from proposed works at the subject land.

Table 7.24 Offsets required for the proposed works (species credits)

Vegetation zone	Species	Habitat condition (vegetation integrity score) loss	Area (ha)	Biodiversity risk weighting	Credit requirements
VZ1	Large-eared Pied Bat	64.8	0.01	3	0
	Large Bent-winged Bat	64.8	0.01	3	0
	Little Bent-winged Bat	64.8	0.01	3	0
	Pink Robin	64.8	0.01	2	0
VZ2	Large-eared Pied Bat	40.2	0.02	3	1
	Large Bent-winged Bat	40.2	0.02	3	1
	Little Bent-winged Bat	40.2	0.02	3	1
	Pink Robin	40.2	0.02	2	0

vii Assessment against biodiversity legislation

The BDAR assessed the impacts of the proposed works in accordance with the EPBC Act, and other relevant legislation (refer Chapter 10 of Appendix L).

In accordance with the EPBC Act, it was concluded that Matters of National Environmental Significance (MNES) are not likely to be significantly impacted by the proposed works and as such, a referral of the project to the Commonwealth is not required.

7.8.5 Mitigation measures

i Wongawilli Pit Top

The BDAR recommends reducing impacts on biodiversity values within the study area by avoiding and/or minimising the removal of native vegetation and fauna habitat. Steps undertaken to avoid and minimise impacts to biodiversity are broken down into site selection and planning, construction and operation phases of the proposed modification.

a Site selection and planning

The location of the proposed conveyor to be installed is necessary to connect the conveyor portal to the existing infrastructure at the Wongawilli Colliery. The reutilisation of infrastructure at the Wongawilli Colliery minimises impacts to native vegetation and flora and fauna habitats present within the broader study area, by avoiding construction of completely new infrastructure.

b Construction

Mitigation measures recommended to avoid and minimise further indirect impacts to vegetation and habitat during the construction phase of the proposed works include:

- installation of appropriate exclusion fencing around trees and vegetation to be retained in the study area;
- installation of appropriate signage such as 'No Go Zone' or 'Environmental Protection Area';
- identification of the location of any 'No Go Zones' in site inductions and a Construction Environmental Management Plan (CEMP);

- all material stockpiles, vehicle parking and machinery storage will be located within cleared areas or areas proposed for clearing, and not in areas of native vegetation that are to be retained;
- proposed hollow-bearing tree to be removed should be placed in the area of retained vegetation to provide additional fauna habitat;
- removal of the hollow-bearing tree should be supervised by a qualified ecologist;
- where appropriate native vegetation cleared from the subject land should be mulched for re-use on the site, to stabilise bare ground;
- wet down areas to reduce dust generation during construction;
- implementation of temporary stormwater controls during construction and to ensure that discharges to the drainage channels are consistent with existing conditions; and
- sediment and erosion control measures should be implemented prior to construction works commencing (eg silt fences, sediment traps), to protect current drainage channels. These should conform to relevant guidelines, should be maintained throughout the construction period and should be carefully removed following the completion of works.

Table 11 and Table 12 of Appendix L outline detailed mitigation measures to be undertaken by WCL in order to minimise any impacts to potential threatened microbats utilising the old gantry and tumbler house or the existing mine tunnel entrance, as a result of works associated with the proposed modification. Some of the management measures are outlined below.

The following measures are recommended for impacts associated with the construction of coal conveyor adjacent to a potential roosting and breeding structures for threatened microbats.

Table 7.25 Impact management and mitigation strategies for the old gantry and tumbler house structures

Impact	Environmental management measures	Timing	Responsibility
Construction of coal conveyor adjacent to a potential roosting and breeding structures for threatened microbats	A microbat survey is to be undertaken during the day prior to the commencement of construction of the proposed conveyor. All potential habitat is to be inspected to confirm if microbats are present.	Pre-construction	Project Ecologist, Environmental Manager
	A detailed schedule of management, monitoring and mitigation measures specific to the construction phase of the project will be implemented in the CEMP.	Pre-construction	Project Ecologist, Environmental Manager
	Appropriate noise barriers are to be installed between the proposed conveyor and the old gantry and tumbler house before the start of construction, ensuring not to impede movement of microbats in and out of the structure.	Pre-construction	Environmental Manager, Contractors
	It will be ensured that any staff that are required to undertake works within the vicinity of the structure are briefed on the importance of minimising disturbance to the structure and any potential resident microbats.	Pre-construction	Environmental Manager, Site Foreman, Contractors
	Any necessary lighting required for the proposed works will be directed away from the structures, and designed such that light spill does not occur within retained vegetation.	Construction	Environmental Manager, Contractors

Table 7.25 Impact management and mitigation strategies for the old gantry and tumbler house structures

Impact	Environmental management measures	Timing	Responsibility
	WCL will maintain appropriate exclusion zones around the structures, and manage any night works by ensuring noise and light pollution is kept to a minimum, particularly through the breeding and lactation period (October and March) in the vicinity of the identified microbat habitat.	Construction, operation	Environmental Manager, Contractors
	If it is identified that bats are present in torpor within the structure, fortnightly winter monitoring should be conducted during any upgrades or maintenance works to ensure that over-wintering roosting colonies are not being adversely impacted.	Construction, operation	Project Ecologist
	Unexpected finds and stop works procedures are to be implemented if microbats are observed exiting the structure during construction.	Construction	Environmental Manager and Site Foreman
	Any permanent lighting required for operation of the proposed conveyor will be designed to be directed away from, and avoid light spill into, the structure and any retained vegetation.	Operation	Environmental Manager
	Permanent noise barriers will be constructed between the conveyor and the microbat structure, to minimise noise or vibration disturbance to resident microbats.	Operation	Environmental Manager
	The structure will be designated as a permanent no-go-zone to avoid disturbance to microbats from increased foot traffic in the vicinity.	Operation	Environmental Manager

Table 7.26 Impact management and mitigation strategies for the existing mine tunnel entrance

Impact	Environmental management measure	Timing	Responsibility
Reutilisation of the existing mine tunnel entrance that provides potential roosting and breeding habitat for threatened microbats	A pre-clearance survey is to be undertaken during the day in September or October, when individuals from all microbat species concerned would have returned to their breeding habitat prior to the breeding season. All areas with the potential to support microbat habitat within the existing mine tunnel entrance will be inspected.	Pre-construction	Project Ecologist, Environmental Manager
	If threatened microbats are not located during pre-clearance		
	All potential habitat found not to support microbats during pre-clearance surveys and considered likely to be impacted by the proposed works is to have temporary exclusion measures installed to prevent microbats from moving in before works begin. These measures are to be installed immediately following the pre-clearance survey, to ensure microbats do not move into the habitat overnight. Exclusion measures may include: • thick tape (such as bitumen tape) or plywood installed over habitat; • expanding foam to remove cracks and gaps that may be utilised by microbats; and • sealing of all side entrances that connect the existing tunnel to other inactive sections of the adit system, including the old gantry and tumbler house. Sealing off these entrances will ensure that microbats are able to continue utilising inactive adit structures, without exposure to works within the exiting tunnel entrance. Exclusion measures are to be confirmed sufficient and effective by a qualified ecologist prior to works beginning. Any habitat not considered likely to be impacted by the works, for example permanently unused sections within the adit system are to remain available to any displaced microbats. This will include the installation of bat-friendly gates at any entrances to the system available to microbats. A detailed schedule of management, monitoring and mitigation measures specific to the construction phase of the project will be implemented in the CEMP.	Pre-construction	Project Ecologist, Environmental Manager

Table 7.26 Impact management and mitigation strategies for the existing mine tunnel entrance

Impact	Environmental management measure	Timing	Responsibility
	If non-breeding threatened microbats are located during pre-clearance		
	If microbats are found to be present in the existing tunnel entrance during the pre-clearance inspection, but are not likely to be utilising the structure as a maternity roost (ie no evidence of pregnant or lactating females), then temporary exclusion measures are to be installed overnight once the bats have left the roost to forage. Planned roost exclusion can only be conducted outside the breeding season (October – March) and over wintering time (mid-May to August) under the supervision of a qualified ecologist to ensure all microbats have vacated the roost. The following safeguards must be considered to minimise potential impacts to displaced bats: • ensure that this procedure is not conducted during an extensive dry period (drought) as this could be detrimental and lead to mortality, if there is no nearby suitable habitat; and • avoid conducting this procedure during windy, full-moon, cold or rainy nights (ie >20 mm in 24 hours), as there is a low likelihood of roost exodus. The most beneficial timing for planned roost exclusion is in autumn (mid-April – early May) and the start of spring (September). This would avoid both the breeding and overwintering period for microbats. If works and exclusion of roosting bats are required during the overwintering months (mid-May to August), when many culvert roosting bats enter torpor (hibernation state), the following additional safeguards must be adhered to: • nocturnal monitoring of roost activity is to be undertaken by a qualified ecologist, and bats must be confirmed as leaving the roost to forage on at least two separate occasions prior to installation of exclusion measures; • if bats are not confirmed as leaving the roost to forage (ie in winter torpor) additional monitoring is to be undertaken until regular foraging has resumed; and • works are not to impact upon the tunnel with bats present in winter torpor. Additional safeguards that must be considered when exclusion devices are installed include: • all roost exclusion should be done after dusk, once individuals have emerged to feed and an ecologist is satisfied no microbat individuals remain within the roost; and • roosting habitat that has been sealed must be regularly monitored to ensure the sealing mechanism remains intact and no microbats are able to utilise the habitat. If it is suspected that the exclusion mechanism has failed then an ecologist must re-inspect the habitat before the seal is reapplied. Alternative roosting habitat should be made or left available wherever possible when undertaking passive roost exclusion.		

Table 7.26 Impact management and mitigation strategies for the existing mine tunnel entrance

Impact	Environmental management measure	Timing	Responsibility
	If breeding threatened microbats are located during pre-clearance		
	Although unlikely, if threatened microbats are found to be present in the existing tunnel entrance during the pre-clearance survey, and appear to be in breeding condition (ie pregnant or lactating females, presence of young), any use of the tunnel will be immediately postponed and appropriately qualified ecologists will be consulted to determine the most appropriate steps to be taken. Appropriate approval authorities will also be notified. Maternity roosts are considered habitat critical to the survival of these species.		
	Reports are to be provided outlining the findings of pre-clearance assessments and detailing the exclusion measures installed and procedure (if required).	All works	Project Ecologist
	Unexpected finds and stop works procedure are to be implemented if microbats are observed within the existing tunnel during works.	Construction, operation	Site Foreman, Environmental Manager and Project Ecologist

c Operation

The following recommendations are made to avoid impacts resulting from 'operation' of the proposed works:

- Any lighting required around the facility should point towards the development and not into surrounding vegetated areas.
- On-going treatment of exotic species from within retained vegetation should be undertaken to assist vegetation resilience and quality.

7.8.6 Conclusion

Avoidance of impacts to native vegetation, threatened ecological communities and fauna habitat have been undertaken to restrict proposed direct impacts associated with the project to the removal of 0.01 hectares of PCT 906 (*Illawarra Subtropical Rainforest in the Sydney Basin Bioregion* (Endangered, BC Act, Critically Endangered, EPBC Act)) and 0.02 hectares of PCT 1245, and the habitat it supports on the subject land.

A total of two ecosystem credits are required to offset impacts to the two vegetation zones identified within the subject land.

No threatened fauna species were recorded at the subject land, however this assessment assumes the presence of four species credit species identified by the BAM calculator (Appendix 2 of Appendix L). These are the Pink Robin, Large-eared Pied Bat, Large Bent-winged Bat and Little Bent-winged Bat. Based on the impact area and biodiversity risk weighting (Section 7.8.4) attributed to these species, four species credits are required to offset impacts to fauna habitat. Mitigation measures to avoid direct impacts and mitigate potential indirect impacts to native fauna are provided in Section 7.8.5 of this report.

There were no threatened flora species recorded or assumed to be present within the subject land.

Matters of National Environmental Significance are not likely to be significantly impacted by the proposed works and as such, a referral of the project to the Commonwealth is not required.

If the mitigation measures provided in this report are implemented, there should be no further impacts to biodiversity values as a result of the proposed works, and the project can proceed as planned.

7.9 Historic heritage

7.9.1 Introduction

Biosis Pty Ltd (Biosis) prepared a heritage assessment and statement of heritage impact (SoHI) for MOD2.

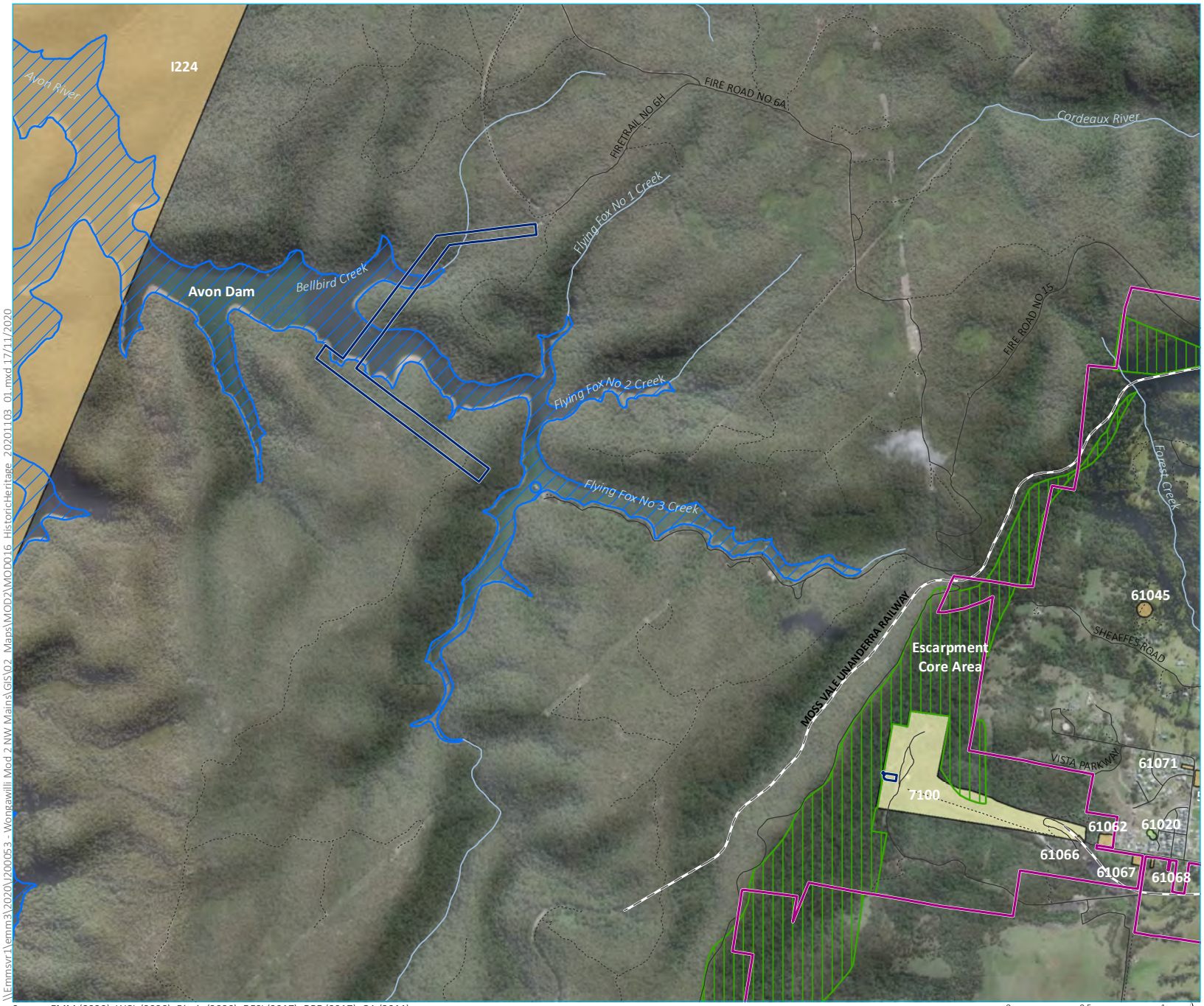
The report (Appendix M) was prepared in accordance with current heritage guidelines including *Assessing Heritage Significance*, *Assessing Significance for Historical Archaeological Sites and 'Relics'* and the *Burra Charter*.

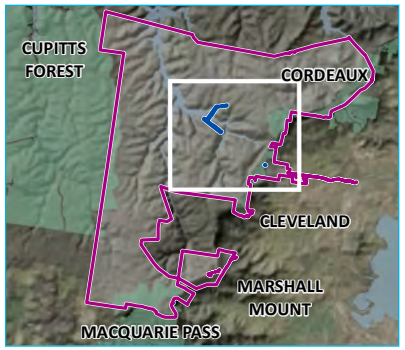
7.9.2 Historical context

The region is identified as having a long history of mining, in particular coal mining, which was first discovered in 1797 and increasing to ten or more collieries by World War I. Wongawilli township is identified as a company town which was established to service the Wongawilli Colliery in 1916.

Buildings and portals associated with the Colliery's pre 1960s mining operations are identified as the historic core of the site and includes the range of buildings at the southern end from the Dumper House (carpenter shop, old offices, bathrooms, lamp room, old fan room), the old workshops and blacksmith (now loco charging station and storage), garden beds, stone retaining walls, the man haulage, and the fire station.

Figure 7.33 depicts the heritage items identified at Wongawilli Colliery and their proximity to MOD2 works.





KEY

- Project application area
- Study area
- State heritage item

Local heritage item

- Item - Landscape
- Item - General
- Item - Archaeological
- Conservation area - Landscape

Existing environment

- Rail line
- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- NPWS reserve

Historic heritage items

Source: EMM (2020); WCL (2020); Biosis (2020); DFSI (2017); DPE (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

Wollongong Coal Limited
Modification assessment report
Figure 7.33

EMM creating opportunities

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7.9.3 Significance assessment

i Assessment approach

An assessment of heritage significance encompasses a range of heritage criteria and values. The heritage values of a site or place are broadly defined as the 'aesthetic, historic, scientific or social values for past, present or future generations'. This means a place can have different levels of heritage value and significance to different groups of people.

Heritage value and significance varies according to the value placed on a site by different groups. *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance* (Australia ICOMOS 2013) (the Burra Charter) characterises the heritage values in accordance with the following four significance values:

- Historical significance (evolution and association).
- Aesthetic significance (scenic/architectural qualities and creative accomplishment).
- Scientific significance (archaeological, industrial, educational, research potential and scientific significance values).
- Social significance (contemporary community esteem).

These values are used for heritage assessment by all state and Commonwealth agencies and were utilised by the NSW Heritage Office to identify the places of heritage significance located within the study area for MOD2.

ii Assessment

The heritage assessment and SoHI undertaken by Biosis did not identify any further historical or archaeological information which alters the existing identified significance of the Colliery, Avon Dam or the Illawarra Escarpment Landscape Conservation Area.

Table 7.27, below, provides a summary of the statement of significance for the listed heritage items. The full statements are provided in Table 5 of Appendix M, which lists the statements of significance for these sites as they appear in the State Heritage Inventory.

Table 7.27 Statements of significance for listed heritage items within the study area

Site number	Site name	Listings	Significance	Summarised statement of significance
7100	Wongawilli Colliery	Wollongong LEP 2009	Local	The Wongawilli Colliery is significant for its association with Wongawilli "Bank Book" Hill and Wongawilli Road residential areas, as evidence of the evolving relationships between mines, mining companies and their workers, and of the joint ownership of the mine and the associated steel industry.

Table 7.27 Statements of significance for listed heritage items within the study area

Site number	Site name	Listings	Significance	Summarised statement of significance
1358	Avon Dam	State Heritage Register, WaterNSW, Wingecarribee LEP 2010	State	Significant for its size and structure being still the second largest of all NSW storage dams in terms of capacity. Represents design qualities by Australia's leading water supply engineer of the time and includes 'strong Egyptian style architectural character'. Additional buildings and grounds, respectively, provide fine examples of interwar architecture and considerable aesthetic and social value.
-	Illawarra Escarpment Landscape Area	Wollongong LEP 2009	Local	

Biosis assessed what impacts MOD2 will have on heritage items listed within the study area, including buildings and infrastructure within Wongawilli Colliery, and adjacent the study area. Table 7.28 provides a summary of the Biosis assessment of the impacts of the proposed development on identified heritage items as assessed against the Heritage Manual guideline Statements of Heritage Impact (Heritage Office & DUAP 1996).

Table 7.28 Assessment of impacts to heritage items within or adjacent to the study area

Heritage item	Significance	Discussion	Assessment	Mitigation measures
Wongawilli Colliery	Local	The proposed works will involve the installation of an additional conveyor to connect the conveyor portal of the existing infrastructure. This will consist of two 5 x 7 m driveheads and a 2 x 63 m conveyor belt held up by pillars. The pillars will be located on a steep slope between the NWMD portal and the existing conveyor. The existing conveyor is part of a large complex of structures identified as B9 (Breaker Building and Transfer Bunker) in the CMP, which includes the belt conveyor that extends into the underground workings, the drive house, breaker building, transfer bunker, and associated structures. These were installed in 1959 along with the Decline Conveyor but altered in subsequent decades. B9 has little significance but associative archaeological significance. The CMP policy states that buildings and structures of associative significance need only be retained and conserved where required. No removal or demolition of the existing conveyor will occur; however, there will be some alternation to the fabric of B9, where the new conveyor connects to the existing conveyor. Furthermore, the proposed works are also in close proximity the Dumper House (B4), which has high significance and primary archaeological significance. Direct impacts may occur to this building due to the use and movement of machinery that could inadvertently damage the building.	Direct - partial	Archival recording Protection of Dumper House (B4) Unexpected finds procedure

Table 7.28 Assessment of impacts to heritage items within or adjacent to the study area

Heritage item	Significance	Discussion	Assessment	Mitigation measures
Avon Dam	State	The Additional Driveage part of the study area crosses the curtilage of the Avon Dam. As the driveage is being developed using the first workings mining method, no impacts are expected to the ground surface. Natural or seasonal variations in surface levels due to wetting and drying of soils are approximately 20 mm, and thus subsidence less than this can be considered no more than the variations occurring from natural processes, and should have negligible impacts on both natural and man-made surface infrastructure (CoA 2014, MSEC 2007, Hume Coal 2017). A geotechnical report provided by SCT Operations Pty Ltd (2020) confirmed this, with the geotechnical assessment concluding that there is no potential for any perceptible surface subsidence impacts as a result of the proposed Additional Driveage.	No impact	Unexpected finds procedure
Illawarra Escarpment Landscape Area	Local	The Wongawilli pit top part of the study area is adjacent to the curtilage of the Illawarra Escarpment Landscape Area; however, no works will occur within the curtilage. Temporary visual and noise impacts will occur during the proposed works but this will be resolved upon completion of the project and not result in any lasting impacts to the heritage item.	No impact	Unexpected finds procedure

Only the proposed minor changes to replace a portion of the Wongawilli upper pit top conveyor network has been assessed as having a direct - partial impact on heritage items. A partial impact represents a loss or reduction of heritage significance and are generally identified as minor impacts to a small proportion of a curtilage of an item or works occurring within the curtilage of a heritage item which may impact on its setting.

The existing conveyor is part of a large complex of structures identified as B9 in the Conservation Management Plan (CMP) and having associative archaeological significance. The CMP policy states that buildings and structures of associative significance need only be retained and conserved where required. As described in Section 3.2, minor section of conveyor will be removed and coal handling infrastructure relocated as such there will be some alternation to the fabric of B9 where the new conveyor connects to the existing conveyor.

In addition, the proposed works are also in close proximity the Dumper House (B4), which has high significance and primary archaeological significance. Direct impacts may occur to this building if construction works are not appropriately managed due to the use and movement of machinery that could inadvertently damage the building.

The Illawarra Escarpment Landscape Area is located adjacent to the Wongawilli pit top however any visual and noise impacts will be temporary in nature during construction and will not result in any lasting impacts.

Therefore, if the appropriate mitigation measures are employed, it is considered that the works associated with the NWMD modification are acceptable from a heritage perspective, and that any loss of heritage significance through the proposed works will be appropriately managed if the recommendations are followed.

7.9.4 Mitigation measures

The following mitigation measures will be implemented to minimise potential impacts to historic heritage sites associated with MOD2.

i Archival recording

A digital photographic archival recording of the Wongawilli Pit Top part of the study area will be undertaken prior to any works occurring. This is in accordance with Policy 12 of the CMP.

The archival recording will comply with the NSW Heritage Council guidelines *How to Prepare Archival Records of Heritage Items* and *Photographic Recording of Heritage Items Using Film or Digital Capture 2006.*

ii Protection of Dumper House (B4)

The existing fencing surrounding the Dumper House will be marked with high visibility bunting to further protect it from any possible damage during the construction of the new conveyor. This is in accordance with Policy 5 of the CMP.

iii Unexpected finds procedure

Any relics discovered during the construction will trigger the implementation of Wollongong Coals unexpected find procedure. Work in the vicinity of any unanticipated relic should cease and an archaeologist will be contacted to make a preliminary assessment of the find, including notification to the Heritage Council, if required.

7.9.5 Conclusion

The modification proposes no removal or demolition of local or State historic heritage sites however it will result in a 'direct – partial' impact against one heritage item identified by the NSW Heritage Council, being some alteration to the fabric of the Breaker Building and Transfer Bunker.

Mitigation measures will ensure that proposed works to and around identified local heritage sites, comprising minor alterations to the fabric of the Breaker Building and the Transfer Bunker or inadvertent damage to the Dumper House caused by use and movement of machinery is appropriately managed during construction.

MOD2 will have no impacts to the heritage value of the Avon Dam and Illawarra Escarpment Landscape Area.

7.10 Aboriginal heritage

7.10.1 Introduction

An Aboriginal Cultural Heritage Assessment (ACHA) was prepared by Biosis Pty Ltd for the proposed modification at Wongawilli Colliery (Appendix N).

The ACHA takes into consideration the proposed extensions to the NWMD and proposed disturbance at the Wongawilli Upper Pit Top, which is referred to as the study area and shown in Figure 7.34

7.10.2 Assessment Approach

The Colliery has previously been assessed for Aboriginal heritage as part of the application for the original consent. As there is a potential for the proposed modification to disturb areas that are not currently disturbed by mining activities, an ACHA was undertaken to determine if Aboriginal objects will be harmed by the proposed modification and determine appropriate mitigation and measures should they be required.

The ACHA and Archaeological Report (AR) contained within, document the findings of the archaeological investigations and consultation conducted. As required under Section 2.3 of The *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010a) (the Code), the AR annexed to the ACHA provides evidence about the material traces of Aboriginal land use to support the conclusions and management recommendations. The ACHA consists of:

- consideration of the environmental context of the site and surrounds to assess the likelihood of Aboriginal objects or places being present;
- consideration of existing regional and local Aboriginal cultural heritage studies;
- a search of Aboriginal Heritage Information System (AHIMS) database to identify whether registered Aboriginal sites are present within the site;
- a site inspection by a Biosis archaeologist accompanied by RAP representatives to identify if any Aboriginal objects or areas of potential archaeological deposit (PAD) are present or likely to occur within the site;
- a record of consultation undertaken with Registered Aboriginal Parties (RAPs) and relevant agencies;
- an assessment of Aboriginal cultural and archaeological significant of the study area; and
- determination of whether further heritage investigation and impact assessment are required.

7.10.3 Existing Environment

i Land use history

Early European land use in the vicinity of the Colliery consisted of forestry and extractive industries. Forestry along the escarpment commenced in the early 1800's, with coal mining commencing in the region from 1849. Coal mining in the area resulted in significant industrial development in the Illawarra region. Since this time large portions of land surrounding the Colliery have been declared a state catchment area. The catchment area was subject of a large state infrastructure project known as the Upper Nepean Scheme (Water NSW 2015). This scheme sought to increase the State's water supply during the 1920s. Following the catchment are being declared no further forestry was undertaken in the catchment, whilst underground mining has continued.

Since 1916 the Colliery has continued to be operated as underground coal mine, supply largely metallurgical coal to a number of markets over time.

ii Ethnohistory

The Illawarra region is the traditional land of the Wodi Wodi, a group of people who spoke a variant of the Dharawal language (Wesson 2009). The area occupied by this group extended from Botany Bay down the coast to around Nowra. To the north of the Wodi Wodi, the Darug are identified, to the west are the Gundangurra, and in the south the Thoorga (Dhauga) are identified (Tindale 1974). The areas inhabited by each of the groups are considered to be indicative only and would have changed through time and may have been dependent on certain circumstances (ie availability and distribution of resources). Interactions between different types of social groupings would have varied with seasons and resource availability. Traditional stories tell of the arrival of the Wodi Wodi to Lake Illawarra, bringing with them the Dharawal or cabbage tree palm from which their language is named (Wesson 2009, p.5). Analysis of middens in the region has provided dates of occupation dating back 6000 to 7000 years on the coast and at Lake Illawarra, and it is accepted that Aboriginal occupation of the south coast dates to around 20,000 years ago (AMBS 2006).

The Illawarra escarpment, named Merrigong, has great symbolic and historical importance for local Aboriginal people and has a number of named mountains. These include Wonga (Wongawilly), meaning native pigeon, Djera (Keira), meaning wild turkey, and Kembla derives from either Jum-bulla, meaning wild game abundant or plenty of game, or from Djembla, meaning wallaby (Wesson & OEH 2005). Aboriginal creation stories express the deep cultural and physical connections between the people and their environment. High places are generally culturally important and were an important area for ceremonial practices and a rich source of food, medicine and other resources (NPWS 2018).

The first recorded contact between Aboriginal and European peoples occurred in 1770, when Captain Cook sailed down the east coast of Australia in the Endeavour and observed cook fires and Aboriginal people carrying canoes along the coast (Organ 1990). The next recorded contact occurred in 1796, when Flinders and Bass travelled along the coast in the Tom Thumb. Organ (1993) also notes an expedition from Jervis Bay by George William Evans, in which the expedition met several groups of Aboriginal people on the way through the Wollongong area in 1812.

iii Desktop assessment

A large number of cultural heritage surface (surveys) and sub-surface (excavations) archaeological assessments have been conducted within the regional and local area surrounding the Colliery. Archaeological assessments are summarised in Section 3.2 of the ACHA (refer Appendix N).

Regional and local archaeological studies have shown extensive use of the Woronora Plateau and Illawarra escarpment. A variety of archaeological evidence such as stone artefacts, grinding grooves, modified trees rock shelters with art and deposit as well as stone arrangements show complex social systems and use of the region. Regional and local archaeological studies have shown extensive use of the Woronora Plateau and Illawarra escarpment.

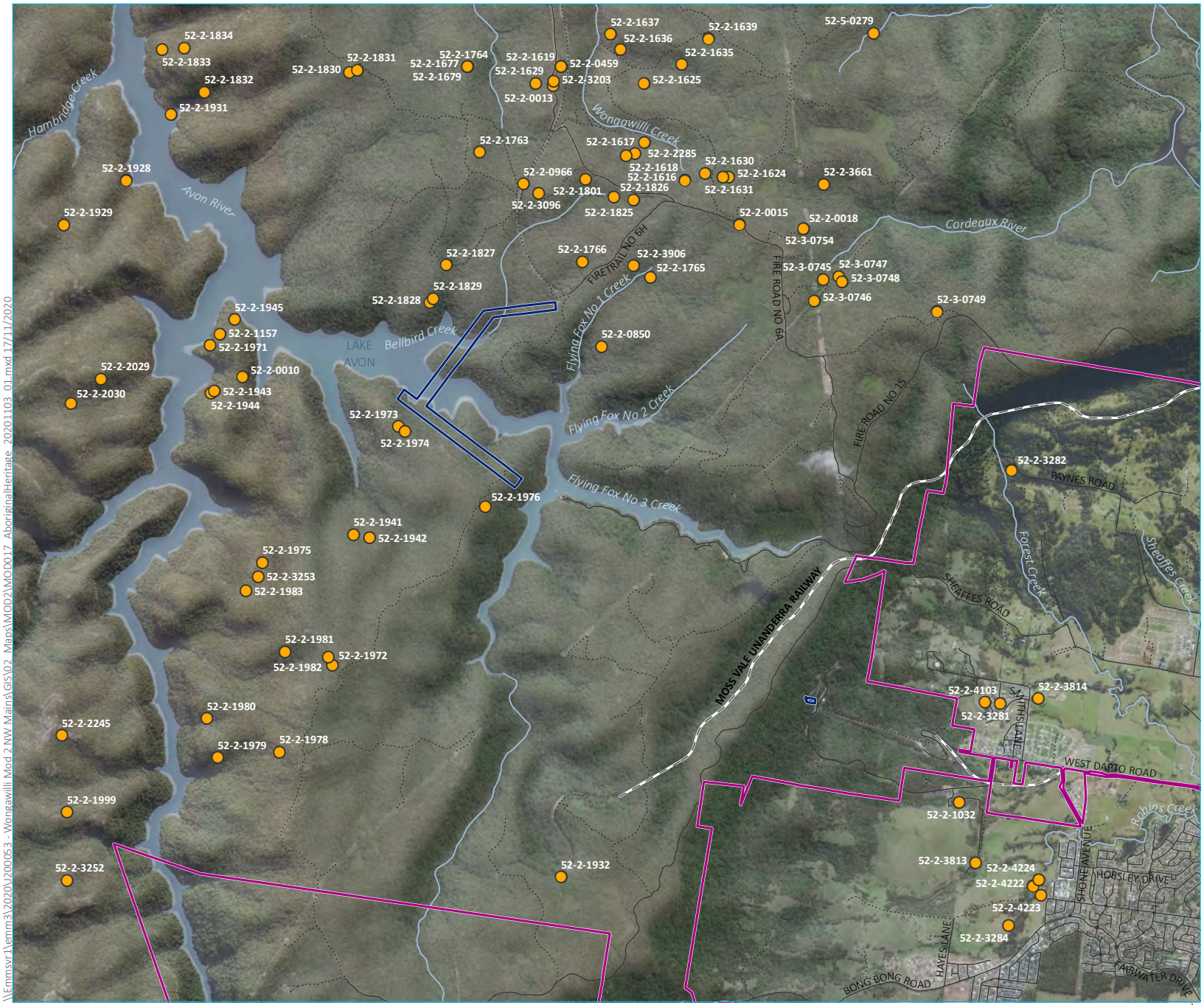
iv AHIMS site analysis

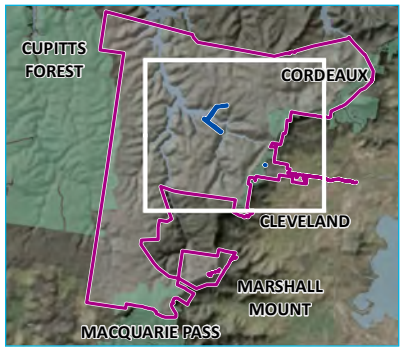
A search of the AHIMS database (Client Service ID: 511747) identified 87 Aboriginal archaeological sites within a 2 by 2 kilometre search area, centred on the study area. None of these registered sites are located within the study area (see Figure 7.34). AHIMS search results are included within Appendix N.

Table 7.29 provides the frequencies of Aboriginal site types in the vicinity of the study area. Some recorded sites consist of more than one element, for example art and potential archaeological deposit (PAD); however, for the purposes of this breakdown and the predictive modelling, all individual site types will be studied and compared. This explains why there are 104 results presented here, compared to the 87 sites identified in AHIMS.

Table 7.29 AHIMS results

Site Type	Number of Occurrences	Frequency (%)
Art (pigment or engraved)	47	45.19
Artefact	25	24.04
Grinding groove	15	14.42
PAD	14	13.46
Stone arrangement	3	2.88
Total	**104**	**100**





KEY

- AHIMS record
- Project application area
- Study area

Existing environment

- Rail line
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- NPWS reserve

Source: EMM (2020); WCL (2020); Biosis (2020); DFSI (2017); DPE (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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AHIMS sites in the vicinity of the study area

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Figure 7.34

EMM creating opportunities

7.10.4 Consultation

The Aboriginal community was consulted regarding the heritage management of the project throughout its lifespan. Consultation has been undertaken as per the process outlined in the DECCW document, *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010b) (consultation requirements). The appropriate government bodies were notified, and advertisements placed in the Illawarra *Mercury Newspaper* (16 June 2020), which resulted in 12 Aboriginal organisations registering their interest.

A search conducted by the Office of the Registrar, *Aboriginal Land Rights Act 1983* (NSW) listed no Aboriginal Owners with land within the study area. A search conducted by the NNTT listed no Registered Native Title Claims, Unregistered Claimant Applications or Registered Indigenous Land Use Agreements within the study area. There was one unregistered Claimant Application within the study area, South Coast Peoples (NC2017/008).

Upon registration, the Aboriginal parties were invited to provide their knowledge on the study area and on the proposal provided in methodology documents.

Site officers from elected RAPs participated in the field investigation and provided comment on the study area with regard to the proposal. A record of consultation undertaken is provided in Section 4 of Appendix N.

7.10.5 Archaeological Investigation

A field survey of the study area was undertaken between 31 August and 2 September 2020 by Samantha Keats (Consultant Archaeologist), Matthew Tetlaw (Research Assistant), Byron Dale (Field Assistant), James Davis (Wodi Wodi Traditional Owner), and Paul Cummins and Kayla Williamson (Woronora Plateau Gundangara Elders Council).

i Sampling strategy

The sampling strategy was informed by previous archaeological work within the region, the survey methodology involved targeted survey of known landforms of archaeological sensitivity in order to re-locate previously recorded Aboriginal archaeological sites and to systematically survey the study area for new Aboriginal sites.

ii Survey methods

The archaeological survey was conducted on foot via means of a meandering foot transect with a field team of four members, identified in Section 7.10.4. Recording during the survey followed the archaeological survey requirements of the Code and industry best practice methodology. Information that recorded during the survey included:

- Aboriginal objects or sites present in the study area during the survey;
- survey coverage;
- any resources that may have potentially been exploited by Aboriginal people;
- landform;
- photographs of the site indicating landform;
- evidence of disturbance; and
- Aboriginal artefacts, culturally modified trees or any other Aboriginal sites.

iii Archaeological survey results

The survey was conducted across two landforms, steep hills and steep low hills. These landforms were targeted on the basis of dense vegetation across most of the study area and limited access to some cliff lines. Poor ground visibility obscured the ability to identify potential artefact scatters, however, shelters and rock platforms were easily detectable.

The field team did not detect any Aboriginal sites or PADs within the study area and determined the archaeological potential of the entire study area to be low. Archaeological field surveys results are further defined in Appendix N.

7.10.6 Statement of significance

Site significance was assessed in accordance to:

- requirements of the Code;
- the Burra Charter; and
- the Guide to Investigating and Reporting Aboriginal Heritage.

The combined use of these guidelines is widely considered to represent the best practice for assessments of Aboriginal cultural heritage. The identification and assessment of cultural heritage values includes the four values of the Burra Charter: social, historical, scientific and aesthetic values. The resultant statement of significance has been constructed for the study area based on the significance ranking criteria assessed in Table 7.30.

Table 7.30 Significance assessment criteria

Site name	Criteria	Ranking
Wongawilli pit top	Cultural – discussions with the local Aboriginal communities reflect that the site is high in value	High
	Historical – the site is not connected to any historical event of personage	Low
	Scientific – the site possesses limited archaeological values	Low
	Aesthetic – the site has sustained significant disturbances associated with construction of the pit top and vent shaft	Moderate
Additional driveage	Cultural – discussions with the local Aboriginal communities reflect that the site is high in value	High
	Historical – the site is not connected to any historical event of personage	Low
	Scientific – the site possesses limited archaeological values	Low
	Aesthetic – the study area is relatively undisturbed and is a typical example of the Woronora Plateau in its natural context	High

7.10.7 Impacts and mitigation

As identified in Figure 7.34 there are no recorded Aboriginal sites within the study area to be impacted by the proposed modification. However, all RAPs noted the high cultural value of the Illawarra escarpment.

As Biosis has identified in Appendix N, the study area has been assessed as being of low potential for identification of any Aboriginal archaeological sites; however, have recommended in the unlikely event an item or items of Aboriginal historical significance should be discovered during the course of development the following protocols be followed:

- Recommendation 1: No further archaeological assessment is required - No further archaeological work is required in the study area due to the entire study area being assessed as having low archaeological potential.

- Recommendation 2: Discovery of unanticipated Aboriginal objects - All Aboriginal objects and Places are protected under the *National Parks and Wildlife Act 1974* (NPW Act). It is an offence to knowingly disturb an Aboriginal site without a consent permit issued by the Heritage NSW, Department of Premier and Cabinet (Heritage NSW). Should any Aboriginal objects be encountered during works associated with this proposal, works must cease in the vicinity and the find should not be moved until assessed by a qualified archaeologist. If the find is determined to be an Aboriginal object the archaeologist will provide further recommendations. These may include notifying Heritage NSW and Aboriginal stakeholders.

- Recommendation 3: Discovery of Aboriginal ancestral remains - Aboriginal ancestral remains may be found in a variety of landscapes in NSW, including middens and sandy or soft sedimentary soils. If any suspected human remains are discovered during any activity you must:

    1. Immediately cease all work at that location and not further move or disturb the remains.

    2. Notify the NSW Police and Heritage NSW's Environmental Line on 131 555 as soon as practicable and provide details of the remains and their location.

    3. Not recommence work at that location unless authorised in writing by Heritage NSW.

- Recommendation 4: The proponent should continue to consult with RAPs about the management of Aboriginal cultural heritage sites within the study area throughout the life of the project.

7.10.8 Conclusion

Biosis has undertaken background research and a survey of the study area as part of the ACHA to identify and characterise any potential Aboriginal heritage constraints within the study area, see Appendix N. No Aboriginal sites or areas of potential archaeological deposit were identified within the study area during the survey. As a result, the study area has been assessed with low archaeological potential to contain Aboriginal sites. No further archaeological investigation has been recommended. Wollongong Coal propose to implement the recommendations as outlined within the ACHA and noted above.

7.11 Social

7.11.1 Introduction

A social impact assessment (SIA) was prepared by EMM for MOD2 to identify the potential social impacts and opportunities, as well as appropriate measures for managing adverse impacts and enhancing potential benefits.

The report (Appendix O) was prepared in accordance with the *Social Impact Assessment Guidelines for State Significant Mining, Petroleum and Industry Development* (DPE 2017) (the SIA guidelines).

7.11.2 Assessment approach

i Overview

The SIA was informed by data collected as part of the social baseline, community consultation and engagement findings, findings from technical studies, previous SIA reports from the same regional area, academic research and relevant government and agency reports.

The local community was informed of the project via the establishment of a community information session, project website, a community survey, SIA email account, regular newsletters distributed by mailbox drop to the local area and via download from the project website, and CCC meetings. These forums provided updates to the community on the proposed project, environmental assessments and the planning and approvals process.

The engagement and consultation undertaken as part of MOD2 is outlined in Chapter 6 of Appendix O.

ii Methodology

The scope of the SIA has been developed in accordance with the social characteristics and community values of the Council, the Wollongong community and the SIA Guidelines. The SIA adopted the approach and principles supported by international and NSW best practice guidance documents. The key components of the SIA are:

- determining the area of social influence;
- compiling demographic and socio-economic characteristics of affected communities;
- review of literature and strategic planning context;
- consultation with local communities and key stakeholders (see agencies identified in Section 6.4);
- analysis of social impacts and evaluation of their significance; and
- development of mitigation and enhancement strategy to address impacts and opportunities.

The following data and information have been used to identify potential impacts and their associated risks:

- data collected as part of the social baseline;
- limited findings from the stakeholder engagement activities;
- findings from technical reports;
- previous SIA reports from the same regional area;

- academic research; and
- relevant government and agency reports.

7.11.3 Social baseline

i Area of social influence

The SIA identified two key areas of social influence, including:

- the local area, which is the primary area of social influence for MOD2 and is known as the Horsley – Kembla Grange Statistical Area 2 (SA2), encompassing the suburbs of Dombarton, Wongawilli, Huntley, Horsley, and Kembla Grange; and
- the regional area, which is the Illawarra Statistical Area (SA4) and includes potentially impacted communities such as Dapto, Wollongong (nearest major city), and Port Kembla.

The communities identified in the local and regional areas have the potential to experience change during the establishment and operation of the project.

ii Key findings

The social baseline analysis included the following key findings for communities within the area that could be influenced by MOD2.

According to the 2016 Census, the local area has a total population of 8,659 people (ABS 2016) and a 2019 estimated resident population of 10,154 (ABS 2020), an increase of 7.2%. From 2011-2016, the population of the local area increased by 16.7%. Overall, the local area experienced a much greater population percentage increase than the regional area (6.3%) and NSW (8.1%).

The median age of persons in the local area is 35, compared to 39 in the regional area and 38 in NSW.

Overall, the regional and local areas depend on the following three industries as the main industries of employment:

- health care and social assistance (15.3% in the local, and 14.7% in the regional area);
- retail trade (12.2% in the local and 10.1% in the regional area); and
- construction (8.9% in the local and 9.5% in the regional area).

While the regional and local industries do not differ greatly, the education and training industry is more prominent in the regional area (10.9%) and in NSW (8.4%) (refer Table A.32 of Appendix O). Mining accounts for 2.3% in the local area, 2.0% in the regional area and 0.9% of the NSW total.

In 2019, there were 377 registered businesses in the local area, none of which employed more than 200 employees. Of these registered businesses, 98.8% were classed as small businesses employing fewer than 20 people (ABS 2016). Most of the businesses in the local area were non-employing or employed 1 - 19 employees of which 15 businesses turned over $2M or more in 2019 compared to 927 in the Wollongong LGA.

Four major health risk factors that can be used as an indicator of physical population health are alcohol consumption, smoking, obesity, and asthma. The regional area population had a slightly higher percentage of the population who consumed alcohol at levels considered to be a high risk to health than NSW, at 16.2% and 15.5% respectively (PHIDU 2020). The percentage of the population in 2019 who smoke was above the state average. The percentage of people who are suffering from asthma is above the NSW average. There is also a higher rate of obesity among the regional population compared to NSW.

The number of properties for sale and rent in the local area indicate that the housing market in the area is tight, with minimal available properties to buy and very few to rent. Housing prices in the regional area have been steadily increasing from 2011-2017, with a dip in the market between 2017-2019, rising again in 2020. There has been an undersupply of rental housing in the local area.

The local area is not well serviced in terms of social infrastructure and services; however, most are accessible with minimal travel in the regional area. Residents within the local area have access to numerous childcare services, primary and secondary schools, and tertiary education institutions within the regional area.

The local area and regional area are located within the Illawarra Shoalhaven Local Health District. The closest public hospital service to the local area, offering the most comprehensive services, is Wollongong Hospital, with more than 500 beds.

Community services located in the regional area service the local area. These services are mainly concentrated in the suburbs of Wollongong.

The only emergency service within the local area is the Dapto Rural Fire Brigade in Wongawilli. The next closest emergency services are two additional Rural Fire stations and one NSW Ambulance station situated in Dapto, within the regional area.

The closest police station is also in Dapto and the closest State Emergency Service (SES) is in situated in Coniston, a 20-minute drive from Wongawilli.

As evidenced from the above social baseline (see full study in Appendix A of Appendix O), key vulnerabilities in the local area community relate to a high percentage of low-skilled workers, poor health indicators and lack of capacity in the housing and rental markets. Opportunities to remedy these vulnerabilities for the project may include improving upon or providing job training opportunities.

7.11.4 Summary of consultation

The Project attracted significant stakeholder and community interest as shown in the number of visits and visitors to the website (as detailed in Appendix O). In addition, interest was promoted by the multiple number of engagement activities described above (Section 7.11.2). However, the low number of responses to the online community survey and comparatively limited attendance to the CID mean the results of consultation are not representative of the community, who may or may not be in support of the Project. Those community members who attended the CID expressed support for the Project and those who raised concerns were against coal mining in general (voiced by members of Protector our Water Alliance) or based on misinformation about the Project and minimised upon further discussion with the Project team. A comparatively small number of community members that expressed concerns over the Project provided their feedback via the website and survey, as outlined in Appendix O. Impact assessment

The SIA conducted a social impacts and benefits assessment, by assessing the proposed change and likely consequences of MOD2 to the current social conditions experienced by the community, as well as the effectiveness of the proposed mitigation and management strategies.

A risk-based framework was adopted for the SIA, taking into consideration the findings from technical reports prepared for MOD2, as well as the perceptions of stakeholders identified from the Russell Vale Colliery.

The SIA acknowledges that assessment of social impacts is complex and as such requires the balancing of a range of factors and often competing interests. The SIA is reflective of this and has:

- assessed some aspects of MOD2 as both negative and positive as they relate to different groups of people;
- identified potential negative impacts and mitigation strategies on the local community while documenting the benefits to the broader region;
- considered the impacts on vulnerable groups and provided management strategies to ensure that any existing disadvantages are not exacerbated; and
- considered each community's access to critical resources, such as housing and health care, and how this affects their resilience.

The social impacts outlined in Table 7.31 have been assessed on a worst-case scenario initially and then the residual effect is assessed on the basis that mitigation and management strategies are successfully implemented.

A summary of assessment, using the social risk framework provided in Appendix B of Appendix O, is provided in Table 7.31.

Table 7.31 Summary of social risks attributed to MOD2

Impact	Description of social risk without mitigation	Affected parties	Duration	Extent	Unmitigated	Mitigated
Traffic and transport	Road delays due to increased traffic	Residents of the local area (particularly in housing estates off Wongawilli Road)	Construction and operation	Local area	Low – 6	Negligible -3
	Public safety from increased traffic	Residents in the local area	Construction and operation	Local area	Medium – 10	Low - 7
Groundwater	Access to groundwater	Groundwater users	Construction and operation	Local and regional area	Negligible- -1	Negligible – 1
	Impacts on livelihood from groundwater depressurisation	Groundwater users	Operation and post-operation	Local and regional area	Negligible – 1	Negligible - 1
Historic heritage	Loss of historic heritage	Residents of the local area	Construction, operation and past closure	Local area	Low – 6	Negligible – 5
Noise	Health impacts from noise	Neighbouring residents	Construction and operation	Immediate local area	High – 12	Low - 6
Noise	Amenity impacts from noise and vibration	Residents in the local area	Construction and operation	Local area	Medium – 8	Low – 6
Air quality	Health impacts from expelled dust	Neighbouring residents	Construction and operation	Immediate local area	Medium – 8	Negligible -2

Table 7.31 Summary of social risks attributed to MOD2

Impact	Description of social risk without mitigation	Affected parties	Duration	Extent	Unmitigated	Mitigated
	Health impacts from GHG emissions	Neighbouring residents	Construction and operation	Local area	Low – 6	Low – 6
Biodiversity	Loss of native species' habitats	Residents in the regional area/ potentially any environmentally concerned persons	Construction and operation	0.03 ha in the local area	Low – 6	Negligible -3

In addition to the above, the SIA also considered the cumulative impacts of MOD2. There are several concurrent development projects operating or intended to operate in and around the local area, including:

- Kembla Grange Resource Recovery Facility, which will involve the development of a waste collection, treatment and disposal centre; and
- the West Dapto (Horsley) Water Infrastructure project, which will involve the development of a sewerage collection, treatment and disposal infrastructure.

7.11.5 Mitigation measures

The proposed mitigation and management strategies for potential social impacts identified in Table 7.31 and outlined in Table 7.32.

Table 7.32 Summary of mitigation and management strategies for identified social risks

Impact	Description of social risk	Proposed mitigation and management strategies	Responsibility
Traffic and transport	Road delays due to increased traffic	Reduced hours of production on weekends and out of hours	Wollongong Coal
	Public safety from increased traffic	Council upgrades to Wongawilli Road (previously owned by the Colliery)	Wollongong City Council
Groundwater	Access to groundwater	No impact or mitigation required	-
	Impacts on livelihood from groundwater depressurisation	No impact or mitigation required	-
Historic heritage	Loss of historic heritage	Archival recording, high visibility bunting, and unexpected finds procedure	Wollongong Coal
Air quality	Health impacts from expelled dust	Dust suppression measures outlined in AQIA	Wollongong Coal
	Health impacts from GHG emissions	No impact or mitigation measures	Wollongong Coal

Table 7.32 Summary of mitigation and management strategies for identified social risks

Impact	Description of social risk	Proposed mitigation and management strategies	Responsibility
Biodiversity	Loss of native species' habitats	Actions to avoid or minimise impacts and offsetting one vegetation zone through the transfer and retirement of biodiversity credits or by paying into the BCT Offset Fund	Wollongong Coal
Noise	Amenity impacts from noise and vibration	Reduced out of hours operation and mitigation measures outlined in noise assessment	Wollongong Coal

It is proposed that a monitoring and management framework be developed to ensure that the identified social impacts are monitored over time to measure the effectiveness or otherwise of the proposed mitigation and management measures, including changing conditions and trends in the local and regional areas over the same period.

It is proposed that the monitoring and management framework identifies the following key aspects:

- track progress of mitigation and management strategies;
- assess actual project impacts against predicted impacts;
- identify how information will be captured for reporting to impacted stakeholders including landholders, communities and government on progress and achievements;
- key performance indicators, targets, and outcomes;
- identify responsible parties; and
- mechanisms for ongoing adaption of management measures when and if required.

To ensure the effectiveness of the management measures, it is recommended that a continuous improvement approach be adopted allowing for the review and adaption of impacts, management measure and outcomes.

7.11.6 Conclusion

The SIA concludes that the initiatives built into the project design, and the mitigation and management measures proposed to address increased traffic, historic heritage, impacts from noise, expelled dust, amenity and loss of native species' habitat, will minimise potential impacts to the local and regional communities.

7.12 Economic

7.12.1 Introduction

An economic assessment for MOD2 has been prepared by Gillespie Economics (Gillespie Economics 2020). The full report is included in Appendix P.

The economic assessment considers both:

- the efficiency of the project – ie the economic costs and benefits; and
- the impacts of the project – ie the effects that the project will have on local economy.

7.12.2 Assessment method

The economic assessment was carried out in accordance with relevant standards and guidelines as follows:

- *Guideline for the economic assessment of mining and coal seam gas proposals* (the Guidelines) (NSW Government 2015); and
- *Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW Government 2018).

Consistent with the above guidelines, two types of analysis were prepared in the economic assessment including:

- a cost benefit analysis (CBA), which assists with evaluating the net benefits of projects and policies, provides economic justification for a project and addresses the public interest; and
- a local effects analysis (LEA) to assess the impacts of MOD2 in the locality, specifically:
  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local economy.

The economic assessment was based on financial, technical and environmental advice provided by Wollongong Coal and EMM and was evaluated using two different scenarios, comprising MOD2 as a project of its own and an evaluation of MOD2 as a subcomponent of a larger future potential mining project (ie mining within the North West Domain, for which Wollongong Coal propose to seek future approval).

The NSW Treasury (2007, p33) notes

> A project may consist of a series of component parts. In such circumstances it is the evaluation of the larger project which is critical and it is essential that this be provided, not just an evaluation of the individual component part.

Consequently, MOD2 will provide access to the North West Domain and ensure continuity of mining operations, assuming that the North West Domain Project will require a 3-5-year period for application preparation, submission and determination.

7.12.3 Assessment criteria

Consistent with the NSW Government (2015), the quantification/valuation of benefits and costs was undertaken:

- in 2020 real values;
- with discounting at 7% and sensitivity testing at 4% and 10%; and
- with an analysis period in 7 years, comprising one year per MOD2, the MOD2 life and one year post MOD2.

Where competitive market prices are available, they have generally been used as an indicator of economic values. Environmental, cultural and social impacts have initially been left unquantified and interpreted using the threshold value method.

An attempt has also been made to estimate environmental, cultural and social impacts using market data and benefit transfer and incorporate them into an estimate of the net social benefit of MOD2.

7.12.4 Cost benefit analysis

i Overview

CBA is the method used to consider the economic efficiency of projects by providing a comparison of the present value of aggregate benefits to society, as a result of a project, with the present value of aggregate costs (ie the net benefit). Provided the present value of benefits to society exceed the present value of the costs, a development is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

CBA involves the following steps:

- identification of the base case (ie 'with' or the 'without the project' scenario), which for MOD2, the 'without the project' scenario would limit the Colliery operations to December 2020 and the Colliery would remain in care and maintenance, with required rehabilitation and decommissioning occurring thereafter;
- identification and valuation of the incremental benefits and costs;
- consolidation of value estimates using discounting to account for temporal differences;
- application of decision criteria;
- sensitivity testing;
- consideration of non-quantified benefits and costs; and
- consideration of the distribution of costs and benefits.

ii Identification of benefits and costs

The CBA of mining projects involves a trade off between:

- the net production benefit of a project to society, including royalties, company tax and net producer surplus and any economic benefits to existing landholders, employees and suppliers; and
- the environment, social and cultural impacts of the project, including net public infrastructure costs.

Relative to the base case, or "without" MOD2 scenario, MOD2 itself is associated with a number of production costs, such as opportunity costs, development costs and operating costs, that Wollongong Coal is willing to incur to establish access to the North West Domain and have continuity of future potential mining operations. These production costs are partially offset by the value of coal extracted, deferred rehabilitation and decommissioning requirements at the mine site, and the residual value of land and capital at the cessation of MOD2. In addition, there may potentially be some environmental, social and cultural impacts as a result of MOD2.

Furthermore, when MOD2 is considered as part of a larger project involving mining the North West Domain then net production benefits are likely to be positive, with royalties and company tax benefits accruing to Australia and NSW and net producer surplus benefits accruing to Wollongong Coal. These net production benefits also need to be considered in relation to the environmental, social and cultural impacts of the larger project.

The potential costs and benefits of the project are summarised in Table 7.33. However, it should be noted that if the potential externality impacts listed in the table are mitigated to the extent where community wellbeing is significantly affected, then no external economic costs arise.

Table 7.33 Potential and alternative economic benefits and costs of the project

Costs	Benefits
Potential incremental economic benefits and costs of MOD2	
Opportunity costs of land and capital	Deferred rehabilitation and decommissioning
Development costs	Sale value of coal
Operating costs, including administration, mining, processing, transportation, mitigation measures and offsets (but excluding royalties)	Residual value of land and capital at the cessation of MOD2
Environmental, social and cultural impacts	
Alternative frame of potential economic benefits and costs of MOD2	
Direct costs	**Direct benefits**
Nil	Net production benefits: • royalties; • company tax; • net producer surplus;
Indirect costs	
Environmental, social and cultural impacts	

The estimated costs of the project are described in detail in the economic assessment (refer Appendix P), and include:

- the opportunity cost of capital and land;
- capital cost of MOD2; and
- annual operating costs.

The production benefits of MOD2 (including estimated value of coal, royalties, deferred decommissioning and rehabilitation and residual value), and the environmental, social and cultural costs and benefits have also been quantified and are described in detail in Appendix P. The environmental, social and cultural costs and benefits accounted for include:

- the cost of obtaining surface and groundwater licences;
- costs related to GHG emissions;
- biodiversity offset related costs (estimated at $20,000); and
- groundwater WALs (assumed to be $2,000/ML ie $0.06M).

The economic assessment that there would be no net infrastructure costs to government, and no loss of surplus to other industries. Economic benefits to existing landholders and to suppliers are not included in the calculations.

MOD2 will provide additional employment for the regional and NSW economy. There are potentially wage benefits for these workers if wages received are in excess of their reservation wage. However, for the purpose of the economic assessment it is assumed that there are no wage benefits to workers.

Environmental, social and cultural impacts of MOD2 have been minimised through project design and mitigation, offset and compensation measures. Where mitigation measures have been identified, these have been included in the capital costs for MOD2, as indicated in the result of the CBA presented in Appendix P.

iii Results

MOD2 is estimated to have global net production benefit of $43.8M (present value at 7% discount rate). Wongawilli Colliery is 100% foreign owned, and therefore the components of the net production benefits that accrue to Australia are government royalties and company tax (assuming a 30% company tax rate). On this basis, the net production benefits of MOD2 that accrue to Australia are estimated at $11.1M (present value at 7% discount rate), comprising royalties of $2.9 M (present value at 7% discount rate) and a company tax deduction of - $14M, that can only be realised if there is positive taxable income from which it can be deducted. If it cannot be realised then the net production benefit to Australia is $2.9 M (present value at 7% discount rate).

These net production benefits can be further apportioned to NSW by assuming that company tax benefits/costs accrue to NSW based on its population share and that all government royalties accrue to NSW. On this basis, the net production benefits of MOD2, which accrue to NSW, are estimated at - $1.6M to $2.9M (present value at 7% discount rate) comprising royalties of $2.9M (present value at 7% discount rate) and a company tax deduction of - $4.5M, that can only be realised if there is positive taxable income from which it can be deducted. If it cannot be realised then the net production benefit to NSW is $2.9M (present value at 7% discount rate).

From Table 7.34 it can be seen that the main potential environmental, social and cultural impacts of MOD2 are immaterial from biophysical perspective and hence immaterial from an economic efficiency perspective. The externalities that were quantified, ie GHG emissions, opportunity cost of holding the required groundwater WALs, and biodiversity offset costs are also minor.

Table 7.34 Global costs and benefits (present value, 7% discount rate)

	Costs	$M	Benefits	$M
Production	Opportunity cost of land	$6.2	Deferred rehabilitation and decommissioning	$9
	Opportunity cost of land	$43.7	Revenue	$42.3
	Capital costs	$29.8	Residual value of land	$5.1
	Operating costs (ex royalties)	$56.2	Residual value of capital	$35.6
	Sub-total	***$135.8***	***Sub-total***	***$92***

Table 7.34 Global costs and benefits (present value, 7% discount rate)

	Costs	$M	Benefits	$M
			Global net production benefits	**- $43.8**
			Australian net production benefits	**-$11.1 to $2.9**
			NSW net production benefits	**-$1.6 to $2.9**
Externalities	Greenhouse gas emissions (Scope 1 and 2)	$0.02	Wage benefits to employment	Not quantified
	Operational noise	No material impact	Economic benefits to existing landholders	$0
	Road transport	No material impact	Economic benefits to suppliers	$0
	Air quality	No material impact		
	Groundwater	$0.06		
	Surface water	No material impact		
	Subsidence	No material impact		
	Biodiversity	$0.02		
	Aboriginal heritage	No material impact		
	Historic heritage	No material impact		
	Net public infrastructure costs	No material impact		

iv NSW cost and benefits

The economic assessment combined the results of Table 7.34 with Table 2.7 in Appendix P, to show the net social benefits of MOD2, by itself, to NSW. This indicates that MOD2 will have net social benefits to NSW of between -$1.7M and $2.8M (present value at 7% discount rate), depending on whether Wollongong Coal can realise the tax deduction that arises from MOD2.

v Consideration of the larger project

MOD2 is the first stage of a larger potential mining project involving mining in the North West Domain. For the purpose of the economic assessment, it was estimated that 375 Mt of in situ coal resource is potentially available to the Wongawilli Colliery (Clark 2017).

It is recognised that any subsequent stages would require a separate approval and that there is uncertainty in regard to obtaining approval. Notwithstanding, some indication of potential net production benefits to NSW of the overall project can be gained from making the following assumptions:

- ROM production of 2.1 Mtpa for 28 years commencing in five years' time;
- product coal recovery following washing of 80%;
- 100% hard coking coal;

- KPMG long term benchmark price for hard coking coal – USD137.2/t;
- KPMG long term AUD:USD exchange rate – 0.73; and
- various probabilities of project approval ranging from 30% to 100%.

Taking the above into consideration, potential expected value of royalty benefits from the larger project range between $57M and $191M (present value at 7% discount rate), depending on the assumed probability of obtaining project approval. This is a minimum benefit of the larger project as it does not include potential company tax benefits and wage benefits. Any residual environmental, social and cultural impacts of this larger project after mitigation, compensation and offset, would also need to be compared against the estimated production benefits and would be the subject of a future economic assessment.

vi Risk and sensitivity analysis

A sensitivity analysis of the various assumptions used in the CBA was undertaken for NSW by applying 4%, 7% and 10% discount rates for the following:

- opportunity cost of land;
- opportunity cost of capital;
- operating costs;
- capital costs;
- deferred rehabilitation and decommissioning costs;
- revenue;
- residual value of land;
- residual value of capital;
- greenhouse gas costs;
- groundwater costs; and
- surface water costs.

DPIE has previously identified that the financial viability of projects is a risk assumed by the project owners. Wollongong Coal is willing to incur a financial loss associated with MOD2 to facilitate access to the North West Domain and ensure continuity of mining operations. Any risk that MOD2 may commence and then cease operation for financial reasons leaving unmet rehabilitation liabilities is mitigated by the fact that Wollongong Coal is required to pay a rehabilitation security deposit to DPIE as the holder of a mining authority under the Mining Act. This security deposit is held by DPIE-DRE to ensure that the legal obligations in relation to rehabilitation and safety of the site can be met following mine closure. If rehabilitation obligations are not met to the satisfaction of the Minister, then the security funds would be used by DPIE-DRE to meet the relevant requirements.

The provision of biodiversity offsets can be associated with a number of risks, which are mitigated through offset ratio requirements in the provision of offsets and commitment to pay into the Biodiversity Conservation Trust Fund, whereby the offsets will be obtained and managed via the Biodiversity Conservation Trust.

This analysis indicates that CBA is most sensitive to changes in revenue (reflecting production levels, the value of coal in USD and the USD/AUD exchange rate) and to a lesser extent operating costs and capital costs. This is because changes in revenue directly impact royalties which is the main component of net production benefits to NSW. Changes in revenue also impact tax estimates.

However, sensitivity analysis indicated that the CBA results are not sensitive to changes in GHG costs, groundwater costs or biodiversity offset costs.

Under all scenarios examined, the net social benefits to NSW range from slightly negative to slightly positive depending on whether tax losses can be realised. This reflects the nature of MOD2 as an initial investment as a component of a larger future potential project.

7.12.5 Local effects analysis

Local Effects Analysis (LEA) compliments the CBA by translating effects identified at the NSW level to the potential impacts on the communities located near the MOD2 area.

For the LEA, the locality is defined as the Illawarra SA4, which includes the LGAs of Wollongong, Shellharbour and Kiama. This area is considered to be the main source of labour and non-labour inputs for MOD2.

MOD2 will employ up to 150 people on site at any one time, including direct employees and contractors. On an average annual basis, direct employment (ie employees, is estimated at 56). Based on historic employment data, 97% of these workers are expected to be sourced from the local area. The effects of MOD2 on regional activity were quantified with consideration of other wage impacts, housing impacts, and environmental and social impacts.

A summary of the local effects is outlined in Table 7.35.

Table 7.35 Summary of local effects

Item	Project direct	Project direct local	Net direct effect (with multiplier)
Local effects			
Average annual direct employment EFT	56	54	26
Net income ($M)			2.5
Non-labour expenditure in the Local Area	7.5		
Regional impacts	**Direct**	**Flow-on**	**Total**
Output ($M)	23	20	43
Value-added ($M)	9	11	19
Income ($M)	6	5	11
Employment	56	62	118
Other local economic impacts			
Contraction in other sectors	No material impact*		
Displaced activities	No material impact*		
Wage rise impacts	No material impact*		
Housing impacts	No material impact*		

Table 7.35 Summary of local effects

Item	Project direct	Project direct local	Net direct effect (with multiplier)
Local Environmental Impacts			
Greenhouse gas emissions (Scope 1 and 2)		$0.00	
Operational noise		No material impact*	
Road transport		No material impact*	
Air quality		No material impact*	
Groundwater		No material impact* - cost borne by Wollongong Coal	
Surface water		No material impact	
Subsidence		No material impact*	
Biodiversity		No material impact* cost borne by Wollongong Coal	
Aboriginal heritage		No material impact*	
Historic heritage		No material impact	
Net public infrastructure costs		No material impact	

* The Illawarra SA4 Local Area population is a small fraction of the NSW population. NSW GHG impact have been apportioned accordingly.

7.12.6 Conclusion

A CBA of MOD2, indicates net production benefits to NSW at -$1.6M to $2.9M (present value at 7% discount rate) comprising royalties of $2.9M (present value at 7% discount rate) and a company tax deduction of -$4.5M, that can only be realised if there is positive taxable income from which it can be deducted. If it cannot be realised then the net production benefit to NSW is $2.9M (present value at 7% discount rate). There will also be some additional externality costs ($0.1M, present value at 7% discount rate) associated with GHGs, biodiversity offsets and the opportunity cost of holding groundwater licences. Overall MOD2 is estimated to have net social benefits to NSW of between -$1.7M and $2.8M (present value at 7% discount rate).

However, from an economic perspective, MOD2 is part of a larger project involving mining in the North West Domain. The expected value of royalty benefits from mining in the North West Domain range from $57M and $191M (present value at 7% discount rate), depending on the assumed probability of obtaining project approval. This is a minimum benefit of mining in the North West Domain as it does not include potential company tax benefits and wage benefits. Any residual environmental, social and cultural impacts of this larger project after mitigation, compensation and offset, would need to be compared against the estimated production benefits. This will be the subject of a future economic assessment.

MOD2 will provide direct economic activity, including jobs, to the local area of Illawarra SA4, and indirect economic activity to the local area via both wage and non-wage expenditure. Environmental, social and cultural impacts of MOD2 to the local community are not expected to be material from an aggregate economic efficiency perspective.

8 Evaluation of merits

8.1 Introduction

A description of the need and justification for MOD2 is provided below with regard to biophysical, social and economic factors; the principles of ecologically sustainable development (ESD); and the consistency of MOD2 with the objects of the EP&A Act.

8.2 MOD2 impacts

This modification report assesses the potential impacts that may result from the MOD2. The assessment of environmental issues has been multi-disciplinary and involved consultation with DPIE and key stakeholders as outlined in Chapter 6 of this report.

MOD2 will not result in significant biophysical, social or economic impacts and MOD2 report has identified that any residual impacts can be appropriately managed.

8.3 MOD2 benefits

MOD2 will extend the life of the Colliery by five years, enable completion of the NWMD and prevent the sterilisation of a high-quality coal resource within Wollongong Coals mining tenements whilst utilising existing site infrastructure.

The first workings mining method proposed by the modification leaves pillars intact and the overlying strata fully supported. Ensuring no potential for the main heading development roadways (ie the approved NWMD and Additional Driveage) to cause perceptible surface ground movement or additional groundwater and surface water impacts to that currently approved.

This modification report has assessed and determined MOD2 will not results in any new significant biophysical, social and economic impacts. As such, the residual impacts can continue to be managed in accordance with the modified consent, updated mitigation measures and management plans which will be revised as part of MOD2.

MOD2 aligns with the strategic policies for the region, including the NSW Strategic Statement on Coal Exploration and Mining in NSW (DPIE - Division of Resources and Geoscience, 2020), and would assist the state to continue to meet predicted growing coal demand, particularly from Asian markets with the majority of coal production to be sold to JSPL's for steel and power generation.

The modification would allow for existing social and economic benefits of the Colliery to continue as a result of the extended mine life. Enable the employment of up to 150 FTE employees, while supporting local and regional suppliers. The modification would also provide stability and certainty to local and regional communities, contributing to negating possible social and economic impacts during a period financial hardship caused by COVID-19. Economic benefits would extend to state and national levels with ongoing royalty payments and export sales.

In addition, the modification will enable the continuation of a brownfield site in a long-established coal mining precinct. Minimal or no changes are proposed to a number of key aspects of the existing operations at the Colliery; in particular, there is no proposed increase in annual coal extraction volumes or water requirements, nor is perceptible subsidence predicted. Potential environmental impacts of the project, such as impacts in relation to traffic, air quality and noise are therefore expected to be much the same as that of the existing operations. Or as is the case with noise and traffic related impacts, reduced given mitigation and management measures documented within this report.

8.4 Ecological sustainable development

The overall objectives of ESD are to use, conserve and enhance natural resources. This ensures that ecological processes are maintained facilitating improved quality of life, now and into the future. Wollongong Coal are committed to the principles of ESD and understand that biophysical, social and economic objectives are interdependent.

Wollongong Coal acknowledge that well-designed and effectively managed operation will avoid significant and/or costly environmental impacts or degradation. With two coal mines in operations, up to date EPA licensing, Wollongong Coal understands the importance of maintaining ESD objectives on site and has extensive experience implementing ESD principles in all its development projects and assets.

The principles of ESD, for the purposes of the EP&A Act, are provided in Clause 7(A) of Schedule 2 of the EP&A Regulation. The four principles of ESD are:

- precautionary principle – the precautionary principle states that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- inter-generational equity – the principle of inter-generational equity is that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- conservation of biological diversity and maintenance of ecological integrity – the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
- improved valuation and pricing of environmental resources – improved valuation, pricing and incentive mechanisms should be promoted.

MOD2 has been designed to reduce impacts to a level which is as low as is reasonably practicable and which are generally in accordance with the impacts of the approved Colliery. Each of the four principles of ESD are considered further below.

8.4.1 Precautionary principle

This modification report has assessed the potential biophysical, social and economic impacts of MOD2, including detailed technical assessments of the key potential issues. The assessments have found that MOD2 will not result in any new significant biophysical, social or economic impacts and the residual impacts can continue to be managed in accordance with the modified consent, updated mitigation measures and management plans which will be revised as part of MOD2.

Wollongong Coal will continue environmental monitoring and to confirm that the impacts of MOD2 are in accordance with the predicted impacts. Environmental management measures will be reviewed and, where required, updated if any impacts are greater than assessed.

8.4.2 Inter-generational equity

Wollongong Coal will continue to undertake ongoing environmental monitoring with mitigation measures to provide effective environmental management across its operation. This management is provided through planning, communication, documentation, review and feedback. These environmental management measures ensure that the health, diversity and productivity of the environment is maintained or enhanced for future generations.

As described above the first workings mining method proposed by modification leaves pillars intact and the overlying strata fully supported resulting in perceptible ground movement. As a result, the modification would not obstruct future potential land uses, environmental outcomes or economic opportunities within the vicinity of the proposed mining activities.

Under the current conditions of its PA, the Colliery is approved to undertake mining operations until 31 December 2020, therefore in the absence of MOD2, it is likely that the approved NWMD and any future underground mining in the North West Domain (subject to a future separate planning process and full merit assessment) would not proceed. The mine would likely be rehabilitated in accordance with conditions under the PA. Should this occur, the economic and social benefits of the NWMD would not be realised, nor that of future potential mining activities. Restricting the ability for both current and future generations to benefit from the Colliery.

8.4.3 Conservation of biological diversity and maintenance of ecological integrity

The potential environmental impacts of MOD2 are detailed in this modification report. MOD2 is not expected to cause direct impacts to threatened species or endangered ecological communities. A BDAR has been undertaken with potential ecological impacts, mitigation measures and offset requirements summarised in Section 7.8 and attached in Appendix L.

8.4.4 Improved valuation and pricing of environmental resources

MOD2 will support the ongoing, efficient operation and supply of coal production from the Colliery and provide an economically viable pathway for Wollongong Coal to continue development of the approved NWMD. Furthermore, MOD2 allows for further assessment into the North West Domain which demonstrates an economically viable resource which would not be accessible without the proposed NWMD.

8.5 Conclusion

MOD2 has been designed to avoid and minimise adverse biophysical, social and economic impacts. MOD2 is anticipated to result in minimal environmental impacts beyond those previously assessed and approved under the consent. The residual impacts have been identified and assessed.

All aspects relating to environmental management will continue in accordance with the PA 19_0161 (as modified), EPL 1087, revised site management plans, and the mitigation measures consolidated in Appendix D.

MOD2 and 5 year extension to the operation of the Colliery will provide immediate and long-term benefits to the local community, region and State.

As the potential environmental impacts can be managed and mitigated with few residual impacts and there are a range of immediate economic benefits from extending the life of the mine through MOD2, Wollongong Coal are confident that MOD2 is in the public interest. MOD2 allows the best use of the approved Colliery and the site and presents an opportunity to meet ongoing coal demand without establishing a greenfield site. Rather, MOD2 will enable production from a brownfield site in a well-established coal mining region.

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Abbreviations

Abbreviation	Definition
µS/cm	Microsiemens per centimetre
mAHD	Australian Height Datum
AAQ NEPM	*National Environment Protection (Ambient Air Quality) Measure*
ABS	Australian Bureau of Statistics
AERMOD	Atmospheric dispersion modelling system
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal heritage impact permit
AQGHGMP	Air Quality and Greenhouse Gas Management Plan
AQIA	Air quality impact assessment
AQMS	Air quality monitoring station
BAM	Biodiversity Assessment Method
BC Act	NSW *Biodiversity Conservation Act 2016*
BCD	Biodiversity and Conservation Division
BDAR	Biodiversity development assessment report
BoM	Bureau of Meteorology
CBA	Cost benefit analysis
CCL	Consolidated coal lease
CHL	Commonwealth Heritage List
CMP	Conservation management plan
Colliery	Wongawilli Colliery
Council	Wollongong City Council
COVID-19	Coronavirus disease
DA	Development approval
DAWE	Commonwealth Department of Agriculture, Water and the Environment
Db	Dust deposition gauges
DDGs	Dust deposition gauges
DoEE	Australian Government Department of the Environment and Energy (DoEE)
DoI	Department of Industry
DPE	NSW Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
EA	Environmental assessment
EC	Electrical conductivity
ESD	Ecologically Sustainable Development
EMM	EMM Consulting Pty Limited

EIS	Environmental Impact Statement
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPA	NSW Environment Protection Authority
EPI	Environmental planning instruments
EPL	Environmental Protection Licence
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EP&A Regulation	NSW Environmental Planning and Assessment Regulation 2000
ESD	Ecologically sustainable development
FEL	Front end loader
FTE	Full time equivalent
GHG	Greenhouse gas
Gujarat NRE	Gujarat NRE Coking Coal Limited
Ha	Hectares
ICNG	*Interim Construction Noise Guideline*
IEA	International Energy Agency
IECA	Illawarra Escarpment Conservation Area
INP	*NSW Industrial Noise Policy*
IPC	Independent Planning Commission
JSPL	Jindal Steel and Power Limited
IS Regional Plan	Illawarra Shoalhaven Regional Plan 2036
Km	Kilometres
Kg	Kilograms
kL	Kilolitres
kV	Kilovolt
LEA	Local effect analysis
LEP	Local Environmental Plan
LGA	Local government area
LOS	Level of Service
Mg/l	Milligrams per litre
ML	Mining leases
MNES	Matters of national environmental significance
Mining Act	NSW *Mining Act 1992*
Mining SEPP	*State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
Mm	Millimetres
MOD1	Modification approved in December 2015
MOD2	The proposed modification (subject of this modification report)
Mt	Million tonnes

Mtpa	Million tonnes per annum
MOP	Mining Operations Plan
NEMP	National Environment Protection Measure
NGAF	National Greenhouse Accounts Factors
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NHL	National Heritage List
NMP	Noise Management Plan
NorBE	Neutral or beneficial effect
NPfI	*Noise Policy for Industry*
NPI	National Pollution Inventory
NSW	New South Wales
NVIA	Noise and vibration impact assessment
NWMD	North West Mains Development
OEH	Office of Environment and Heritage
Oz	Ounces
PA	Project approval
PAA	Project application area
PAC	Planning Assessment Commission
PCTs	Plant community types
$PM_{2.5}$	Particulate matter less than 2.5 µm in aerodynamic diameter
PM_{10}	Particulate matter less than 10 micrometres (µm) in aerodynamic diameter
POEO Act	NSW *Protection of the Environment Operations Act 1997*
POEO Regulation	Protection of the Environment Operations (Clean Air) Regulation 2010
RAPs	Registered Aboriginal Parties
RBL	Rating background level
RING	*Rail Infrastructure Noise Guideline*
RMS	Roads and Maritime Services (RMS)
RNP	*NSW Road Noise Policy*
ROM	Run-of-mine (coal)
SES	State Emergency Services
SEPP	State environmental planning policy
SEPP 33	*State Environmental Planning Policy No 33 – Hazardous and Offensive Development*
SGA	Subsidence and geotechnical assessment
SHI	State Heritage Inventory
SHR	State Heritage Register
SIA	Social impact assessment
SIDRA	Signalised & unsignalised intersection design and research aid

SoHI	Statement of heritage impact
SSD	State significant development
SWA	Surface water assessment
TECs	Threatened ecological communities
TfNSW	Transport for NSW
TIA	Traffic impact assessment
TDS	Total dissolved solids
TIA	Traffic impact assessment
TMP	Traffic Management Plan
TSP	Total suspended particles
WAL	Water access licence
WCSP 2028	Wollongong 2028 Community Strategic Plan
WNSW Act	*WaterNSW Act 2014*
Wollongong Coal	Wollongong Coal Pty Ltd