TARRAWONGA COAL MINE FINAL VOID AND MINE CLOSURE PLAN

19 December 2024

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2-1	Document Revised	TCPL	Env Supt	18 Dec 24
2-2	Final	TCPL	Env Supt	19 Dec 24

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1 Introduction

This Final Void and Mine Closure Plan has been prepared by Tarrawonga Coal Pty Ltd (TCPL) for the Tarrawonga Coal Mine to satisfy Condition 65, Schedule 3 of the Tarrawonga Coal Project State Significant Development Project Approval (PA) MP11_0047.

The Tarrawonga Coal Mine (formerly known as East Boggabri Coal Mine) is located approximately 42 kilometres (km) north-northwest of Gunnedah in New South Wales (NSW) (Figure 1). The Tarrawonga Coal Mine is owned and operated by TCPL, a wholly owned subsidiary of Whitehaven Coal Limited (Whitehaven).

The Tarrawonga Coal Mine is an open cut coal mine which has been in operation since 2006. Run-of-mine (ROM) coal is crushed and screened on-site, and the sized ROM coal is loaded onto on-highway trucks for transport via the Approved ROM Coal Transport Route to the Whitehaven Coal Handling and Preparation Plant (CHPP). The Tarrawonga Coal Mine is approved to operate until December 2030.

The mine forms part of a mining precinct located in and around Leard State Forest, which also includes the Boggabri Coal Mine and Maules Creek Coal Mine (operated by Idemitsu and Whitehaven, respectively).

Whitehaven also owns the former Rocglen (in closure and rehabilitation), and Vickery Coal Mines located around 10 km to the south of the Tarrawonga Coal Mine.

1.1 History of operations

The Tarrawonga Coal Project was approved (PA MP11_0047) by the NSW Planning Assessment Commission under delegation of the NSW Minister for Planning and Infrastructure, pursuant to section 75J of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on 22 January 2013.

PA MP11_0047 has been modified on 10 separate occasions and currently allows Whitehaven to extract up to 3.5 million tonnes per annum (Mtpa) of ROM coal by open cut methods until December 2030.

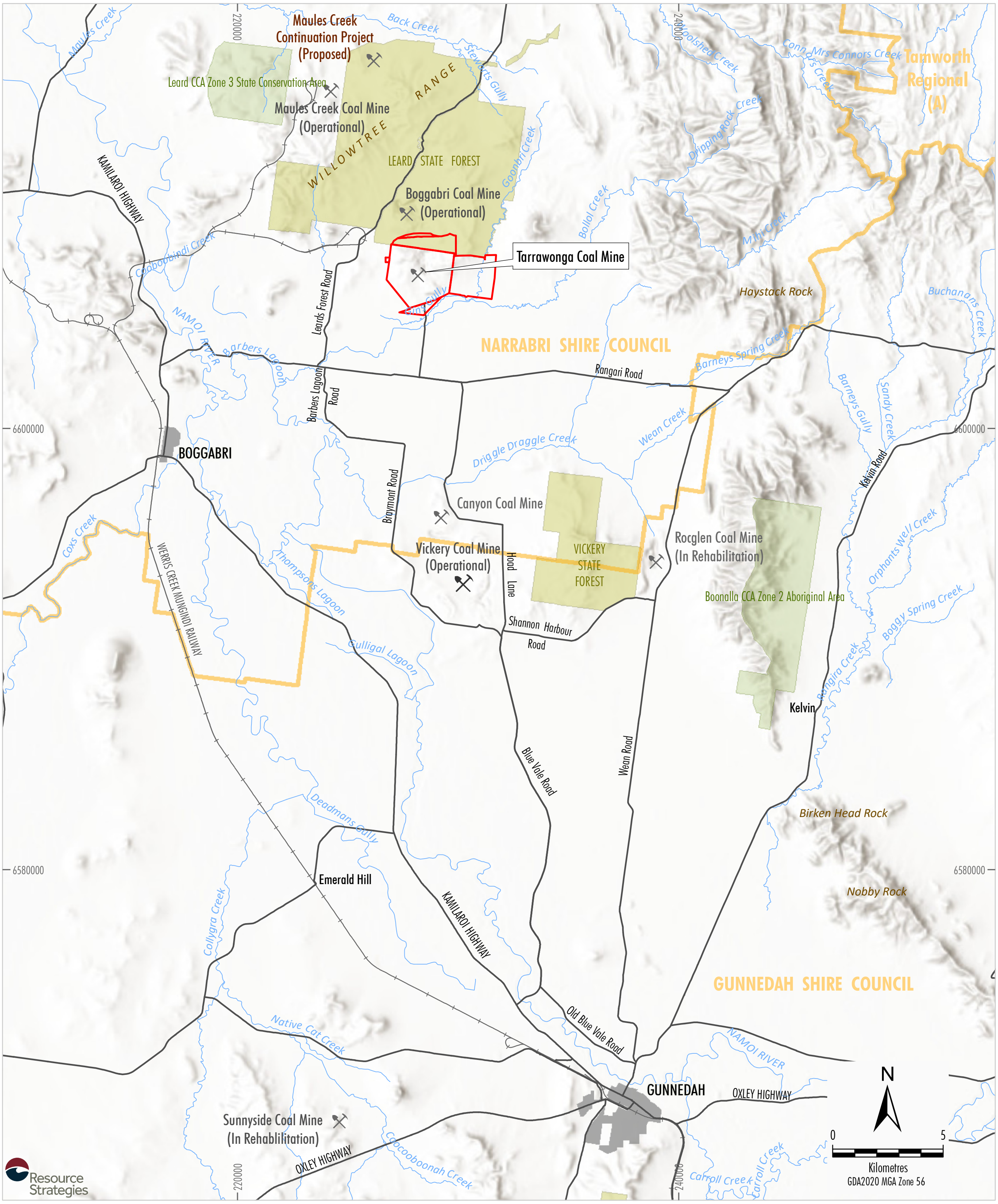
Additionally, the Tarrawonga Coal Mine was granted approval under the *Environment Protection and Biodiversity Conservation Act 1999* on 11 March 2013 (Commonwealth Approval Decision 2011/5923).

1.2 Purpose and scope

This Final Void and Mine Closure Plan has been prepared in accordance with Condition 65, Schedule 3 of PA MP11_0047. This plan is a component of the overall Tarrawonga Rehabilitation Management Plan[1] for the Tarrawonga Coal Mine.

Mine closure planning is integral to life of mine planning and requires progressive review over the life of a project. As required by Condition 65, Schedule 3 of MP11_0047, this Final Void and Mine Closure Plan will be submitted to the NSW Resources Regulator by the end of December 2024.

[1] The Rehabilitation Management Plan required under Condition 64, Schedule 3 of MP11_0047.



LEGEND

- Mining Tenement Boundary (ML, CL and AUTH)
- NSW State Forest
- State Conservation Area, Aboriginal Area
- Major Roads
- Railway
- Local Government Boundary

Source: LPMA - Topographic Base (2010); NSW Department of Industry (2018)

WHITEHAVEN COAL

TARRAWONGA COAL MINE

Regional Location

Figure 1

1.2.1 Tarrawonga Coal Mine Life of Mine Modification

PA MP11_0047 has been modified on 10 separate occasions. This Final Void and Mine Closure Plan has been prepared in consideration of the Tarrawonga Coal Mine Life of Mine Modification (i.e. Modification 7 of PA MP11_0047) approved on 8 February 2021, and the subsequent three Modifications supporting the new life of mine.

The Tarrawonga Coal Mine has an operational mine life until December 2030.

The main activities associated with Modifications 7 to 10 include:

- ROM coal production rate of 3.5 Mtpa;
- 3.5 Mtpa ROM coal transported along the Northern Section of the Approved ROM Coal Transport Route;
- reduction of the open cut extent to avoid mining (Figure 2):
  - the Upper Namoi alluvium; and
  - Goonbri Creek.
- revision of the post-mining landform and land use;
- relocation of the ROM coal stockpile and associated infrastructure[2];
- construction of a new site access road and intersection to allow haulage of ROM coal along a section of Goonbri Road[2];
- construction and use of a water transfer pipeline between the Tarrawonga Coal Mine and Vickery Extension Project (a separate Development Application for State Significant Development [SSD] 7480[3], approved August 2020);
- road haulage of water from the Vickery Coal Mine to the Tarrawonga Coal Mine along the Northern Section of the approved haul route;
- allowance of onsite disposal of end-of-life heavy plant tyres, otherwise known as off-the-road (OTR) tyres (excluding the disposal of road tyres typically used by trucks and/or passenger vehicles on registered roads); and
- extension of road haulage hours to 4:00 am – 11:15 pm on Mondays to Fridays and 5:00 am – 7:15pm on Saturdays.

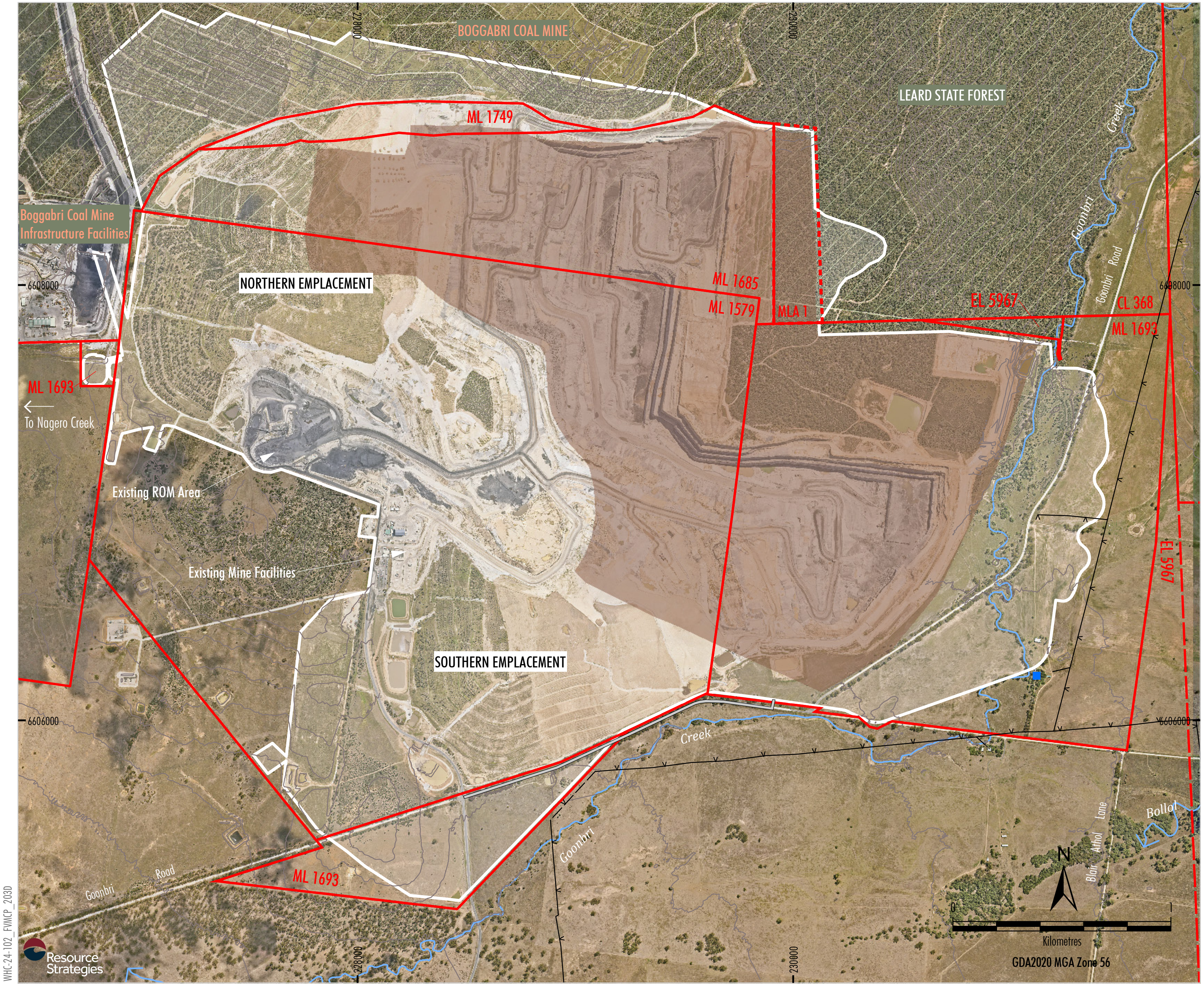
The reduction in open cut extent and landforms presented in Modification 7 were considered to be the most viable from an economic and environmental perspective. The approved Tarrawonga Coal Mine open cut extent ceases mining at 200 metres (m) from the Upper Namoi alluvium and therefore foregoes coal extraction from some areas permitted under MP 11_00447 (i.e. underlying the Upper Namoi alluvium). In doing so, TCPL is not required to construct infrastructure such as a low permeability barrier and the Goonbri Creek realignment following the approval of Modification 7.

1.2.2 Verification by independent reviewers

Condition 65(a), Schedule 3 of PA MP11_0047 requires this Final Void and Mine Closure Plan to be reviewed and verified by suitably qualified, experienced, and independent persons (including a groundwater expert) whose appointment has been approved by the Secretary. Dr Noel Merrick (HydroAlgorithmics) and Dr Damian McGarry (HydraLogic) were endorsed by the Secretary in accordance with Condition 65(a), Schedule 3 of PA MP11_0047 on 22 November 2024. Both Dr Noel Merrick and Dr Damian McGarry have verified this Final Void and Mine Closure Plan (HydroAlgorithmics, 2024; HydraLogic, 2024).

2 Although approved under MP11_0047, TCPL do not intend to enact these modifications.

3 The Vickery Extension Project (SSD 7480) was approved by the NSW Department of Planning, Industry and Environment (formerly Department of Planning and Environment) on 12 August 2020.



LEGEND

- Mining Lease Boundary (ML & CL)
- Mining Lease Application Boundary (MLA 1)
- Exploration Licence (EL)
- Leard State Forest
- 11kV Electricity Transmission Line
- 11kV Electricity Transmission Line Realignment
- Stream ≥ 3rd Order
- Mine-owned Dwelling
- Approximate Extent of Approved Surface Development
- Approximate Extent of Approved Open Cut

Source: NSW Spatial Services (2023)
Orthophoto: Whitehaven (2024)

WHITEHAVEN COAL

TARRAWONGA COAL MINE

Indicative General Arrangement

Figure 2

1.3 Statutory obligations

This Final Void and Mine Closure Plan has been prepared in accordance with Condition 65, Schedule 3 of PA MP11_0047. This Final Void and Mine Closure Plan forms part of the overarching Rehabilitation Management Plan for the Tarrawonga Coal Mine. The requirements of Condition 65, Schedule 3 of PA MP11_0047 and where they are addressed in this plan are provided in Table 1.

Table 1 – Project Approval MP11_0047 requirements for this Final Void and Mine Closure Plan

Project Approval MP11_0047 condition	Section of this plan
65. The Proponent shall prepare and implement an updated Final Void and Mine Closure Plan (as a component of the overall Rehabilitation Management Plan required under condition 64 of schedule 3) following consultation with the Secretary. A draft plan must be prepared and submitted to Resources Regulator by the end of December 2019, and a final plan must be prepared and submitted to Resources Regulator by the end of December 2024. Each version of the plan must:	-
(a) be subject to independent review and verification by suitably qualified, experienced and independent person/s (including a groundwater expert) whose appointment has been approved by the Secretary;	Section 1.2.2
(b) identify and consider:	-
• options for continued mining beyond current project life;	Section 1.2.1
• interactions with the final landform of adjoining mines (including any direct or indirect interaction between final voids);	Sections 5.1.2 and 5.3.3
• opportunities for integrated mine planning with adjoining mines to minimise environmental impacts of the mines' final landforms;	Section 5.1.2
• all reasonable and feasible landform options for the final void (including filling);	Section 5.3.1
• predicted stability of the proposed landforms; and	Sections 5.3.4 and 7.1
• predicted hydrochemistry and hydrogeology (including long-term groundwater recovery and void groundwater quality);	Section 5.3.3
(c) include a detailed proposed landform design; and	Section 5 and Figure 3
(d) demonstrate that the proposed final landform:	-
• satisfies the relevant objectives in Table 15;	Section 6.1
• minimises the extent of any resulting pit lake;	Section 5.3.2 and 5.3.3
• avoids salt scalding;	Sections 5.1.1 and 5.2
• maximises the capacity of emplaced spoil to drain to the natural environment; and	Sections 5.1.1 and 5.1.3
• ensures that drained waters do not adversely affect the downstream environment.	Section 5.4

1.4 Consultation

1.4.1 Government

TCPL met with the Department of Infrastructure and Environment – Division of Resources and Geoscience (DPIE – DRG; now within the NSW Resources) in September 2019 to provide an overview of Modification 7 including the revised final landform and a summary of the environmental study findings. DPIE – DRG confirmed that it agreed with the Modification scope and the proposed Modification 7 activities.

TCPL also consulted the following agencies regarding Modification 7 and the revised final landforms:

- NSW Office of Environment and Heritage (OEH) (now within the Department of Climate Change, Energy, the Environment and Water [DCCEEW]);
- NSW Department of Industry – Water (now within the DCCEEW);
- NSW Environment Protection Authority (EPA);
- NSW DPIE (now the Department of Planning, Infrastructure and Housing [DPHI]);
- NSW Resources Regulator;
- NSW Roads and Maritime Services;
- Transport for NSW;
- NSW Department of Industry – Fisheries;
- NSW Department of Industry – Lands;
- NSW Health; and
- Local Land Services.

1.4.2 Community

A Community Consultation Committee (CCC) has been established for the Tarrawonga Coal Mine, with meetings held quarterly. The CCC consists of representatives from the local community, the Narrabri and Gunnedah Shire Councils and Whitehaven.

TCPL also engages with local communities and stakeholder groups regarding the final land use and rehabilitation concepts for the Tarrawonga Coal Mine as part of the Tarrawonga Rehabilitation Management Plan.

TCPL will continue to engage with the community via the CCC and joint Boggabri-Tarrawonga-Maules Creek CCC as part of any future Modification assessment processes.

1.5 Key guidelines

The following guidelines have been considered in the preparation of the Final Void and Mine Closure Plan:

- ESG3: Mining Operations Plan (MOP) Guidelines (Department of Trade & Investment Regional Infrastructure and Services [DTIRIS], 2013).
- Guidelines for Coal Mine Open Pit Final Void Closure and Relinquishment – Addressing Uncertainty in Coal Mining Environmental Planning (Amanzi Consulting Pty Ltd, 2017).
- Integr*ated Mine Closure – Good Practice Guide, 2nd Edition* (International Council on Mining & Metals, 2019).
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Form and Way: Rehabilitation management plan for large mines (NSW Resources Regulator, 2021).
- Guideline: Form and way for rehabilitation objectives statement, rehabilitation completion criteria statement and final landform and rehabilitation plan for large mines (NSW Resources Regulator, 2021).
- Guideline: Rehabilitation objectives and rehabilitation completion criteria (NSW Resources Regulator, 2021).
- Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure and Completion, Mine Rehabilitation (Commonwealth Department of Industry, Tourism and Resources, 2016).

2 Existing environment

2.1 Surrounding land uses and other nearby mining operations

The Tarrawonga Coal Mine is situated predominantly on the hills and foot slopes adjoining the Leard State Forest. Land use in the region is dominated by agriculture, mining associated with the Tarrawonga Coal Mine and other nearby mines including the Boggabri and Maules Creek Coal Mines, and biodiversity conservation areas for these and other nearby mines.

2.2 Geology and hydrogeology

The Tarrawonga Coal Mine is located in the Gunnedah Basin, which contains sedimentary rocks, including coal measures, of Permian and Triassic age.

The Tarrawonga Coal Mine coal resource is located within the Maules Creek sub-basin of the Early Permian Bellata Group, which lies within the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*. The Tarrawonga Coal Mine targets coal seams in the Maules Creek Formation within the 'Gunnedah-Oxley Basin – Namoi' Management Zone defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*.

Further detail regarding the geology and hydrogeology at the Tarrawonga Coal Mine can be found in Section 4.4.1 and Appendix A of the Tarrawonga Coal Project Environmental Assessment (EA) (TCPL, 2012).

2.3 Hydrology

The Tarrawonga Coal Mine is located entirely within the Namoi River catchment. The Namoi River has a catchment area of approximately 42,000 square kilometres. The Namoi River is a tributary of the Barwon River, which ultimately flows into the Murray-Darling System. The local drainage catchments are Nagero Creek, Goonbri Creek and Bollol Creek, which ultimately flow into the Namoi River just north of Boggabri.

Further detail regarding the hydrology of the Tarrawonga Coal Mine can be found in Section 4.5.1 and Appendix B of the Tarrawonga Coal Project EA (TCPL, 2012).

2.4 Existing rehabilitation at the Tarrawonga Coal Mine and other nearby mines

Whitehaven has a proven history of successful rehabilitation outcomes which achieve the following rehabilitation objectives:

- Progressively rehabilitate areas, including establishing landforms, during mining.
- Use modern techniques to ensure final landforms are safe, stable and self-sustaining – to support future land uses beyond mining.
- Undertake rehabilitation actions that restore ecosystem functions, including establishing flora ecosystems.
- Undertake rehabilitation that reflects the surrounding landscape or improves on it.
- Establish landforms that incorporate micro-relief patterns consistent with the surrounding topography.
- Minimise the visual impact of final landforms as far as is reasonable and feasible.

2.4.1 Tarrawonga Coal Mine

The planned final land use at the Tarrawonga Coal Mine is woodland as well as land suitable for pasture. Progressive rehabilitation commenced in 2007, and as of January 2022, approximately 157 hectares (ha) out of a total 568 ha of woodland has been rehabilitated.

Rehabilitation activities have focused on the Northern and Southern Emplacements (Figure 2). While a traditional landform design has been used, future rehabilitation will adopt a more geomorphic design to facilitate improved drainage, reduced maintenance requirements and result in a more natural final landform.

Rehabilitation monitoring results at the Tarrawonga Coal Mine indicate that the initial cover crop has been successful in stabilising the rehabilitation areas, and tube stock establishment on the Northern Emplacement has also been largely successful to date with survival rates ranging between approximately 75 percent (%) and 95 % (TCPL, 2010; TCPL, 2019b and Eco Logical Australia Pty Ltd [Eco Logical], 2018).

A mid-storey layer has developed on the western batters of the Northern Emplacement that consists of juvenile eucalyptus species that are expected to form the canopy as they mature (Eco Logical, 2017). Rehabilitation monitoring indicates that the majority of the canopy species planted on the Northern Emplacement are between 5 and 10 m tall with canopy recruitment of Eucalypt species recorded (Eco Logical, 2018). A revised framework for rehabilitation management at the Tarrawonga Coal Mine was developed to improve progressive rehabilitation outcomes. These regulatory requirements for rehabilitation are further described in the Tarrawonga Coal Mine Rehabilitation Management Plan (TCPL, 2022).

Monitoring results for the latest annual reporting period (2023) showed an increase in the desirable surface vegetation cover by up to 11.6 % since initial monitoring with native grass cover for woodland re-establishment targets were met in 2021 and 2019 rehabilitation areas. All rehabilitation sites showed increased tree density (TCPL, 2023).

Successful progression of rehabilitation at the Tarrawonga Coal Mine is shown below (Plate 1; Plate 2).

A number of endemic fauna species continue to be recorded at the rehabilitation sites, including the Eastern Grey Kangaroo (*Macropus giganteus*), Common Wallaroo (*Macropus robustus*), Red-necked Wallaby (*Macropus rufogriseus*), Wall Skink (*Cryptoblepharus virgatus*), Lace Monitor (*Varanus varius*), Eastern Striped Skink (*Ctenotus robustus*), Jacky Dragon (*Amphibolurus muricatus*) and Bearded Dragon (*Pogona barbata*) (Eco Logical, 2017 and TCPL, 2019b). Fauna surveys for spring birds also showed a steady trend in species richness, while winter bird surveys indicated a slight decrease in species richness (TCPL, 2023).

TCPL has established standing habitat trees on the slopes of rehabilitation areas with the installation of more nest boxes planned as rehabilitation progresses. During 2016, a threatened bird species (Speckled Warbler [*Chthonicola sagittata*]) was recorded within the Tarrawonga Coal Mine rehabilitation area (Eco Logical, 2017).

Plate 1 – Northern Emplacement Progressive Rehabilitation Between 2017 and 2022

Plate 2 – Southern Emplacement Progressive Rehabilitation Between 2021 and 2022

2.4.2 Other nearby mines

Whitehaven is progressively rehabilitating several of its other closed and operational coal mines in the region, including the Maules Creek, Canyon, Vickery, Sunnyside and Rocglen Coal Mines (Figure 1) as well as the

Narrabri and Werris Creek Coal Mines located farther afield. To date, Whitehaven has completed successful rehabilitation campaigns in its Sunnyside and Rocglen Coal Mines.

The pre-mining land use at the Sunnyside Coal Mine comprised land cleared for agricultural cultivation and grazing, with a predominantly cropping and pastoral land use. Whitehaven aims to return the site to pastures in the flat areas and woodland on the slopes, to reflect the surrounding vegetation.

Rehabilitation activities at the Rocglen Coal Mine commenced in mid-2019 following the cessation of mining. Rehabilitation works were completed in mid-2024, with the following years to include monitoring and maintenance of the area. The former mine will be returned to woodland vegetation that blends into the surrounding Vickery State Forest, as well as some pasture for grazing.

Whitehaven is also enhancing several biodiversity offset properties associated with these mines. An overview of the rehabilitation status of these mines is provided on the Whitehaven website.

3 General rehabilitation and mine closure goals

The general rehabilitation and mine closure goals for the Tarrawonga Coal Mine are described in Table 2. TCPL's mine closure goal is to achieve relinquishment to the satisfaction of the relevant Minister(s) and that all relevant mining tenement and PA MP11_0047 conditions will have been met. Rehabilitated land will be considered suitable for surrender when the nominated standards and/or completion criteria for land use, landform reconstruction, landform stability, revegetation, and beneficial water use have been met or if the relevant Minister(s) otherwise accept the rehabilitation status. Achievement of the general rehabilitation and mine closure goals will be managed through the Tarrawonga Rehabilitation Management Plan.

Table 2 – General rehabilitation and mine closure goals

Short term	Medium to long term
• Minimise active disturbance areas by progressively rehabilitating, and by restricting clearing to the minimum required for operations. • Recover vegetation and habitat resources during clearing activities and re-use in rehabilitated areas to provide habitat resources for fauna (e.g. trees, hollows). • Use soil resources stripped from disturbance areas directly for rehabilitation, but if this is not possible, minimise the time soil is stored in temporary stockpiles before being re-used. • Install erosion and sediment control measures prior to the commencement of soil stripping and rehabilitation activities. • Plant cover crops on newly rehabilitated mine landform areas (and topsoil stockpiles) after completing earthworks, to minimise the potential for soil erosion. • Stabilise new infrastructure disturbance areas (e.g. road and dam embankments) as soon as possible by topsoiling and seeding. • Maintain vegetation screens to facilitate growth and screening of Tarrawonga Coal Mine activities. • Progressively backfill the open cut with overburden and interburden and reshape completed areas to their final landform shape so that they can be progressively rehabilitated.	• Create a physically and chemically stable mine landform that integrates with the adjoining hilly topography of the Willowtree Range. • Create micro-relief and macro-relief between landforms (e.g. the Southern and Northern Emplacements) that reflect the characteristics of the surrounding topography. • Construct the final top surface of the Northern Emplacement so that it drains in a stable manner to the natural environment (e.g. Goonbri Creek) or existing drains via swales, rock-lined drop structures and/or sediment basins. • Partially backfill the final void to the extent required to minimise long-term drawdown and water quality effects on local groundwater aquifers, so that their beneficial use is not compromised. • Construct the final void highwall to achieve negligible instability risk and minimise risk of flood interaction for all flood events up to and including the Probable Maximum Flood (PMF) level. • Revegetate the mine landforms to a combination of native woodland/forest and agricultural land uses that meet community and regulatory expectations in consideration of existing land uses and conservation values.

4 Post-mining land uses and final landform features

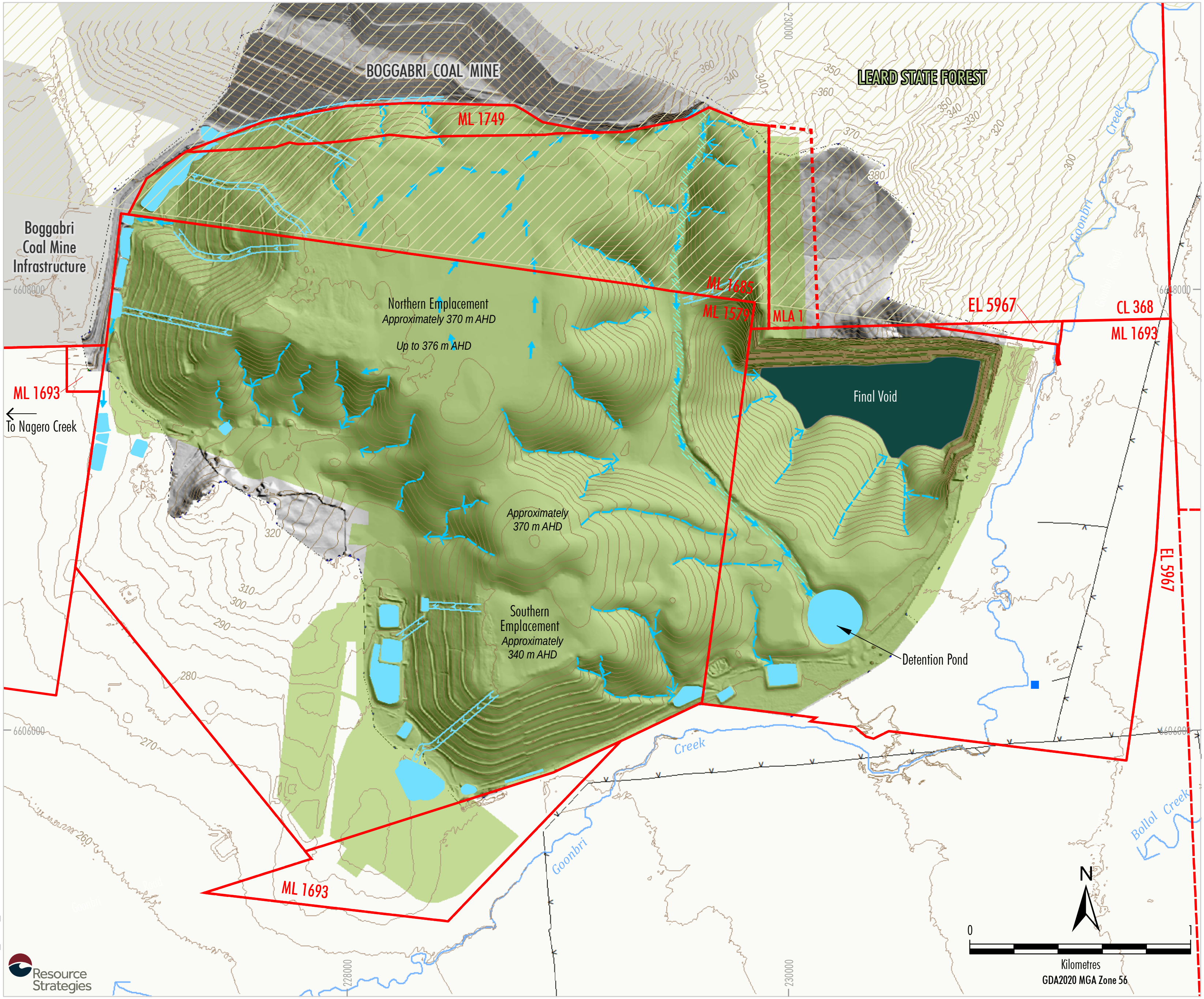
The conceptual post-mining land uses will comprise a combination of native ecosystem (woodland/forest) and agricultural (pasture) land uses. Agricultural land will be limited to grazing only. The final landform will provide a combination of approximately 568 ha of native woodland/forest and approximately 257 ha of agricultural land suitable for grazing. Figure 3 illustrates the conceptual final landform and post-mining land use areas.

The conceptual final landform has been designed to integrate with the surrounding natural and modified landforms, including consideration of elevation, slope and drainage. The key features of the final landform include:

- Rehabilitated waste rock emplacements incorporating natural landform design features (i.e. micro-relief and macro-relief) that reflect characteristics of the topography found in the adjacent Leard State Forest (e.g. elevated landforms with steeper slopes in some areas relative to the surrounding plains).
- Rehabilitated infilled open cut areas that slope down and merge with the natural topography and drain south towards the natural environment (e.g. Goonbri Creek).
- Water management features designed to be stable in the long-term.
- A final void located primarily in Mining Lease (ML) 1693.
- Rehabilitated infrastructure areas that are flat and contiguous with the surrounding agricultural areas.

Finalised designs for the Tarrawonga Coal Mine final landforms have been informed and refined, based on ongoing rehabilitation monitoring results. The general arrangement and final landform of the Tarrawonga Coal Mine are presented in Figure 3.

The final landform design will be progressively reviewed and refined as the mine progresses to closure in 2030.



LEGEND

- Mining Lease Boundary (ML & CL)
- Mining Lease Application Boundary (MLA 1)
- Exploration Licence (EL)
- Leard State Forest
- 11kV Electricity Transmission Line
- 11kV Electricity Transmission Line Realignment
- Stream ≥ 3rd Order
- Mine-owned Dwelling
- Rehabilitated Landform
- Swale/Drainage Path
- Sediment Basin/Farm Dam/Detention Pond
- Drop Structure
- Surface Water Flow/Direction

*Note: * Extent of flood bund subject to detailed design.*

Source: © State of New South Wales and Department of Planning and Environment (2017); © Department of Finance, Services & Innovation (2017); Whitehaven Coal Limited (2018); WRM (2018)

WHITEHAVEN COAL

TARRAWONGA COAL MINE

Indicative General Arrangement - Final Landform

Figure 3

5 Rehabilitation domains and final landform concepts

Consistent with contemporary rehabilitation guidelines, conceptual rehabilitation domains would be used to guide rehabilitation at the Tarrawonga Coal Mine. In accordance with the methodology provided in the *ESG3: Mining Operations Plan (MOP) Guidelines* (DTIRIS, 2013), and the Tarrawonga Rehabilitation Management Plan (Whitehaven, 2022), Table 3 outlines the mining domains and final land uses for the Tarrawonga Coal Mine.

Table 3 – Rehabilitation domains[1]

Code	Domain title	Description
Mining Domains		
1	Infrastructure Area	Existing infrastructure and facilities, including administration areas, workshops, and coal handling and preparation facilities. This domain includes areas disturbed to stockpile topsoil and vegetation for reuse in rehabilitation.
2	Infrastructure Area (Reject Emplacement Area [REA])	Existing REA between the Northern Emplacement and Southern Emplacement Areas. Implementation of a capping/cover strategy and landform design is underway (Whitehaven, 2022).
3	Water Management Area	Network of dams, channels and associated water management infrastructure (pipelines and pumps, etc.).
4	Overburden Emplacement Area	Footprint of out of pit (Northern Emplacement and Southern Emplacement and environmental bunds) and in-pit waste rock dump areas. Reject from the Whitehaven CHPP is back hauled and co-disposed of within the Northern Emplacement and Southern Emplacement.
5	Active Mining Area (Open cut void)	Footprint of the open cut mining pit(s).
Final Land Use Domains		
A	Final Void	Tarrawonga has approval to retain a single void along the eastern perimeter of the open cut pit. The final void will include flood mitigation as required, and safety infrastructure.
B	Water Management Area	Footprint of water management structures and dams retained in the final landform.
C	Agricultural – Grazing	Backfilled areas of the open cut in-fill areas (approximately 285 mAHD) will be rehabilitated with selected topsoil resources suitable for sustainable managed livestock grazing.
D	Native Ecosystem	The elevated areas of the Northern Emplacement, Southern Emplacement and the open cut infill area to the east of the Northern Emplacement would be revegetated with native tree, shrub and grass species to achieve a native woodland/forest post-mining land use. This domain will include at least 13 ha commensurate with the White Box Yellow Box Blakeley's Red Gum Grassy Woodland and Derived Native Grassland Endangered Ecological Communities (EEC). Species selection and planting densities will vary to enhance integration with adjacent Leard State Forest and Boggabri waste emplacement area.

[1] per the Tarrawonga Rehabilitation Management Plan (TCPL, 2022).

The conceptual post-mining rehabilitation domains are described in Sections 5.1 to 5.4 and shown on Figure 4.

The conceptual post mining rehabilitation domains include:

- Domain 1C: former infrastructure area rehabilitated to Agricultural Land suitable for grazing.
- Domain 2C: infilled open cut area rehabilitated to Agricultural Land suitable for grazing.
- Domani 2D: overburden emplacement areas and the infilled open cut area to be rehabilitated to be rehabilitated to Native Ecosystem.
- Domain 3B: water management area footprints to remain post-mining.
- Domain 4C: former stockpiled material area rehabilitated to Agricultural Land suitable for grazing.
- Domain 5A: single final void in the eastern perimeter of the open cut pit to remain post-mining.

5.1 Domains 2D and 2C – overburden emplacement areas and infilled open cut area

5.1.1 Northern Emplacement and open cut infill area

The Northern Emplacement and open cut infill area will be rehabilitated to create a final landform that merges into the undisturbed hilly topography of the Willowtree Range to the north-east in Leard State Forest.

The objective of the current rehabilitation is to re-profile the available finalised Northern Emplacement batters to a stable overall slope of generally less than 10 degrees (°), and to revegetate the completed landform to open native woodland with flora species characteristic of the local area. Fauna habitat features (e.g. tree trunks) are to be incorporated into the rehabilitation areas. The Northern Emplacement will gently slope up from the natural ground surface on the western edge of ML 1579.

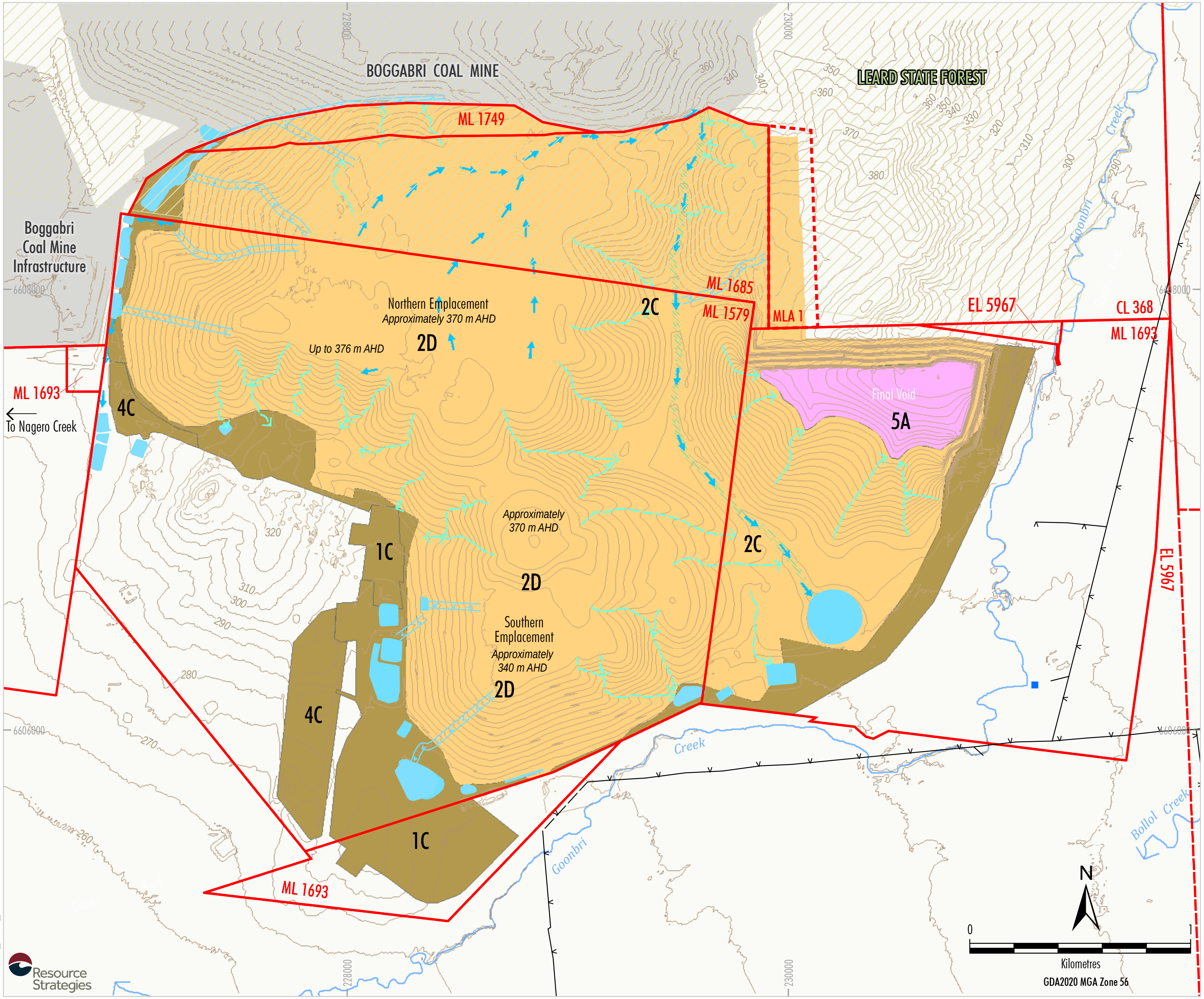
The Northern Emplacement includes three elevated catchment areas constructed to approximately 370 m Australian Height Datum (AHD), with localised areas up to approximately 376 m AHD to introduce micro-relief. The top surface of the northern extent of the emplacement would remain approximately 1,500 m wide. The shape of the Northern Emplacement top surface will drain incident rainfall from the centre of the emplacement via wide swale drains that gradually slope to the west and north-west. Engineered rock-lined drop structures would then facilitate drainage from the top surface swales down the emplacement batters to shallow sediment basins at the base of each structure (Figure 3). A geomorphic design will be adopted on the eastern batters of the Northern Emplacement, which will outfall to a central swale running generally from the northern extent of the open cut infill area to a detention pond at the south-western extent of the open cut infill area (within ML 1693) (Figure 3).

Drop structures will be designed to be safe and structurally stable and non-polluting in the long-term. The long-term stability of the drop structures will be verified by qualified engineering design and geotechnical assessment (Section 7.1).

The drop structures will discharge to the existing sediment dams to provide for energy dissipation/erosion protection prior to discharge to the downstream drainage network. Alternatively, energy dissipaters/erosion protection will be provided at the outlet of the drop structures. Collection drains will be constructed in the rehabilitated, former active mining area to convey runoff to a sediment dam downstream prior to discharge off-site.

The southern extent of the Northern Emplacement will continue to be integrated at a reduced level with the much smaller Southern Emplacement to its south-east. The Northern and Southern Emplacements have been designed to maximise the drainage of runoff from the emplaced spoil to the natural environment (e.g. Goonbri Creek).

The elevated areas of the Northern Emplacement and the open cut infill area to the east of the Northern Emplacement would be revegetated with native tree, shrub and grass species to achieve a native woodland/forest land use and pasture species for an agricultural land use post-mining. Revegetation of woodland/forest areas of the Northern Emplacement and open cut infill areas will aim to integrate with the Leard State Forest.



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Mine-owned Dwelling
Stream ≥ 3rd Order
Swale/Drainage Path
Drop Structure
Surface Water Flow/Direction
1C Infrastructure Area
- Pasture/Agricultural Land Suited to Grazing
2C Infilled Open Cut Area
- Pasture/Agricultural Land Suited to Grazing
2D Overburden Emplacement Area and Infilled Open Cut Area
- Native Woodland/Forest
4C Stockpiled Material
- Pasture/Agricultural Land Suited to Grazing
5A Open Cut Void
3B Water Management Infrastructure

Source: © State of New South Wales and Department of Planning and Environment (2017); © Department of Finance, Services & Innovation (2017); Whitehaven Coal Limited (2018); WRM (2018)

WHITEHAVEN COAL

TARRAWONGA COAL MINE

Conceptual Rehabilitation Domains

Figure 4

Shallow stilling ponds would be located at the base of the Northern Emplacement drop structures which would then outfall to a central swale running generally from the northern extent of the open cut infill area to a sediment basin at the south-western extent of the open cut infill area (within ML 1693) (Figure 3). Water management structures including drains, banks, drop structures and dams are to be constructed in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004), the Water Management Plan and in consideration of the design details from the International Erosion Control Association (IECA, 2008) to ensure the long-term, permanent structures are stable and such that drained waters do not adversely affect the downstream environment. In addition, if the presence of significant salt scalds are identified on the spoil (i.e. the Northern and Southern Emplacements), a specialist consultant will be engaged to develop a site-specific management report to remediate salinity scalds.

Sediment dams to the west and south of the Northern and Southern Emplacements would be retained in the final landform until runoff water quality is similar to runoff water quality from similar landforms outside the Tarrawonga Coal Mine, to ensure that there is no adverse effect to the downstream environment. Some dams may also be retained in the final landform as a water source for fauna or for agricultural use (refer to Section 5.4).

5.1.2 Integration of the Northern Emplacement with the Boggabri Coal Mine

The final landform design concept for the southern extent of the Boggabri Coal Mine waste rock emplacement includes slope angles to the Northern Emplacement of generally 10º or shallower. The Boggabri Coal Mine waste rock emplacement would generally have an east-west orientation and a maximum height of 395 m AHD.

TCPL will continue to implement the Tarrawonga Boggabri Common Boundary Integrated Management Plan, with Boggabri Coal Operations Pty Ltd (BCOPL), to guide rehabilitation of the northern extent of the Northern Emplacement. The Tarrawonga Boggabri Common Boundary Integrated Management Plan was prepared in consultation with the then Department of Resources and Energy (DRE) and endorsed by both BCOPL and TCPL in August 2015. TCPL will continue to consult with BCOPL regarding the implementation of the Tarrawonga Boggabri Common Boundary Integrated Management Plan as required.

A rock-lined drainage corridor located between the Northern Emplacement and the Boggabri Coal Mine waste rock emplacement will facilitate drainage from these constructed landforms to a series of sediment basins/farm dams to the west of the Northern Emplacement (Figure 3). Riparian vegetation, including species characteristics of natural riparian systems in the local area, will be planted in the surrounds of the drainage corridor.

5.1.3 Southern Emplacement

The Southern Emplacement will be progressively constructed to a maximum height of approximately 370 m AHD and be integrated with the Northern Emplacement. The Southern Emplacement will be constructed predominantly with batter slopes of 10º or shallower and will be revegetated with native tree, shrub and grass species to achieve a native woodland/forest post-mining land use (Figure 3). A geomorphic design will be adopted on the eastern batters of the Southern Emplacement, which will outfall to a central swale running generally from the northern extent of the open cut infill area to a detention pond at the south-western extent of the open cut infill area (within ML 1693) (Figure 3).

The drop structures will discharge to the existing sediment dams to provide for energy dissipation/erosion protection prior to discharge to the downstream drainage network. Alternatively, energy dissipaters/erosion protection will be provided at the outlet of the drop structures. Collection drains would be constructed in the rehabilitated, former active mining area to convey runoff to a sediment dam downstream prior to discharge to the natural environment (e.g. to Goonbri Creek).

Flood modelling of Goonbri Creek (Appendix A; WRM, 2024) shows PMF flood levels in the creek adjacent to the final void location are in the range of 280 to 284 m AHD. Surface modelling of the final landform indicate the final void spill level is above 285 m AHD and therefore, the final void is immune to flooding from Goonrbi Creek in the PMF (WRM, 2024).

To provide freeboard and allow for potential landform consolidation overtime, a minimum bund height of 3 m above the central swale channel bed level will be considered in the detailed design stage of the final landform.

5.2 Domains 1C and 4C – infrastructure areas and stockpile areas

The approved mine facilities area and operational infrastructure will be removed at the end of the mine life, which includes:

- coal and gravel crushing, screening and loadout infrastructure;
- administration and workshop buildings and stores;
- heavy vehicle servicing, parking and washdown facilities;
- septic facilities; and
- hydrocarbon and dangerous goods storage facilities.

During the decommissioning phase, the priority will be to dismantle fixed equipment and infrastructure for removal from site and re-used at another location or recycled. Non-salvageable/non-recyclable infrastructure will be disposed of at suitable off-site disposal areas, or on-site, subject to demonstration that no land contamination risk would be posed and relevant approvals are obtained.

A land contamination assessment will be conducted during the mine closure phase and any contaminated soil remediated in accordance with the relevant Environmental Management Plan guidelines (under the EP&A Act and the NSW *Contaminated Land Management Act 1997*). If the presence of salt scalds are identified at former soil stockpiles, a specialist consultant would be engaged to develop a site-specific management report to remediate salinity scalds.

Some concrete hardstands, internal access roads, sheds, buildings and sediment dams may be retained for post-mining land uses, if agreed by the relevant regulatory authorities and the ultimate landholder.

Once all equipment and infrastructure components have been removed and any contaminated land remediated, the approved mine facilities area and any access roads no longer required will be deep ripped, topsoiled and seeded with pasture species for use as agricultural land suitable for managed livestock grazing. Any undisturbed areas within the approved mine facilities area will remain undisturbed. Similarly, former soil stockpile areas would also be deep ripped, topsoiled and seeded with pasture species for agricultural use.

5.3 Domain 5A – Final Void

5.3.1 Final Void Design

Modification 7 maximises the recovery of coal within the approved open cut extent with approval to mine within 200 m of the Upper Namoi alluvium, avoiding mining the Upper Namoi alluvium itself, and reducing economically prohibitive capital costs.

Condition 37, Schedule 3 of PA MP11_0047 requires TCPL to construct the Goonbri Creek diversion and low permeability barrier prior to undertaking any mining operations within 200 m of the Upper Namoi alluvium. Other associated works would include realignment of a section of Goonbri Road and an 11-kilovolt electricity transmission line. TCPL considers the capital costs of these works to be economically prohibitive under the current market conditions. In the absence of these capital works, TCPL would cease mining at 200 m from the Upper Namoi alluvium under PA MP11_0047.

A number of options were considered by TCPL with respect to the size, depth and location of the final void as part of Modification 7. The final landform presented in Modification 7 and the final void are the preferred option in consideration of all relevant short, medium and long-term environmental and economic considerations, with a final void to remain at the eastern extent of the open cut at the cessation of mining (Figure 3). The final void will be partially backfilled to the extent required to minimise long-term drawdown and water quality effects on local groundwater aquifers, so that their beneficial use is not compromised. Bulk filling of the final void is not considered financially viable, and there would be a high risk that the groundwater within the fill of the final void would discharge off-site.

The final void has been designed to avoid the Upper Namoi alluvium and to achieve the rehabilitation objectives outlined in Schedule 3, Condition 61 of PA MP11_0047 (reproduced below):

- *Minimise the size and depth of the final void as far as is reasonable and feasible*
- *Minimise the drainage catchment of the final void as far as is reasonable and feasible*
- *Negligible high wall instability risk*
- *Minimise risk of flood interaction for all flood events up to and including the Probable Maximum Flood level*

Surface water modelling of the final landform indicates the final void is immune to flooding from the Goonbri Creek in the PMF (WRM, 2024). The final void spill level is above 285 m AHD which is higher than the adjacent

PMF level in Goonbri Creek, therefore, a permanent bund along the eastern side of the final void is not required.

The bund crest level along the central swale drainage path adjacent to the final void has a height of 2 m and 6 m above the drain bed level. To provide freeboard and allow for potential landform consolidation over time, a minimum bund height of 3m above the central swale channel bed level, located in the open cut infilled area along the western side of this drainage path is recommended. This will be considered in the detailed design stage of the final landform as the mine progresses towards closure.

5.3.2 Final Void Extent and Catchment Area

The catchment area of the final void will be defined by diversion channels to reduce the amount of emplaced spoil and runoff reporting into the final void (Figure 3). The catchment area and depth of the final void will be minimised as far as reasonable and feasible via partial backfilling to the extent required to minimise long-term drawdown and water quality effects on local groundwater aquifers (Section 5.3.1) and to minimise the extent of the resulting pit lake. The key features of the final void are:

- floor level of 160 m AHD;
- overtopping level above 285 m AHD;
- storage volume to the overtopping level of approximately 5,000 ML (based on the landform surface only and excluding any storages within pore spaces of the backfilled pit); and
- total catchment area of 128 ha.

Post-closure, a 1.0 % reduction of the Nagero Creek catchment and 0.7 % reduction of the Goonbri/Bollol Creek catchment are predicted for Modification 7 (Hydro Engineering & Consulting Pty Ltd [HEC], 2019).

5.3.3 Predicted Final Void Hydrology and Hydrochemistry

A final void water recovery analysis has been conducted by WRM (2024). The final void water recovery analysis also included simulations of the long-term salinity of the final void waterbody (WRM, 2024).

Inflows into the final void will comprise incident rainfall, runoff and groundwater (including waste rock emplacement infiltration). Once mining operations and backfilling activities in the open cut cease, inflows to the final void will no longer be collected and pumped out, and as a result, the void would gradually begin to fill with water. The final void is predicted to form a permanent waterbody and is expected to reach an equilibrium level of approximately 214 m AHD after approximately 150 years (approximately 70 m below the spill level of the final void) (WRM, 2024).

The final void is predicted to create a localised groundwater sink which would prevent salts or poorer quality groundwater from migrating out from the mine area and adversely impacting the beneficial use of local groundwater aquifers. An equilibrium level of the final void waterbody approaching, but below the pre-mining groundwater level, will minimise the long-term groundwater drawdown associated with the final void (AGE, 2024; Appendix B).

Modelled long-term salinity of water within the final void rises slowly over time due to the void being a sink for groundwater flow, and there is no net outflow from the void to remove salt load. Final void salinity levels are predicted reach approximately 11,500 milligrams per litre (mg/L) at the end of the simulation period (WRM, 2024). As this concentration is less than sea water, and the increase in density from freshwater would be only 2 %, there is no risk of density-driven migration of saline water out of the final void in a direction opposite to the apparent hydraulic gradient.[4] In simulating pit lake salinity, the model assumes conservation of mass and fully mixed conditions. The final void waterbody is not predicted to spill under any of the simulated climatic sequences (i.e. the final void water body would not pollute downstream waters).

5.3.4 Cumulative impacts

Previous analyses (HydroSimulations, 2019) included consideration of cumulative groundwater impacts of Modification 7 and the Boggabri, Maules Creek and the Rocglen Coal Mines. Post-mining groundwater inflows from the coal seams or interburden attributed to the *Water Sharing Plan for the NSW Murray Darling Basin*

[4] For context, experience gathered at an Andean salar in Argentina suggests that a density correction of about 10 m is required for a brine density of about 1.2 tonnes per cubic metre (t/m^3) (N. Merrick, pers. comm.). The Tarrawonga Coal Mine pit lake is expected to have an ultimate density of only 1.02 t/m^3. It follows that the density-corrected hydraulic gradient would be in the same direction as the apparent hydraulic gradient for pit water level more than 10 m below ambient groundwater levels (approximately 270 m AHD to the east and about 265 m AHD to the south of the final void).

Porous Rock Groundwater Sources 2020 is predicted to be up to 52 megalitres per annum (ML/annum), which is below the current licenses held by TCPL for the Tarrawonga Coal Mine (i.e. 300 ML). Inflows are also predicted to be less than those predicted under the approved Tarrawonga Coal Project (TCPL, 2012).

The cumulative impacts of groundwater impacts are yet to be fully considered as part of this Final Void and Mine Closure Plan, as the groundwater assessment for this plan is based on best available information from a newly developed groundwater model that captures the bigger mining precent which consists of the Boggabri, Maules Creek and Tarrawonga Coal Mines. This groundwater model was in its final stages of development and was not complete at the time when this document was written. Compared to the previous analysis presented in the draft Final Void and Mine Closure Plan (TCPL, 2019), the final void equilibrium water level is much lower, which is likely contributed to lower groundwater inflow estimates that did not consider inflows derived from backfilled spoil (AGE, 2024). It is understood that the final void design would be further reviewed once the development of the new groundwater model is complete, and this Final Void and Mine Closure Plan would be continuously improved based on future tools and data that would become available as the mine progresses to closure in 2030.

Final void design and mine planning will continue to be undertaken by TCPL in consultation with relevant government agencies as a component of the Tarrawonga Rehabilitation Management Plan and approvals process. This would include model verification and re-simulation of the behaviour of the final void waterbody using the results of the groundwater and surface water monitoring programs (Section 7.1).

5.3.5 Final Void Stability and Safety

The highwall on the eastern and northern sides of the final void will be benched with an overall slope of approximately 48°. The overall slope of the western and southern sides of the final void will be approximately 10° to 15°. A geotechnical assessment to assess final void highwall stability will be undertaken post-mining (Section 7.1).

General principles that may be adopted to make the final void safe and stable include:

- battering back low wall and highwalls to minimise potential for failures and mass movement;
- excavating or capping exposed coaliferous material with inert material, to prevent ignition from spontaneous combustion, bushfires or human interference;
- constructing a physical barrier to isolate the perimeter of the void to prevent human access. The highwall areas will be secured by the construction of a trench and a safety berm, as well as a security fence along the entire length of the eastern and northern highwalls;
- suitable signs, clearly stating the risk to public safety and prohibiting public access, will be erected at intervals along the entire length of the fence; and
- surface runoff from land surrounding the void will be diverted to prevent any potential development of instability of the void walls.

5.4 Domain 5D – Water Management Infrastructure

At the cessation of mining activities and once they are no longer required, mine water dams will be emptied by pumping to the final void and any contaminated soils removed and/or treated. The dams will be retained for future use as water storages for livestock watering (as agreed with relevant regulatory authorities and the ultimate landholder) or filled and/or reprofiled and revegetated.

Sediment dams will be retained pending the achievement of long-term acceptable water quality in runoff from rehabilitated landforms to ensure that there is no adverse effect to the downstream environment. Sediment dam spillways will be designed for a 1 % AEP peak discharge.

6 Rehabilitation management

6.1 Rehabilitation objectives

Condition 61, Schedule 3 of PA MP11_0047 Table 14 prescribes the rehabilitation objectives for the Tarrawonga Coal Mine. Rehabilitation objectives outlined in Table 14 of PA MP11_0047 have been reproduced in Table 4 below, which outlines where in this Final Void and Mine Closure Plan each rehabilitation objective is addressed. The rehabilitation objectives in Table 4 also reflect Modification 7, as described below.

Under the approved Tarrawonga Coal Mine, the alluvial soils would be used to establish Class 3 agricultural suitability land in accordance with Schedule 3, Condition 61 of PA MP11_0047. Under Modification 7 there is no mining of the Upper Namoi alluvium, and the establishment of Class 3 agricultural suitability land is not proposed. Modification 7 therefore provides approximately 257 ha of rehabilitated land suitable for grazing post-mining. Rehabilitation objectives for the modified life of mine are detailed in Table 4.

As described in Section 1.2.1, Modification 7 reduced the approved open cut extent at the Tarrawonga Coal Mine to avoid mining the Upper Namoi alluvium and Goonbri Creek. Given that mining of the Upper Namoi alluvium is no longer proposed, the low permeability barrier and Goonbri Creek diversion required under Schedule 3, Condition 37 of PA MP11_0047 are no longer required for the modified Tarrawonga Coal Mine (under Modification 7).

Table 4 – Rehabilitation objectives for the modified Tarrawonga Coal Mine

Feature	Objective	Section of this plan
Mine site (as a whole)	Safe, stable and non-polluting	Whole document
	Constructed landforms drain to the natural environment	Sections 5.1.1 and 5.1.3
	Landforms fully integrated with the final landform for the Boggabri coal mine as per the EA	Section 5.1.2
Final void	Minimise the size and depth of the final void as far as is reasonable and feasible	Section 5.3.2
	Minimise the drainage catchment of the final void as far as is reasonable and feasible	Section 5.3.2
	Negligible high wall instability risk	Sections 5.3.4 and 7.1
	Minimise risk of flood interaction for all flood events up to and including the Probable Maximum Flood level	Section 5.3.2
Surface infrastructure	To be decommissioned and removed, unless Resources Regulator agrees otherwise	Section 7.3
Agricultural land	Establish a minimum of 257 hectares of Class 3 agricultural suitability land, including 160 hectares suitable for grazing	Section 4
All land – excluding the 257 ha of agricultural land and the final void	Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of: • local native plant species (particularly Box Gum Woodland EEC); and • a landform consistent with the surrounding environment	Sections 5.1.1 and 5.1.3

Feature	Objective	Section of this plan
Goonbri Creek and Upper Namoi Alluvium	From PA MP11_0047 labelled as Table 13: • Upper Namoi alluvial aquifer – No direct disturbance to the alluvial aquifer, or mining operations (excluding flood bun construction within 10 metres of the aquifer) – No more than negligible environmental consequences to the alluvial aquifer, including: - negligible change in groundwater levels; - negligible leakage to the mining pit workings; - negligible change in groundwater quality; - negligible stability and erosion risks; and - negligible impact to other groundwater users. • Goonbri Creek – Hydraulically and geomorphologically stable – Negligible change to off-site flooding characteristics (including flood levels, velocities and flood storage capacity) – Riparian vegetation, habitat, energy management and dissipation, bedload transport, biophysical maintenance and pool holding capacity that is the same or better than existing prior to mining • Flood bund (if required, see condition 37 of PA MP11_0047) – Hydraulically and geomorphologically stable – Negligible change to off-site flooding characteristics (including flood levels, velocities and flood storage capacity) – Provides suitable protection for flood events up to and including the Probable Maximum Flood.	N/A – mining in the Upper Namoi Alluvium is not proposed and the low permeability barrier and Goonbri Creek diversion are no longer required
Community	Ensure public safety	Sections 5.3.4 and 7.7
	Minimise the adverse socio-economic effects associated with mine closure	Sections 5.3.4 and 7.7

6.2 Rehabilitation practices and measures

Rehabilitation practices and measures will continue to be outlined in the Tarrawonga Rehabilitation Management Plan. Typical rehabilitation practices and measures include:

- vegetation clearing measures;
- soil management measures;
- progressive rehabilitation practices;
- selection of native plant species for revegetation;
- re-establishment of agricultural land;
- erosion and sediment control system; and
- weed and vertebrate pest management.

6.3 Rehabilitation monitoring

A rehabilitation monitoring program has been developed for the Tarrawonga Coal Mine and it is conducted to:

- assess and track the performance of rehabilitated areas against the rehabilitation completion criteria (Section 6.4);
- evaluate the effectiveness of rehabilitation techniques used (i.e. success of initial cover crop, success of tree and shrub tube stock plantings, adequacy of drainage controls, and the general stability of the rehabilitation site);

- monitor any potential threats to rehabilitation success (e.g. weed incursion, pest species, dispersive soils, evidence of erosion/sedimentation); and
- determine the requirement for ameliorative/contingency measures such as thinning to reduce the density of revegetated areas, or additional plantings in areas where vegetation establishment has been sub-optimal.

The rehabilitation monitoring program includes regular inspections of rehabilitation areas by TCPL personnel (to observe overall performance and stability of the area), and annual revegetation monitoring surveys undertaken by suitably qualified and experienced specialists. The revegetation monitoring surveys are conducted in accordance with the Biodiversity Assessment Method (OEH, 2017) and include the assessment of fixed monitoring plots in rehabilitation areas against the rehabilitation performance indicators and completion criteria (Section 6.4).

Details of the rehabilitation monitoring program are provided in the Tarrawonga Rehabilitation Management Plan.

A detailed rehabilitation monitoring report would continue to be prepared annually that includes a summary of previous monitoring reports, results of the current year's monitoring and planned remedial works, if required. Results of the monitoring program would be summarised in the Annual Review.

The frequency of rehabilitation monitoring post-closure will be defined in the Tarrawonga Rehabilitation Management Plan and during the lead up to mine closure.

6.4 Rehabilitation completion criteria

The completion criteria are objective target levels or values assigned to a variety of indicators (e.g. slope, species diversity, percent groundcover), which can be measured to demonstrate progress and ultimate success of rehabilitation. As such, they provide a defined end point, at which point in time rehabilitation can be deemed successful and the lease relinquishment process can proceed. The rehabilitation completion criteria for the Tarrawonga Coal Mine are listed in Table 5.

These completion criteria, which may be subject to refinement as the operation progresses, including through consultation with the relevant stakeholders, will be utilised to demonstrate achievement of rehabilitation objectives. The achievement (or otherwise) of the completion criteria will be monitored and reported within the annual reports to be submitted to relevant government agencies.

Table 5 – Rehabilitation Objectives, Performance Indicators and Completion Criteria

Final land use domain	Rehabilitation objective	Performance indicator	Completion criteria
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	All infrastructure that is not to be used as part of the final land use is removed to ensure the site is safe and free of hazardous materials.	No external services connected to site (generator and mobile communication tower used).	N/A
		Demolition and removal of all surface infrastructure that is not required for the final land use.	Infrastructure removed.
	All infrastructure that is not to be used as part of the final land use is removed to ensure the site is safe and free of hazardous materials.	Removal of all concrete footings, foundations and pavements.	All concrete footings, foundations and pavements have been removed.
		Surveying and sealing of all holes and exploration boreholes with departmental guidelines and relevant standards.	Sealing completed and verified.
	There is no residual soil contamination onsite that is incompatible with the final land use or that poses a threat of environmental harm.	Waste material and/or visible contamination areas on site surface.	There are no visible signs of contamination following the removal of plant, equipment and materials.
			Any contamination has been appropriately remediated in accordance with legislative requirements for the intended final land use.
			Retained dams are decontaminated in accordance with regulatory requirements.
			Surface layer is free of any hazardous materials.
	Residual waste materials stored on site (e.g. tailings, coarse rejects and other wastes) will be appropriately contained / encapsulated so it does not pose any hazards or constraints for intended final land use.	Quality assurance records for the locations of rejects and depth of capping material, and records of contamination.	There are no visible signs of contamination following the removal of plant, equipment and materials.
			All rubbish / waste materials have been removed from site.
			Any carbonaceous material has been removed from the footprint of the infrastructure areas and disposed of in the void, with at least 3 m cover.
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	The final landform is stable for the long-term and does not present a risk of environmental harm downstream / downslope of the site or a safety risk to the public / stock / native fauna.	Visual / measured / modelled evidence of erosion / landform stability.	Survey or remote sensing of the rehabilitated landforms shows an absence of erosion that could compromise stability.
			Any erosion is minimal with no ongoing management works.

Final land use domain	Rehabilitation objective	Performance indicator	Completion criteria
Water Management Areas (B) **Agricultural – grazing (C)** **Native Ecosystem (D)**	Landform that is commensurate with surrounding natural landform and where appropriate, incorporates geomorphic design principles.	Minimal active erosion.	There are no gully or tunnel erosion features and there is an absence of rilling (> 300 mm deep).
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	Runoff water quality from mine site meets the requirements of the relevant development consent(s) / Environmental Protection Licence and does not present a risk of environmental harm.	Water quality parameters selected from Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 and/or Environment Protection Licence.	Runoff water quality from rehabilitation areas represents an acceptable level of change from a defined reference condition (refer to *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*). Water quality in retained dams and/or voids is suitable for the final land use.
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	Groundwater quality meets the requirements of the relevant development consent(s) / Environment Protection Licence and does not present a risk of environmental harm.	Water quality parameters from Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.	Water quality generally consistent with ANZECC guidelines for specific environment. Independent hydrological assessment report.
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	Impacts to groundwater regime are within range as per the development consent(s) / pre-mining environmental assessment.	Groundwater levels and flows.	If there were any impacts to groundwater levels / groundwater flow these would be generally consistent with development consent(s) (including associated Management Plans).
Final Void (A) **Water Management Areas (B)**	Structures that take or divert water such as final voids, dams, levees, etc. are appropriately licensed (e.g. under the *Water Management Act 2000*) and where required ensure sufficient licence shares are held in the water source(s) to account for water take.	Final landform considers advice from relevant Government Agency whether sufficient licence shares are available in the water source to account for water stored in voids and dams in the proposed final landform.	Water approvals / licences are granted by relevant NSW Government Agency.
Final Void (A) **Water Management Areas (B)** **Agricultural – grazing (C)** **Native Ecosystem (D)**	The risk of bushfire and impacts to the community, environment and infrastructure has been addressed as part of rehabilitation.	Appropriate bushfire hazard controls (where required) have been implemented on the advice from the NSW Rural Fire Service.	Bushfire controls implemented similar to surrounding land management on similar vegetation communities.

Final land use domain	Rehabilitation objective	Performance indicator	Completion criteria
Agricultural – grazing (C)	Revegetation is sustainable for the long-term and only requires maintenance that is consistent with the intended final land use.	Vegetation health, species composition and regeneration.	Rehabilitation monitoring verifies that species in pasture rehabilitation areas comprise of a mixture of grasses representative of pasture vegetation.
			Rehabilitation monitoring verifies that vegetation health is comparable to reference sites (within 20 %).
			Rehabilitation monitoring verifies that species in pasture rehabilitation areas comprise a mixture of grasses representative of pasture vegetation.
			Established species survive and/or regenerate after disturbance.
			Species are capable of setting viable seed, flowering or otherwise reproducing.
Agricultural – grazing (C)	Land use capability is capable of supporting the target agricultural land use 257 ha of Class 3 agricultural suitability land.	Native plant species record from monitoring plots are characteristic of pasture species suitable for grazing.	Rehabilitation monitoring verifies that species in pasture rehabilitation areas comprise a mixture of grasses representative of pasture vegetation.
			Pasture areas are assessed to have a Rural Land Class VI or better (capable of sustaining grazing), consistent with the final landform.
			Area of land rehabilitated to pasture is commensurate with the Project Approval and RMP.
Agricultural – grazing (C)	Land use capability of supporting the target agricultural land use 160 ha suitable for grazing.	Native plant species recorded from monitoring plots are characteristic of pasture species suitable for grazing.	Rehabilitation monitoring verifies that species in pasture rehabilitation areas comprise of a mixture or grasses representative of pasture vegetation.
			Pasture areas are assessed to have a Rural Land Class VI or better (capable of sustaining grazing), consistent with the final landform.
			Area of land rehabilitation to pasture is commensurate with the Project Approval (PA MP11_0047) and the Tarrawonga Rehabilitation Management Plan.

Final land use domain	Rehabilitation objective	Performance indicator	Completion criteria
Native Ecosystem (D)	The vegetation composition of the rehabilitation is recognisable as the target vegetation community (Narrow leaved Ironbark – Cypress Pine – White Box shrubby open forest Biometric Vegetation Type [BVT] 316 and Plant Community Type [PCT] 592 contained within the BioNet Vegetation Classification).	Native plant species recorded from monitoring plots are characteristic of the target vegetation community (e.g. target PCT).	Rehabilitation monitoring verifies that native ecosystem indicators have achieved the completion criteria targets list in Table 16.
Native Ecosystem (D)	The vegetation structure of the rehabilitation is recognisable as, or is trending towards (based on ongoing monitoring data) the target vegetation community (Narrow leaved Ironbark – Cypress Pine – White Box shrubby open forest [BVT 316 and PCT 592] contained within the BioNet Vegetation Classification).	Cover and abundance of plant growth forms recorded from monitoring plots are characteristic of the target vegetation community (e.g. PCT), or an ongoing trend toward becoming characteristic is evident from the monitoring data	
Native Ecosystem (D)	Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable.	Indicators of nutrient cycling are suitable for sustaining the target vegetation community (e.g. PCT(s))	Rehabilitation monitoring verifies that native ecosystem indicators have achieved the completion criteria targets list in Table 16 in the Tarrawonga Rehabilitation Management Plan.
			Established species survive and/or regenerate after disturbance.
			Species are capable of setting viable seed, flowering or otherwise reproducing.

7 Mine closure planning

Planning for mine closure would be conducted over the life of the mine, in consultation with the relevant regulatory agencies and community (Section 7.8) and would consider the amelioration of potential adverse socio-economic effects due to the reduction in employment at mine closure (Section 7.7).

This section outlines anticipated key aspects associated with closure of the Tarrawonga Coal Mine, including anticipated verification studies, how the Tarrawonga Coal Mine would be integrated with the adjoining Boggabri Coal Mine, infrastructure decommissioning and rehabilitation resource planning, land contamination assessment requirements and post-closure monitoring and maintenance activities.

7.1 Verification studies

Various technical studies and assessments and other works would be undertaken during the mine closure phase to verify and confirm that the Tarrawonga Coal Mine rehabilitation completion criteria (Section 6.4) have been met. Anticipated technical studies and assessments include a geotechnical stability assessment of the final void and a stability assessment of key final landforms (e.g. waste emplacements and retained water management infrastructure including drop structures and stilling basins).

As described in Section 5.3.4, final void model verification and re-simulation of the behaviour of the final void waterbody using the results of the post-mine groundwater and surface water monitoring programs would be undertaken post-closure.

7.2 Integration with adjoining Boggabri Coal Mine

As described in Section 5.1.2, rehabilitation of the Northern Emplacement will be integrated with the southern extent of the Boggabri Coal Mine waste rock emplacement.

The Tarrawonga Boggabri Common Boundary Integrated Management Plan, which has been developed between TCPL and BCOPL and in consultation with the Resources Regulator, details the integrated landform design and rehabilitation concepts. This plan will continue to be implemented with BCOPL to guide rehabilitation of the northern extent of the Northern Emplacement, and the drainage corridor located between the Northern Emplacement and the Boggabri Coal Mine waste rock emplacement.

7.3 Infrastructure decommissioning

Decommissioning and removal of infrastructure not required in the final landform will take place during the mine closure phase. Surface infrastructure will be decommissioned and removed in consultation with the Resources Regulator. Decommissioning of the mine infrastructure area will include removal of foundation and hardstand materials, services, equipment and infrastructure, remediation of any land contamination, ripping, topsoiling (if necessary) and seeding.

Any infrastructure including dams, levee banks, roads and buildings, which have been determined during consultation to be beneficial for future use by the ultimate post-mine landowners, will be left in place, subject to approval by the Resources Regulator and any other relevant regulatory agencies.

7.4 Rehabilitation resources

TCPL maintains a site soil balance which is updated annually to ensure adequate resources are available for rehabilitation of disturbed areas. A site soil balance will continue to be reviewed and updated as soil stripping activities and progressive rehabilitation activities are undertaken.

7.5 Land contamination assessment

As described in Section 5.2, a land contamination assessment will be undertaken once mining operations have ceased, during the mine closure phase. The assessment will focus on decommissioned infrastructure areas, including ROM coal handling and stockpiling areas, mine facilities area, including fuel storage areas and chemical storage facilities.

The land contamination assessment will be undertaken in accordance with the requirements of the *NSW Contaminated Land Management Act 1997* and in consideration of relevant guidelines, including the Managing Land Contamination Planning Guidelines SEPP 55–Remediation of Land (Department of Urban Affairs and Planning and EPA, 1998), Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011) and the National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 2013).

Any potential contamination areas will be remediated as recommended in the assessment, which is expected to involve excavation of the contaminated materials and disposal at an off-site licensed facility or on-site subject to relevant approvals being obtained. Rehabilitation of the area would be undertaken in accordance with the rehabilitation objectives for the Infrastructure Area Domain (Section 5.2) (i.e. revegetated with pasture species), or domain applicable to the area.

As part of the decommissioning process for sediment dams not required for the final landform, following dewatering, any contaminated soils/sediments would be excavated/removed for disposal at an off-site licensed facility or on-site subject to contaminant type and any relevant approvals being obtained.

7.6 Post-closure monitoring and maintenance

The mine closure phase will commence once all mining activities at the Tarrawonga Coal Mine have ceased, all relevant infrastructure required to be removed has been decommissioned and removed and once all final landform rehabilitation works (e.g. bulk shaping, soil placement and revegetation activities) have been completed. The post-closure monitoring and maintenance phase is relevant to the period after the completion of all works needed to implement closure of the Tarrawonga Coal Mine up until relinquishment of the site.

7.6.1 Post-closure Monitoring

TCPL currently conducts numerous environmental monitoring programs at the Tarrawonga Coal Mine in accordance with the PA MP11_0047, environmental protection licence 12365 and environmental management plan requirements, including air quality, noise, blasting, surface water, groundwater, rehabilitation and offset area monitoring programs.

Some of these monitoring programs will continue during the post-closure phase (e.g. surface water and groundwater monitoring, rehabilitation monitoring), however, some programs will become redundant and will cease (e.g. blast monitoring) or will be gradually refined once coal extraction and landform bulk shaping and soil placement rehabilitation works have ceased (e.g. noise and air quality monitoring). TCPL will refine its monitoring programs in consultation with the relevant government agencies during the mine closure phase.

It is anticipated that the surface water and groundwater monitoring program will be progressively refined during the post-closure period to focus on runoff areas from the major mine landforms and groundwater aquifers potentially impacted by the Tarrawonga Coal Mine.

Rehabilitation performance monitoring will continue throughout the post-closure phase and results from the rehabilitation monitoring program will be used to confirm that the rehabilitation completion criteria have been met.

Amendments to the monitoring programs during the post-closure phase will be reflected in revisions to the Tarrawonga Coal Mine environmental management plans, and subject to approval by relevant regulatory agencies. It is expected that the residual monitoring programs will be undertaken for approximately 10 years following mine closure or as deemed required subject to relevant agency consultation.

7.6.2 Post-closure Maintenance

Results from the post-closure monitoring programs will be used to inform the post-closure maintenance requirements (e.g. the requirement for erosion control, supplementary rehabilitation plantings, weed and pest control activities). It is expected that any maintenance requirements will be undertaken on a campaign/as required basis.

Post-closure maintenance activities will continue until the specific completion criteria have been met and confirmation has been received from the relevant authority.

7.7 Social closure planning

Cessation of the mining operations is expected to result in a contraction in regional economic activity.

The magnitude of the regional economic impacts at the end of the Tarrawonga Coal Mine life depends on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time.

The Gunnedah Basin is a prospective location with a range of coal and coal seam methane resources. New mining resource developments in the region help broaden the region's economic base and buffer against impacts of the cessation of individual activities (Gillespie Economics, 2011).

TCPL will continue to engage with the local community and regulatory stakeholders on key environmental and socio-economic issues during the closure and post-mining phase. The final version of the Final Void and Mine Closure Plan will include further consideration of economic and social impacts at mine closure.

7.8 Mine closure consultation

Proposed rehabilitation and post-mining land use concepts have been continuously developed throughout the Tarrawonga Coal Mine approval process, in consultation with relevant government agencies and key stakeholders, including the CCC.

As described in Section 1.4, the following government agencies and key stakeholders have been consulted regarding the revised final landform:

- OEH;
- NSW DCCEEW – Water;
- NSW EPA;
- NSW DPHI;

- NSW Resources Regulator;
- NSW Roads and Maritime Services;
- Transport for NSW;
- NSW Department of Industry – Fisheries;
- NSW Department of Industry – Lands;
- NSW Health;
- Local Land Services;
- CCC; and
- Registered Aboriginal Parties.

TCPL will continue to consult with relevant government agencies and the community throughout the mine life and during mine closure.

8 Review and implementation of this plan

8.1 Review protocol

In accordance with the requirements of Condition 5, Schedule 5 of PA MP11_0047, this Final Void and Mine Closure Plan will be reviewed and revised, if necessary, within three months of the submission of an:

- Annual Review under Condition 4, Schedule 5 of PA MP11_0047;
- Incident Report under Condition 8, Schedule 5 of PA MP11_0047;
- Independent Environmental Audit under Condition 10, Schedule 5 of PA MP11_0047; or
- any modification to the conditions of PA MP11_0047.

Review of this Final Void and Mine Closure Plan will be completed under PA MP11_0047 to the satisfaction of the Secretary.

8.2 Implementation

Key TCPL personnel responsible for implementation of this draft Final Void and Mine Closure Plan and conducting the review protocol above include the General Manager, Operations Manager and the Environment Superintendent.

9 Limitations

The following sections summarise limitations encountered at the time this Final Void and Mine Closure Plan was prepared.

9.1 Groundwater inflow rates

Recent assessment of groundwater inflow rates only considered the surrounding Permian aquifer and did not consider inflow derived from backfilled spoil. Recharge in the Permian itself was found negligible relative to the spoil due to enhanced infiltration from the disturbed material therefore, precluding the effects of enhanced recharge in spoil proximal to the pit void results in reduced estimates of groundwater (AGE, 2024). This was a consequence of the development stage of the Boggabri Coal Mine, Tarrawonga Coal Mine and Maules Creek Coal Mine (BTM-complex) model when it was used to perform the present inflow analysis. Setup of the closure simulations, that include the effects of enhanced recharge in the spoil was absent at the time the analysis was undertaken. Per advice, this is scheduled for 2025 (AGE, 2024).

Inflow rates used in the assessment (i.e. simulated groundwater inflow at different stage elevations) are not consistent between the groundwater model and surface water model. It is expected that the inflows will change once the effect of enhance recharge through the spoil is included. Previous work undertaken by HydroSimulations (2019) indicated that roughly 80 % of groundwater inflow to the pit void could be derived from spoil. Inflow rates will be reviewed once the BTM-complex model would be completed in 2025.

9.2 Final void source/sink behaviour

The modelled equilibrium water level is approximately 40 m lower than the previous analysis (HEC, 2019) presented in the draft Final Void and Mine Closure Plan (TCPL, 2019a). The key reason for the lower modelled water level is the revised estimate of groundwater inflows which are less than adopted in the previous assessment. The new equilibrium level is attributed to the reduced groundwater inflows from the absent spoil recharge.

At the modelled equilibrium level in the previous analysis, the adopted groundwater inflow to the void was approximately 240 ML per year, nearly 80 % greater than the latest groundwater inflow estimates (WRM, 2024).

9.3 Final void water balance model

The model results presented in this report are based on data derived from historical climate records and best available data. The sensitivity of these results to future climate change should be considered in the detailed design assessment of the final landform leading to the mine closure in 2030.

TCPL is committed to reviewing and updating this Final Void and Mine Closure Plan, as required, throughout the mine life and during mine closure, and during the detailed design phase of the final landform.

10 References

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Tarrawonga Coal Pty Ltd (2019b). Mining Operations Plan - Tarrawonga Coal Mine - 1 November 2015 to 30 November 2020.

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Appendix A

Tarrawonga Coal Mine, Final Landform Surface Water Modelling

TARRAWONGA COAL MINE

Final Landform Surface Water Modelling

Whitehaven Coal Limited

19 December 2024

1068-45-B2

DETAILS

Report Title	Tarrawonga Coal Mine, Final Landform Surface Water Modelling
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1068-45-B2
Date	19 December 2024
Author	DN/HD/AL
Reviewer	MB

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1 INTRODUCTION

1.1 BACKGROUND

The Tarrawonga Coal Mine is located approximately 42 kilometres (km) north-northwest of Gunnedah in New South Wales (NSW) (Figure 1.1). The Tarrawonga Coal Mine is owned and operated by Tarrawonga Coal Pty Ltd (TCPL), a wholly owned subsidiary of Whitehaven Coal Limited (Whitehaven). The mine forms part of a mining precinct located in and around Leard State Forest, which also includes the Boggabri Coal Mine and Maules Creek Coal Mine (operated by Idemitsu and Whitehaven, respectively).

The Tarrawonga Coal Mine is an open cut coal mine which has been in operation since 2006. Run of mine (ROM) coal is crushed and screened on-site, and the sized ROM coal is loaded onto highway trucks for transport via the Approved ROM Coal Transport Route to the Whitehaven Coal Handling and Preparation Plant. The Tarrawonga Coal Project was approved (PA 11_0047) by the NSW Planning Assessment Commission under delegation of the NSW Minister for Planning and Infrastructure pursuant to section 75J of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) on 22 January 2013. Additionally, the Tarrawonga Coal Mine was granted approval under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) on 11 March 2013 (Commonwealth Approval Decision 2011/5923).

The Tarrawonga Coal Mine is approved to operate until December 2030.

1.2 FINAL VOID AND MINE CLOSURE PLAN

TCPL is preparing a Final Void and Mine Closure Plan for the Tarrawonga Coal Mine, as a component of the overall Rehabilitation Management Plan, to satisfy Condition 65, Schedule 3 of the Tarrawonga Coal Mine Project Approval (PA 11_0047).

1.3 SCOPE OF SURFACE WATER MODELLING

WRM Water & Environment Pty Ltd (WRM) has been requested to undertake surface water modelling to support development of the Final Void and Mine Closure Plan. The completed scope of work has assessed:

- Flooding behaviour of the landform for flood events up to the Probable Maximum Flood to confirm the flood immunity of the final void.
- Long-term water level and water quality behaviour in the final void.

The methodology and results of the flooding and final void assessments are documented in the following sections.

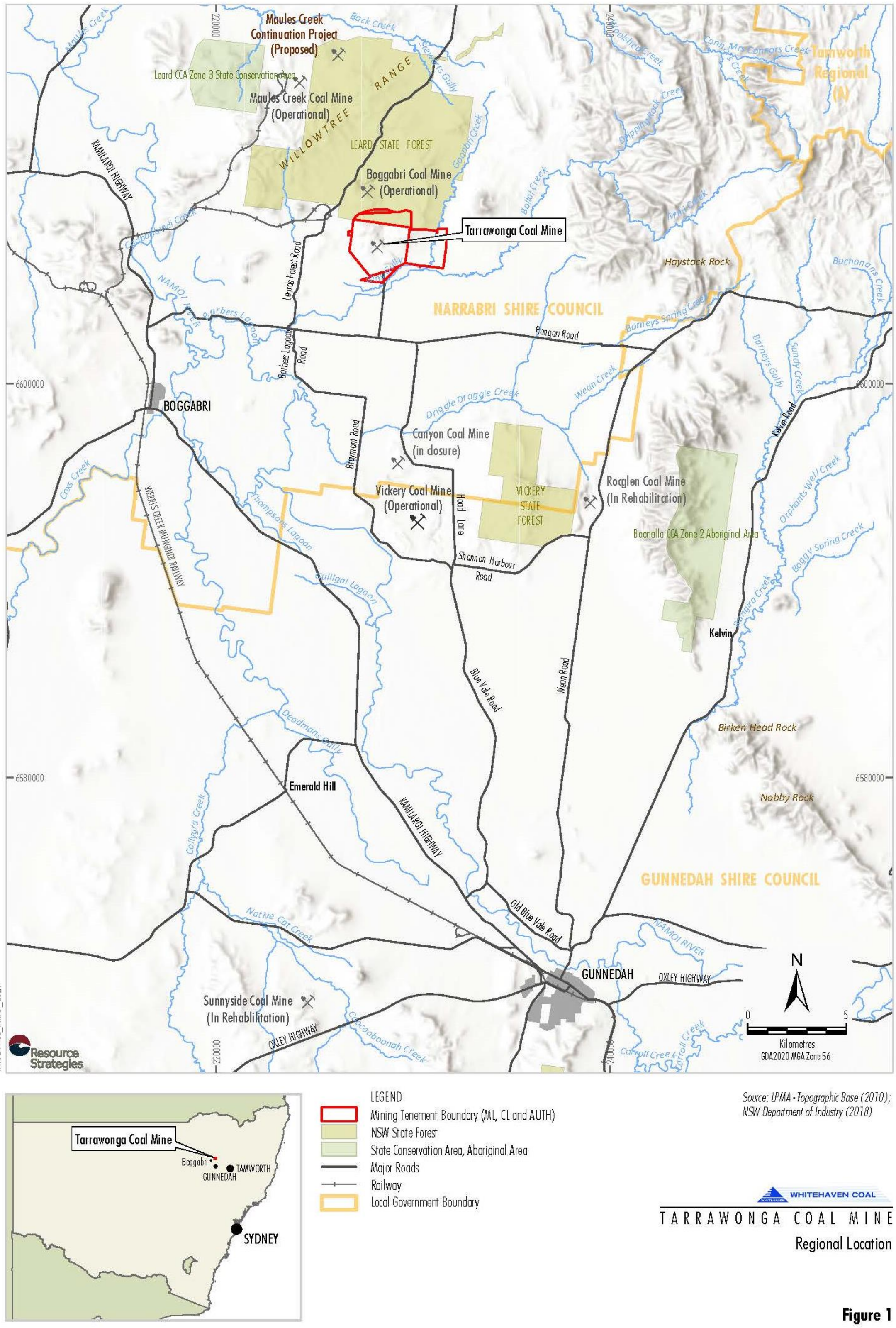

Figure 1.1 Locality Map, Tarrawonga Coal Mine

2 FINAL LANDFORM DRAINAGE ASSESSMENT

2.1 FINAL LANDFORM DESIGN SURFACE

The design of the final landform for Tarrawonga Coal Mine was developed by WSP and provided to WRM in the file:

Tarrawonga_Design_v12_Rev4_EasternPitHighwallMerged_pts_20241203.csv

WRM integrated the design surface with the surrounding topography obtained from LiDAR aerial survey undertaken in March 2023. Combining the design surface and background topography required some trimming of edges of the design surface to provide a smooth transition to the surrounding topography at the boundary of the design surface. At some locations, there are slight anomalies in ground level at the interface between the two surfaces. These anomalies will be resolved through future detailed design of the final landform surface.

Figure 2.1 shows the final landform surface. Key drainage aspects of the landform include:

- Final void with a floor level of approximately 160 mAHD in the eastern corner of the mining pit.
- Western portion of the final landform surface drains to the west.
- Runoff from the eastern portion of the final landform is collected in a central drainage line that diverts stormwater runoff around the final void to discharge to the Goonbri Creek floodplain to the south of the final void.
- A detention pond at the outlet of the central drainage line to reduce peak discharges to the Goonbri Creek floodplain.

2.2 FLOOD MODELLING METHODOLOGY

Flood modelling of the final landform was undertaken to confirm the flood immunity of the final void.

A rain-on-grid (ROG) TUFLOW two-dimensional hydraulic model was developed to identify flow paths and flood depths across the site. The ROG model applies rainfall hyetograph data extracted from the Bureau of Meteorology (BOM) directly to cells within the model domain and automatically determines catchment boundaries and flow paths.

The model was run for the 1% annual exceedance probability (AEP) design rainfalls and probable maximum flood (PMF) events.

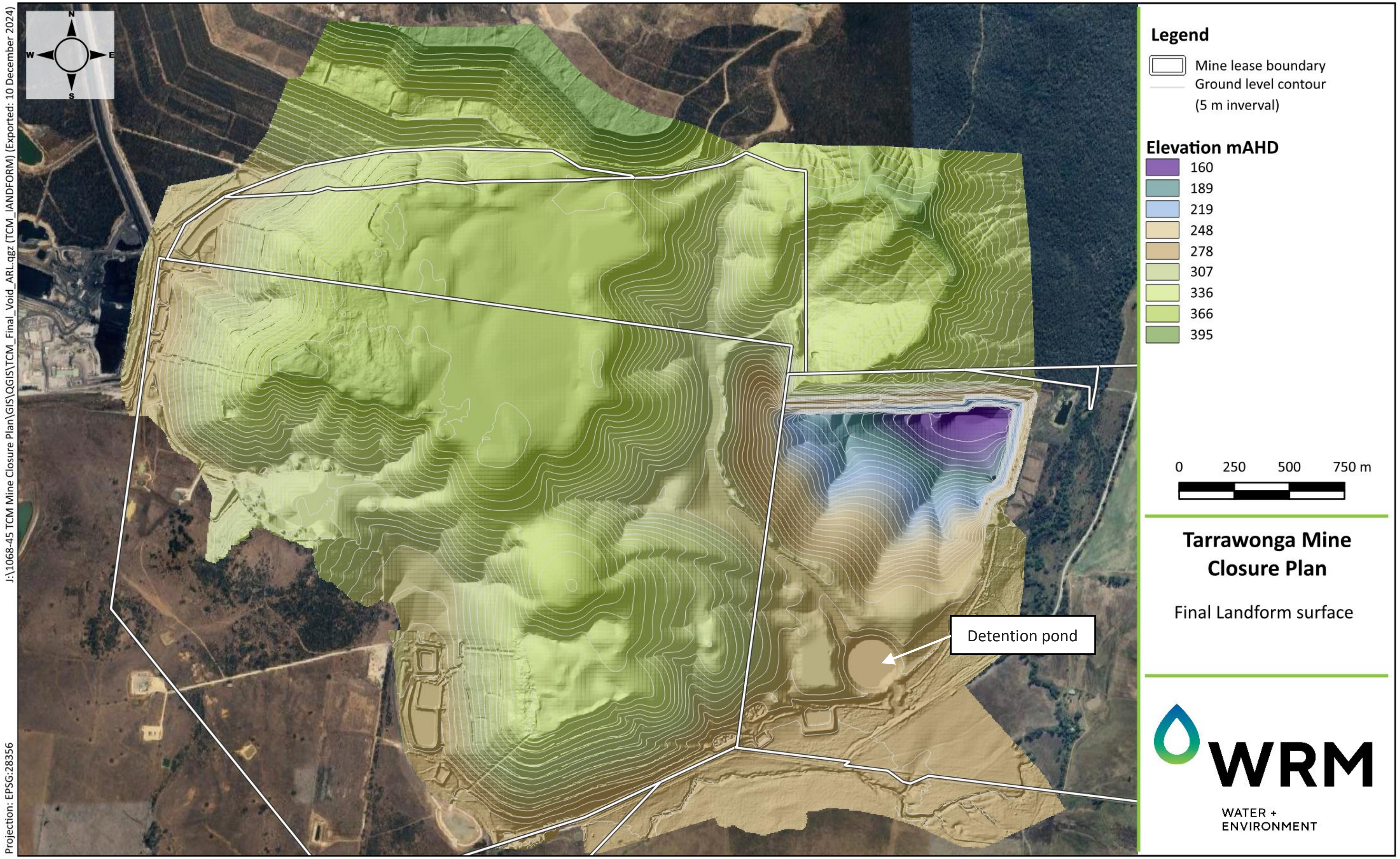

Figure 2.1 Final landform surface

2.3 MODEL CONFIGURATION AND ASSUMPTIONS

Figure 2.2 shows the TUFLOW model configuration adopted in this study. Details of the hydraulic model configuration are described below.

2.3.1 Topography and grid cell size

A digital elevation model of the design surface with a 2 m grid size was provided by WSP. A 5 m grid size resolution was adopted for the TUFLOW model.

2.3.2 Outflow boundaries

A normal-depth rating curve (HQ) boundary condition was adopted for each downstream model boundary where water exits the model domain. The downstream boundaries of the models were set well downstream of the landform design surface to minimise the influence of the model boundaries on drainage from the landform surface. The normal depth slope was calculated from the upstream channel slope.

2.3.3 Detention pond starting water level

The detention pond at the outlet of the main drain was assumed to be full at the start of the rainfall event. This assumption provides the worst case for downstream flows and velocities.

2.3.4 Rainfall input

The ROG TUFLOW model had rainfall directly applied to each grid cell within the model extent using an input rainfall hyetograph, extracted using the QGIS ARR to TUFLOW utility (https://wiki.tuflow.com/QGIS_ARR_to_TUFLOW).

A range of storm durations and temporal patterns were investigated using the ROG TUFLOW model to confirm the critical storm duration. The critical storm duration giving the highest flow rate was found to be 1 hour and temporal pattern 9.

2.3.5 Adopted rainfall losses

Rainfall initial and continuing losses were applied within the TUFLOW rain-on-grid model, with initial loss sourced from the AR&R Data hub probability neutral burst initial losses. Continuing loss was adjusted from the default data hub value to achieve reasonable agreement with the Rational Method. For the 1% AEP 1 hour event, the initial and continuing losses were 15.6 mm and 0.4 mm/hr respectively.

2.3.6 Adopted Manning's 'n' values

The TUFLOW model uses Manning's 'n' values to represent the hydraulic resistance of different material types. The landform was assumed to be vegetated with light vegetation, apart from areas identified as waterbodies (shown in Figure 2.2). Adopted Manning's 'n' values for each land use classification are listed in Table 2.1.

A sensitivity case was modelled to assess the potential impact of higher roughness in the main drainage channel from the final landform. The Manning's n value for the main drain was increased to 0.08.

Table 2.1 Adopted Manning's 'n' values

Land use	Manning's 'n'
Light vegetation	0.035
Waterbody	0.020

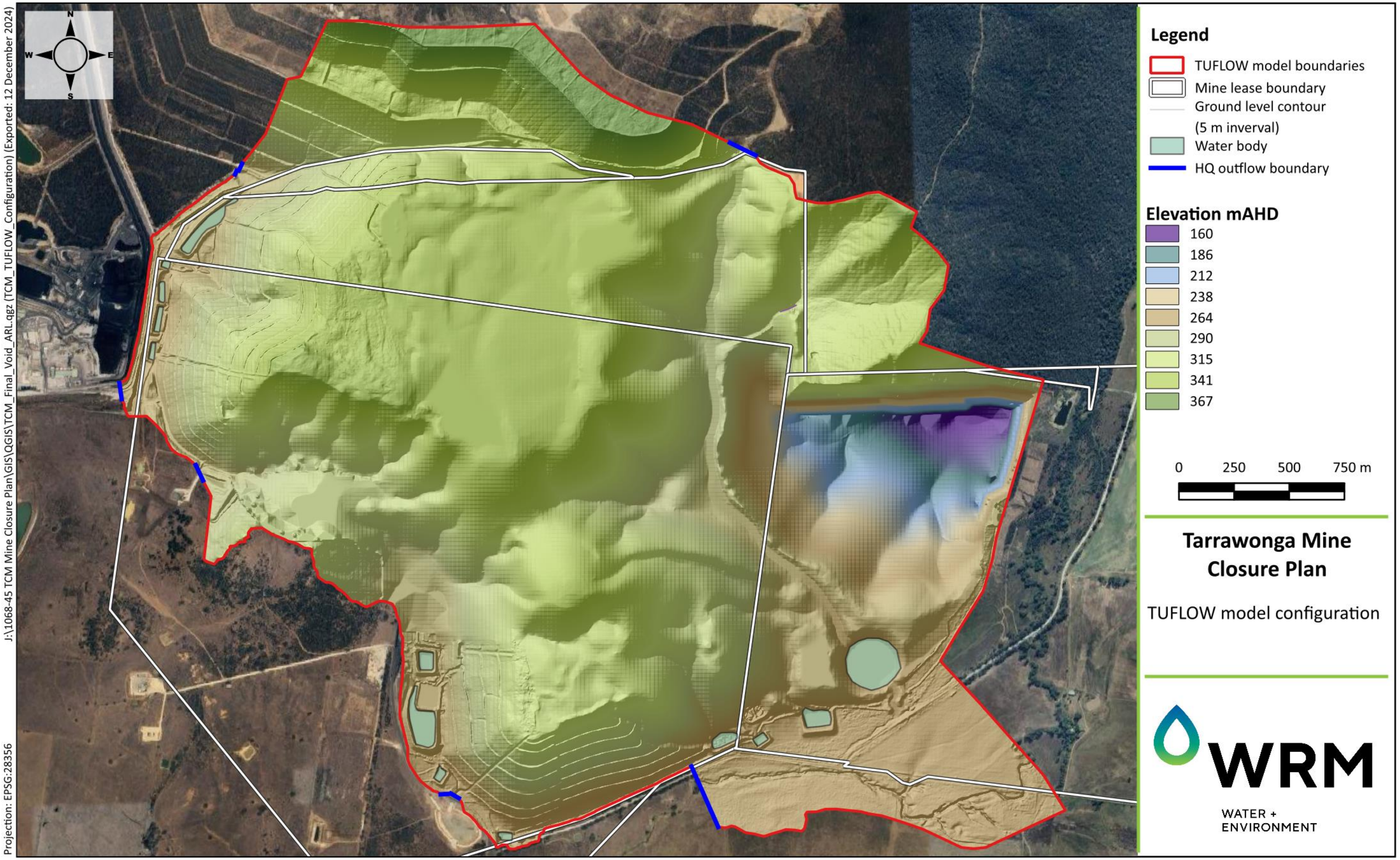

Figure 2.2 TUFLOW model configuration

2.4 VALIDATION OF ESTIMATED DISCHARGES

The results of the ROG model were validated against the Rational Method to confirm that the model provided a realistic estimate of stormwater runoff rates. The catchment of the main drainage path upstream of the detention pond (see Figure 2.3) was selected to compare the Rational Method and ROG peak flow results.

Rational Method calculations are summarised in Table 2.2.

The ROG model peak 1% AEP flow rate of 50 m^3/s is in good agreement with the Rational Method estimate of 48 m^3/s.

Table 2.2 Rational method calculations – main drainage path upstream of detention pond

Parameter	Value	Source/Method
Catchment area	351 ha	Figure 2.3
Runoff coefficient	C_{10} = 0.48 C_{100} = 0.58	Table 4.5.4 - QUDM, 2016
Time of concentration	35.5 min	Overland flow time = 22.9 min (Friend's Equation, QUDM, 2016) Channel flow time 2.3 km @ 3 m/s = 12.6 min
Rainfall Intensity (1 hr, 10% AEP) Rainfall Intensity (35.5 min, 1% AEP)	38.2 mm/hr 85.2 mm/hr	ARR Data Hub (https://data.arr-software.org/)
Design Flow (1% AEP)	48 m^3/s	Rational Method

2.5 ESTIMATION OF PMP RAINFALLS

Probable maximum precipitation (PMP) rainfalls were estimated using the Generalised Short Duration Method (GSDM) and the Revised Generalised Tropical storm Method (GTSMR). The parameters used in estimating PMP are:

- For GSDM:
  - The terrain was assumed to be smooth (S = 1), where the majority of the catchment's elevation changes within 400 m based on available LiDAR data;
  - Elevation Adjustment Factor, EAF = 1;
  - Moisture Adjustment Factor, MAF = 0.76; and
  - Up to 6-hour duration.
- For GTSMR:
  - Located in the coastal zone;
  - Annual Moisture Adjustment Factor, AMAF = 0.65;
  - Winter Moisture Adjustment Factor, WMAF = 0.60;
  - Decay Amplitude Factor, DAF = 0.84; and
  - Topographical Adjustment Factor, TAF = 1.

Table 2.3 shows the estimated 1% AEP and PMP rainfall depths for durations from 1 to 3 hours.

Table 2.3 Design rainfall depths

Duration	1% AEP (mm)	PMP (mm)
1 hr	60.0	350
2 hr	72.2	450
3 hr	79.9	500

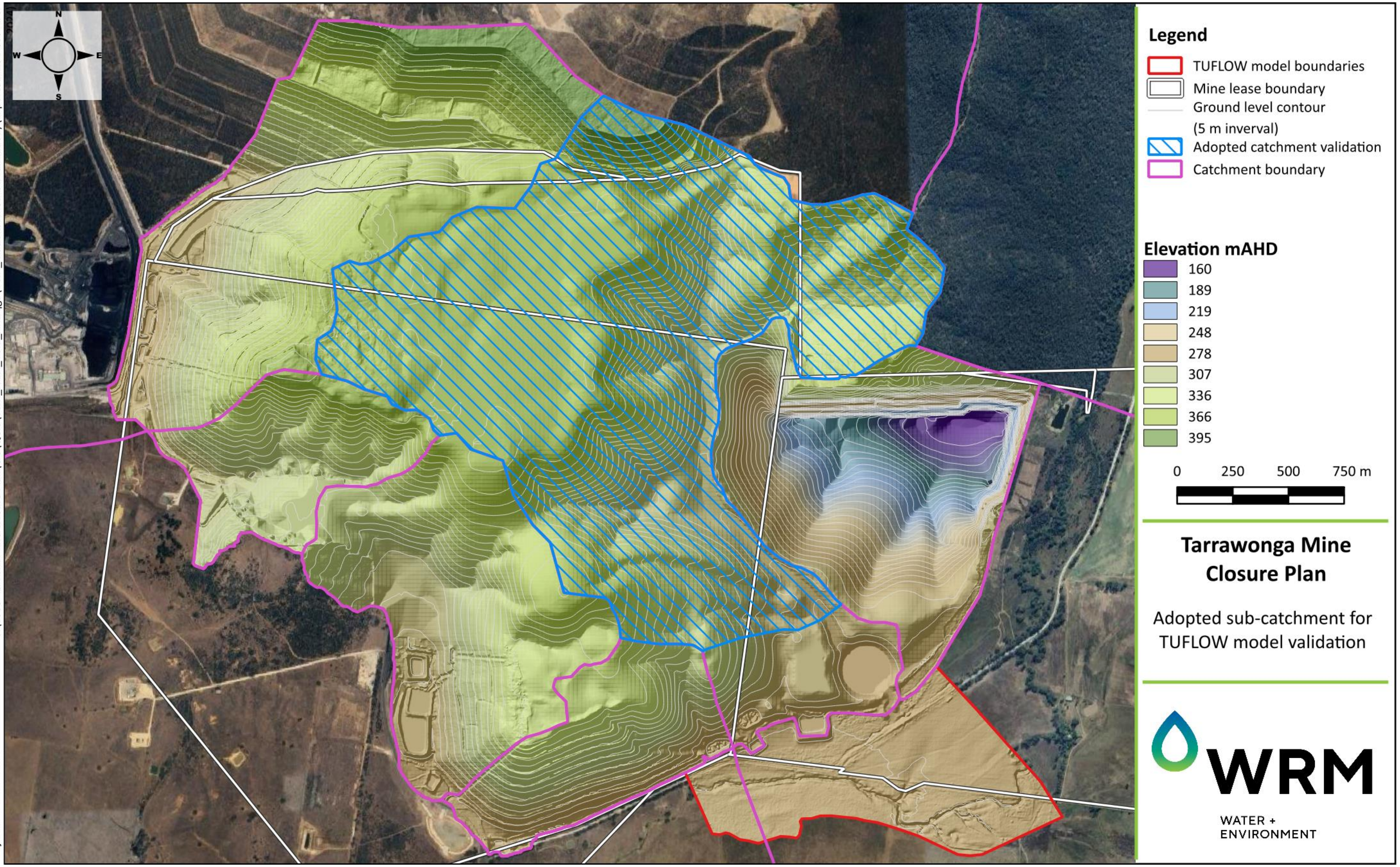

Figure 2.3 Adopted sub-catchment for TUFLOW model validation

2.6 MODEL RESULTS

2.6.1 Design discharges

The ROG estimated design discharges for the main drainage path upstream of the outlet pond are:

- 1% AEP = 50 m^3/s; and
- PMF = 415 m^3/s.

The detention pond attenuates the 1% AEP peak discharge from 50 m^3/s to 36 m^3/s.

2.6.2 Water levels and velocities

Figure 2.4 and Figure 2.5 show the flood extent and depths for the 1% AEP and PMF design events respectively, for local stormwater runoff (not inclusive of Goonbri Creek flooding).

Figure 2.6 shows the flood velocities for the 1% AEP design event. Along the main drain through the final landform, flow velocities for the 1% AEP event are generally in the range of 1.8 to 2.5 m/s.

The model results show that the final void is outside the main drainage paths up to the PMF event.

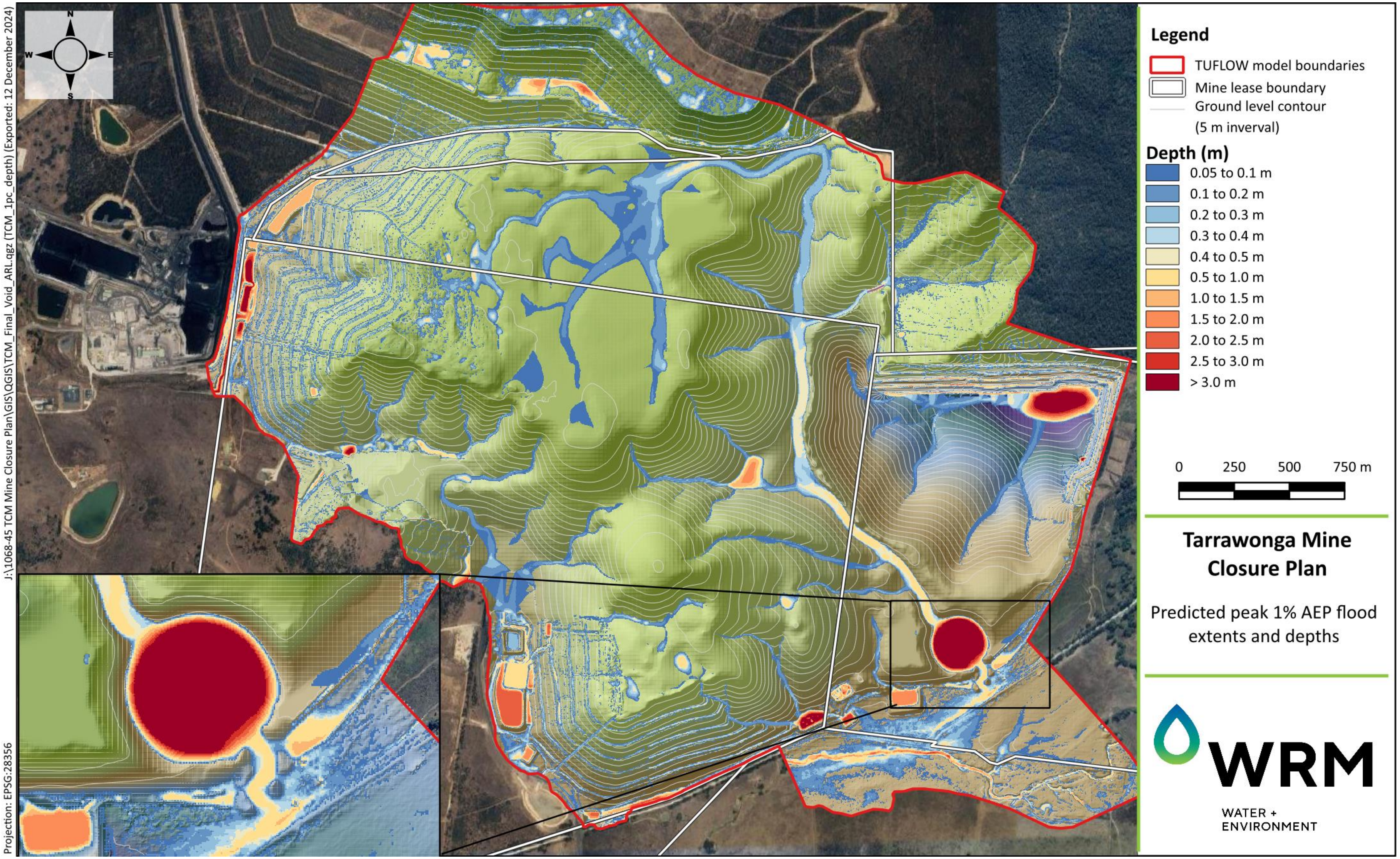

Figure 2.4 1% AEP event flood extent and depth (site runoff only)

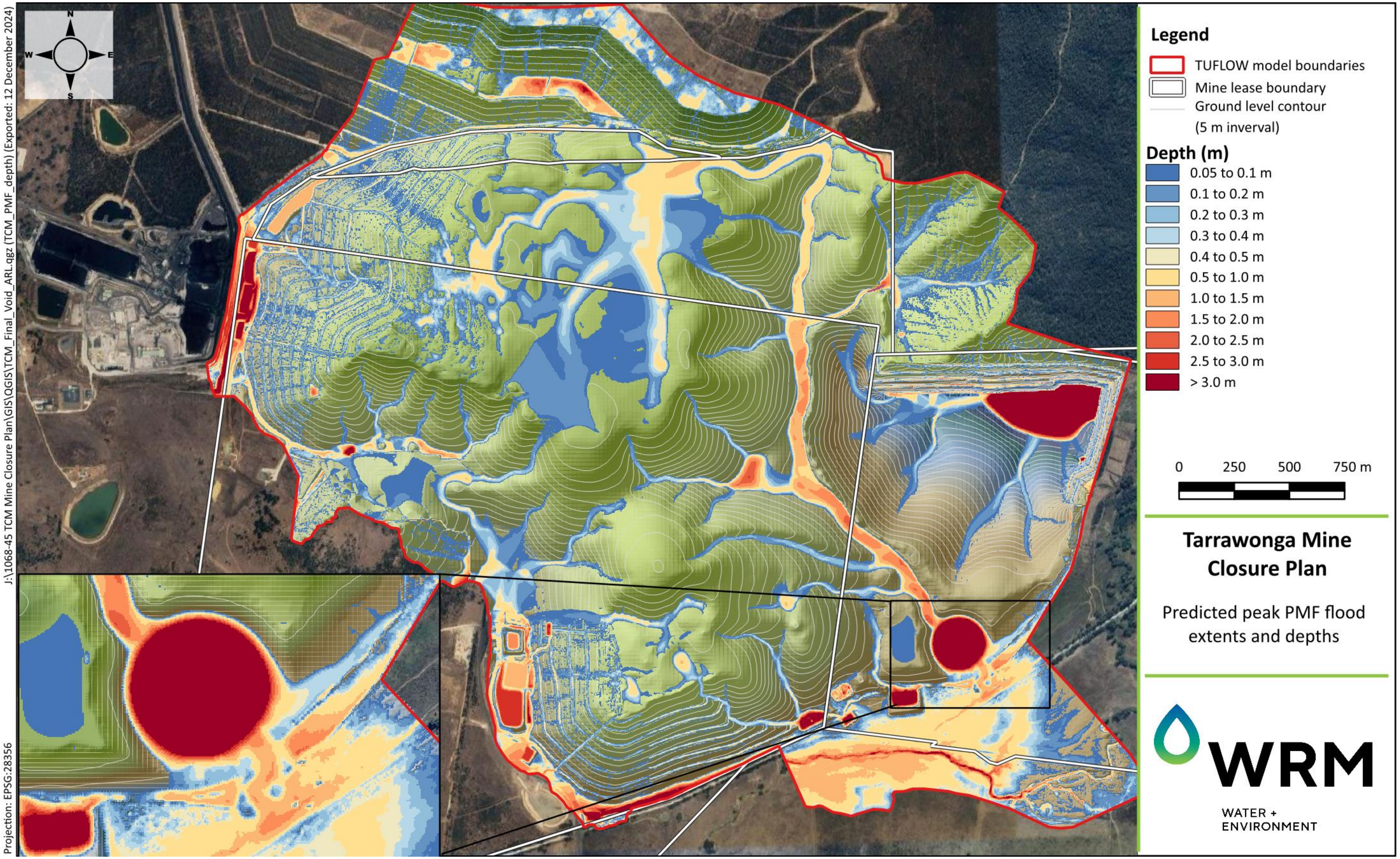

Figure 2.5 PMF event flood extent and depth (site runoff only)

Figure 2.6 1% AEP peak flood velocity (site runoff only)

2.7 FINAL VOID FLOOD IMMUNITY

2.7.1 Landform runoff

Figure 2.7 shows a typical cross-section of the main drain and bund adjacent to the final void, including 1% AEP and PMF water levels. The drain has a wide trapezoidal section with a bed width of approximately 40 m. The bund has a base width of approximately 30 m and an average height of approximately 3.8 m above the drain bed level.

Figure 2.8 shows a longitudinal profile of the flow depth along the main drain adjacent to the final void, as well as the height of the bund above the drain bed level. The 1% AEP flow depth is generally less than 0.5 m. The PMF flood depth is between 1 and 2 m.

The results of the sensitivity analysis for higher roughness in the main drain (see Section 2.3.6) indicate water levels are approximately 0.2 to 0.5 m higher than the base case.

As shown in Figure 2.8, the proposed bund crest level is not a uniform height above the channel bed level, ranging between approximately 2 m and 6 m. To provide freeboard and allow for potential landform consolidation over time, a minimum bund height of 3 m above the channel bed level is recommended for the detailed design stage of the final landform.

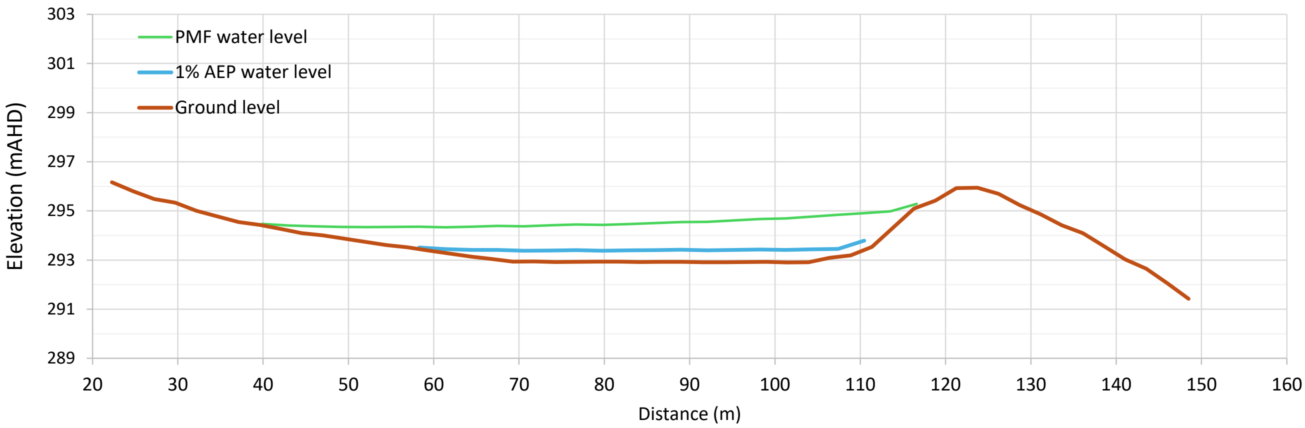

Figure 2.7 Typical cross-section of main drain adjacent to final void

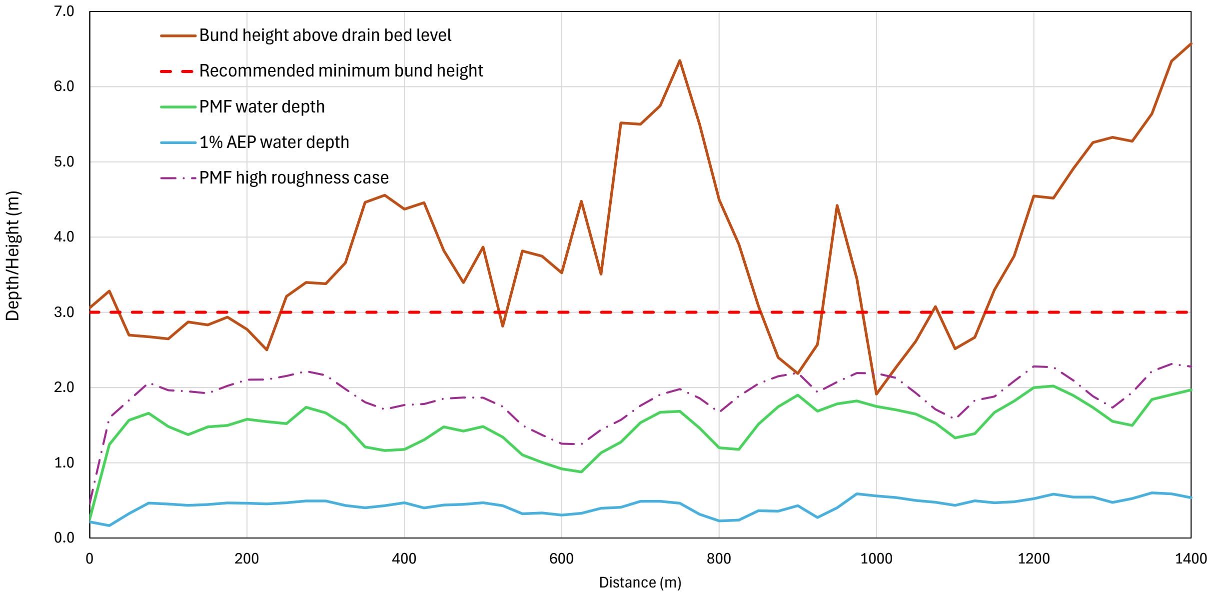

Figure 2.8 1% AEP and PMF depth and bund height along main drain adjacent to final void

2.7.2 Goonbri Creek

Flood modelling of Goonbri Creek (WRM, 2024) shows PMF flood levels in the creek adjacent to the final void location are in the range of 280 to 284 mAHD. Figure 2.9 shows the extent of the 285 mAHD contour within the final void, indicating that the void spill level is just above 285 mAHD. This confirms that the final void is immune to flooding from Goonbri Creek in the PMF.

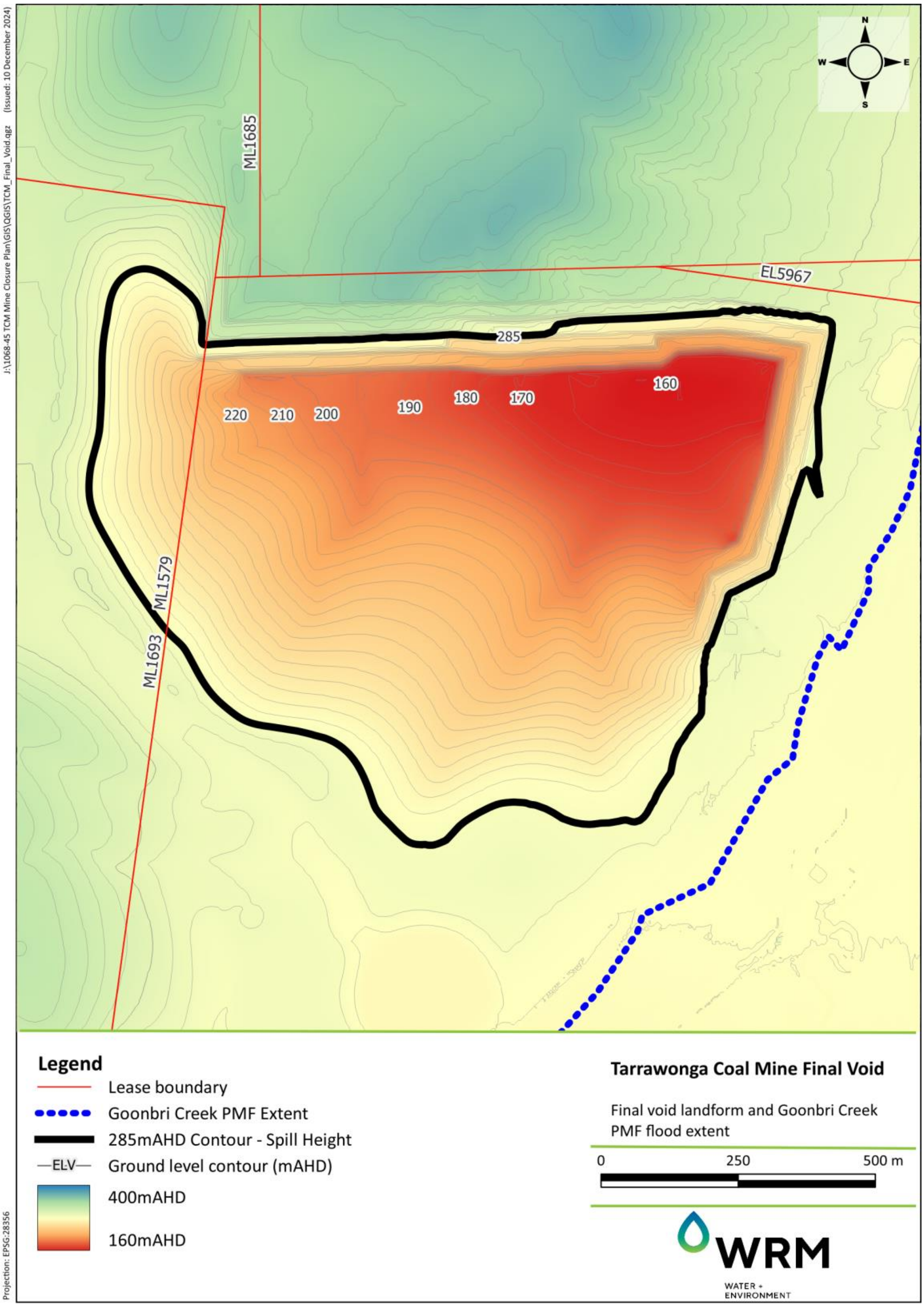

Figure 2.9 Goonbri Creek PMF flood extent adjacent to final void

2.8 IMPACTS OF LANDFORM CONSOLIDATION

Advice provided to WRM on landform consolidation is:

- Most consolidation of spoil occurs in the first few months after placement, prior to and during shaping.
- The material will continue to consolidate as water levels recover to the long-term stable level in the final void.
- Expected settlement is in the range of 1 to 2 m, which mostly occurs during the early stages of spoil placement and landform shaping.

Provided settlement is relatively uniform across the landform, it will have minimal impact on the drainage system. Drain bed and bank levels will remain at similar elevations relative to each other.

The average bed gradient of the main drainage path adjacent to the final void is 1.6%. The drain bed level falls approximately 25 m along the perimeter of the final void. Hence, a reduction in bed level of 2 m would not represent a significant reduction in gradient.

Mitigation measures for any impact of consolidation would include:

- Adopting 3 m minimum height from the drain bed level to the bund crest level.
- Monitoring drain bed and bund levels following landform construction.
- Undertaking maintenance and remediation of any identified areas of erosion, deposition or excessive settlement along the drain.

2.9 MAIN DRAIN OUTFLOWS TO GOONBRI CREEK

Figure 2.10 shows the modelled flow velocities at the outlet of the main drain to Goonbri Creek for the 1% AEP event. The adopted modelling assumes no flow in Goonbri Creek (apart from minor flow generated by local rainfall), which will be the worst case for flood velocities because elevated water levels in Goonbri Creek would slow velocities from the outlet of the main drain.

The model results show velocities exceeding 2 m/s at the pond outlet, which reduce with distance downstream. Velocities reduce to approximately 1 m/s or less at the mining lease boundary. The configuration of the pond outlet channel will be refined through detailed design to ensure discharges from the site are conveyed at non-erosive velocities.

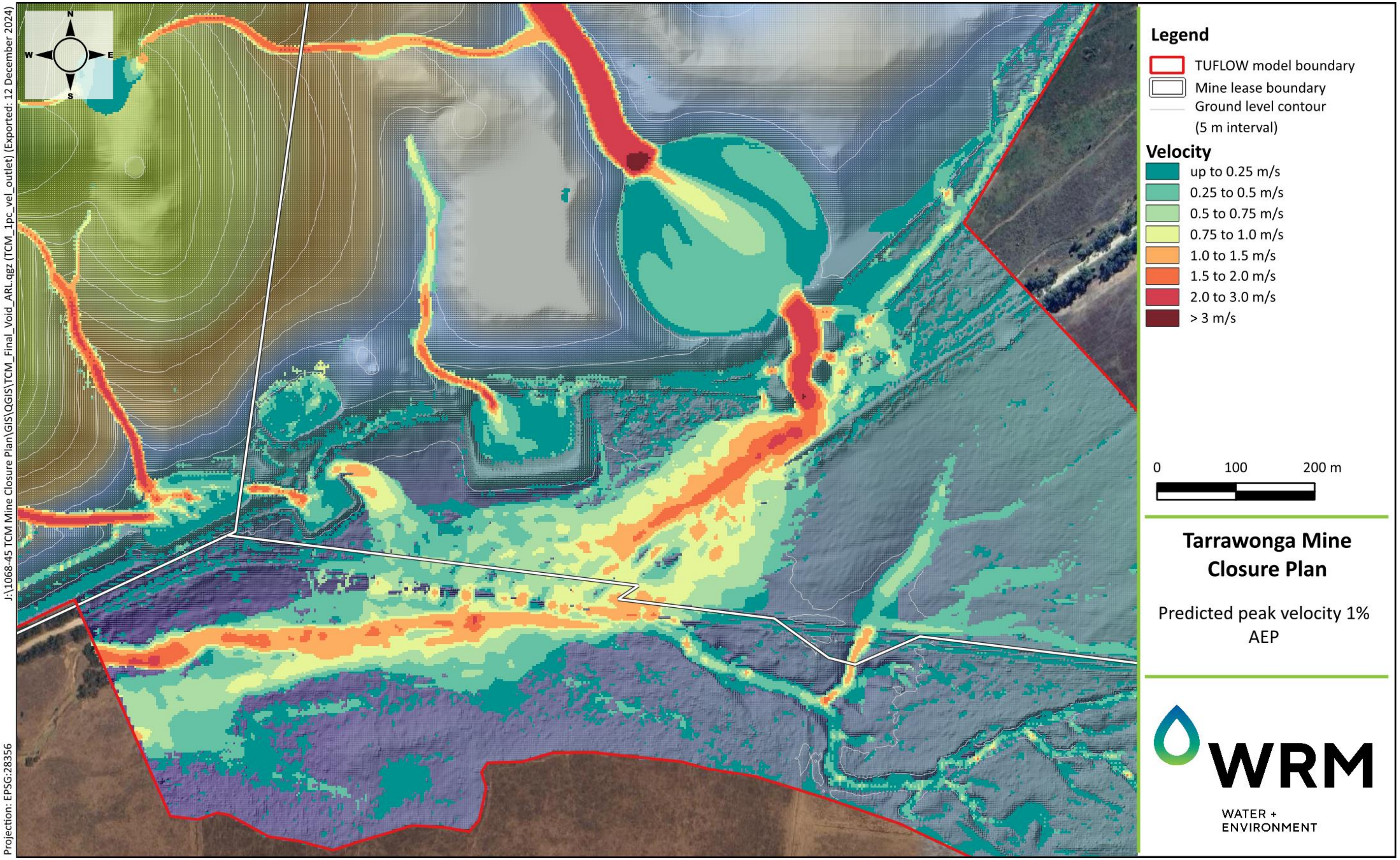

Figure 2.10 **1% AEP flood velocity at main drain outlet, landform runoff only**

3 FINAL VOID WATER BALANCE

3.1 VOID CATCHMENT

The catchment of the final void is shown in Figure 3.1. Key features of the final void are:

- Floor level of 160 mAHD.
- Overtopping level above 285 mAHD.
- Storage volume to the overtopping level of approximately 50,000 ML (see Figure 3.2). This volume is based on the landform surface only and does not include any storage within pore spaces of the backfilled pit.
- Total catchment area of 128 ha.

The adopted catchment surface types within the void catchment are shown in Table 3.1. Approximately 25% of the void catchment is classified as "Pit" land use, including the remnant highwall and pit floor, wicath the remaining 75% of the catchment rehabilitated.

Table 3.1 Final void catchment and land use areas (ha)

Catchment	Pit	Rehab	Total
Final Void	32	96	128

3.2 METHODOLOGY

Water levels in the residual void will vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater. The GoldSim water balance simulation model was used to simulate the long-term void water level behaviour, salinity, and the interaction of the pit lake water with the surrounding groundwater table.

The GoldSim model was used to simulate the generation, movement, and loss of water on a daily time-step within the final void, over a 500-year period. The volume of water in the void was calculated at each time step as the sum of direct rainfall to the void surface, catchment runoff, and groundwater inflows, less evaporation losses from the water surface within the void. The model also tracks the quantity of salt within the system.

Key components of the model are summarised in the following sub-sections, including descriptions of key model inputs and assumptions.

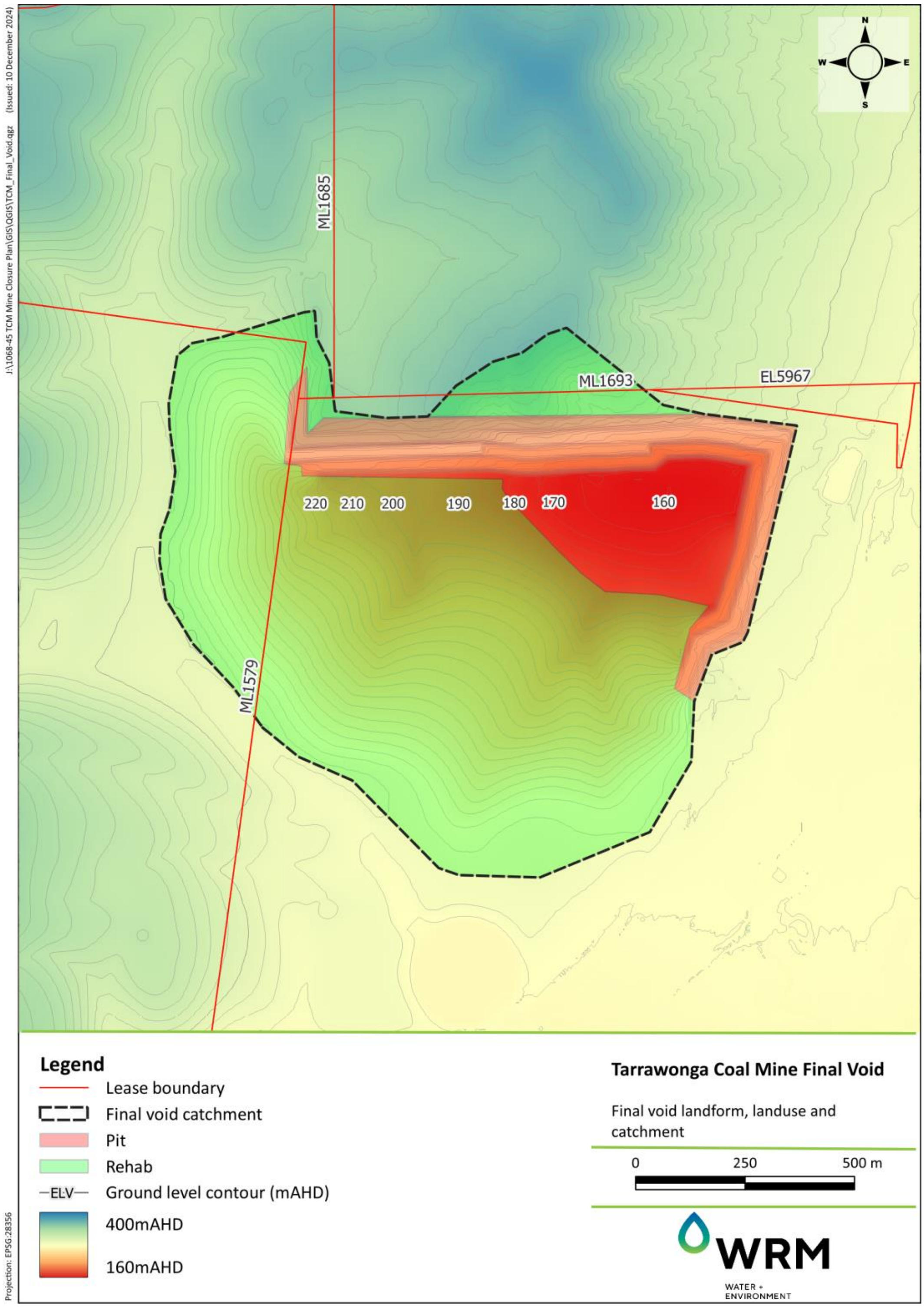

Figure 3.1 Final void catchment area

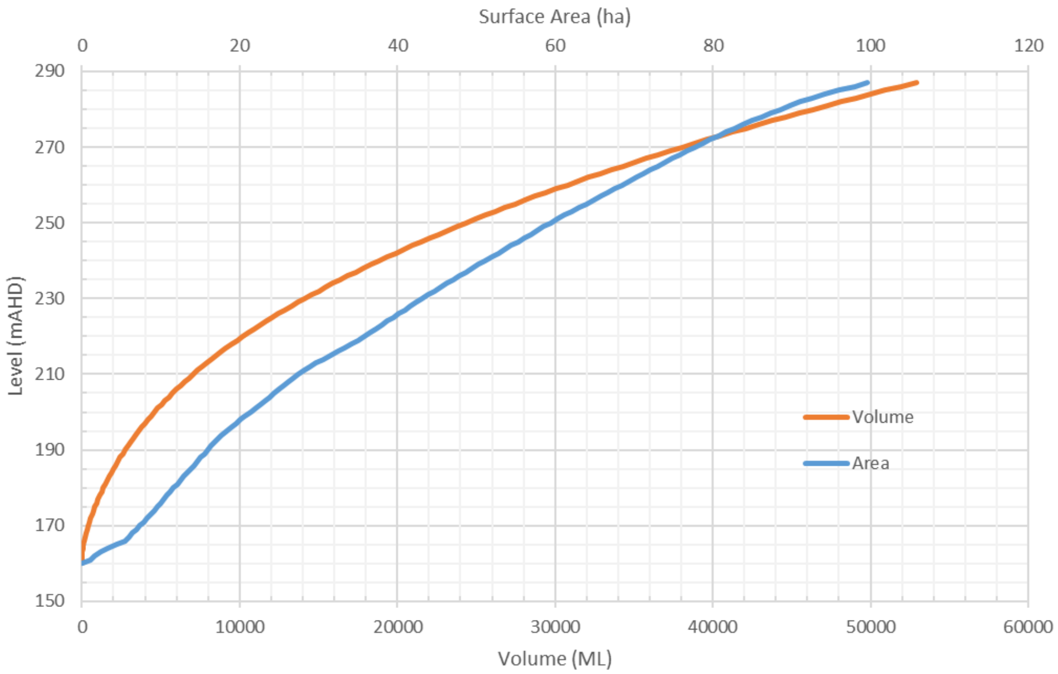

Figure 3.2 Final void stage-storage-surface area relationship

3.3 MODEL INPUTS AND ASSUMPTIONS

3.3.1 Rainfall and evaporation

Long-term daily rainfall and evaporation data for the area from January 1889 to November 2024 (135 years) obtained from the Queensland Government Scientific Information for Land Owners (SILO) database was used for the simulation.

Morton's lake evaporation was used to estimate evaporation losses from the void waterbody. Figure 3.3 shows the long-term monthly averages for Morton's lake evaporation and rainfall data.

The 133 years of SILO rainfall and evaporation data was repeated three times to create a representative long-term (500-year) climate sequence.

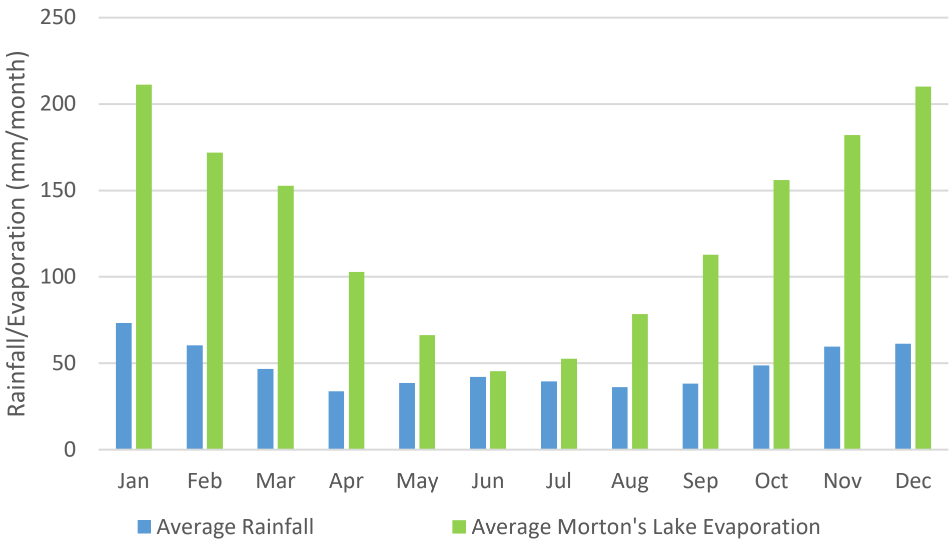

Figure 3.3 Distribution of monthly rainfall and evaporation (SILO 1889-2024)

3.3.2 Catchment runoff

Catchment runoff to the final void was estimated using the Australian Water Balance Model (AWBM) daily rainfall-runoff model with parameters adopted for previous water balance investigations in the area of interest. The adopted AWBM parameters for the two adopted catchment land use types are shown in Table 3.2.

Table 3.2 also shows the calculated coefficient of runoff, which is the average proportion of rainfall that becomes runoff. Approximately 6% of rainfall becomes runoff for rehabilitated areas and 32% for pit areas which have minimal soil cover.

Table 3.2 Adopted AWBM parameters

Parameter	Rehab	Pit
C1 (mm)	13	2
C2 (mm)	127	20
C3 (mm)	255	0
A1	0.13	0.1
A2	0.43	0.9
A3	0.44	0
BFI	0	0
K_{base}	0	0
K_{surf}	0	0
Coefficient of runoff	0.057	0.318

3.3.3 Water quality

Each of the water input sources to the final void was assigned a representative salinity to calculate the long-term salt accumulation within the void. The adopted salinity (represented as total dissolved solids [TDS]) for each source is shown in Table 3.3. It was assumed that direct rainfall has a salinity of zero.

Table 3.3 Adopted salinity for final void inputs

Source	Adopted TDS (EC)[a]	Reference
Groundwater	1,340 mg/L (2,000 µS/cm)	Representative value from Section 5.7.4, 2023 Water Management Plan (WHC, 2023).
Rehabilitated	147 mg/L (220 µS/cm)	LDP1, 2022 Annual Review (WRM, 2023).
Pit	335 mg/L (500 µS/cm)	Representative of best pit water dam quality (corresponding to fresh runoff), 2022 Annual Review (WRM, 2023).

[a] TDS calculated by multiplying EC by TDS factor of 0.67

3.3.4 Groundwater

Groundwater inflow to the final void will vary over time as regional groundwater levels recover post-mining and the void water level rises.

Estimated groundwater inflows to the final void were provided by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE), based on groundwater modelling. The groundwater inflows were provided as a relationship between void water level and groundwater inflow, as shown in Table 3.4.

Table 3.4 Groundwater Inflow

Void water level (mAHD)	Inflow (kL/d)	Inflow (ML/yr)
260	96	35
250	170	61
240	230	84
230	290	110
220	350	130
210	400	140
200	450	160
190	490	180
180	540	200
170	580	210
160	620	230

3.4 MODEL RESULTS

The final void water level modelled over the 500-year simulation period is shown in Figure 3.4. The model results show:

- The final void water level rises from its starting level (160 mAHD) to an equilibrium level of approximately 214 mAHD.
- The final void reaches equilibrium after approximately 150 years, with long term void water levels varying between approximately 212 and 216 mAHD.
- The maximum modelled water level is approximately 70 m below the pit overflow level of 285 mAHD.
- The long-term average water volume within the final void is approximately 8,000 ML.

Figure 3.5 shows the modelled long-term salinity of water within the final void, which rises slowly over time due to the void being a sink for groundwater flow. There is no net outflow from the void to remove salt load.

Modelled long-term groundwater inflow is shown in Figure 3.6. The long-term equilibrium groundwater inflow to the final void is approximately 135 ML/yr.

The modelled equilibrium water level is approximately 40 m lower than the previous analysis (HEC, 2019) presented in the draft Final Void and Mine Closure Plan (WHC, 2019). The key reason for the lower modelled water level is the revised estimate of groundwater inflows which are significantly less than adopted in the previous assessment. At the modelled equilibrium level in the previous analysis, the adopted groundwater inflow to the void was approximately 240 ML/yr, nearly 80% greater than the latest groundwater inflow estimates.

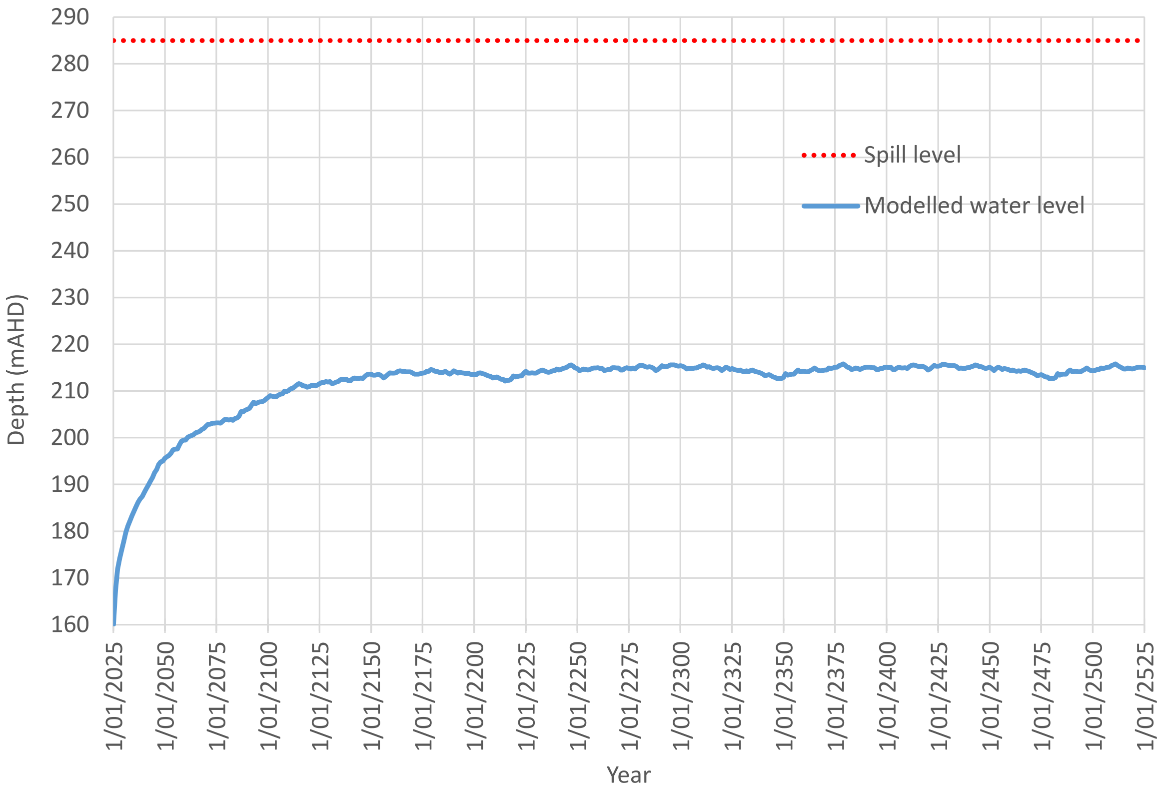

Figure 3.4 Modelled long-term final void water levels

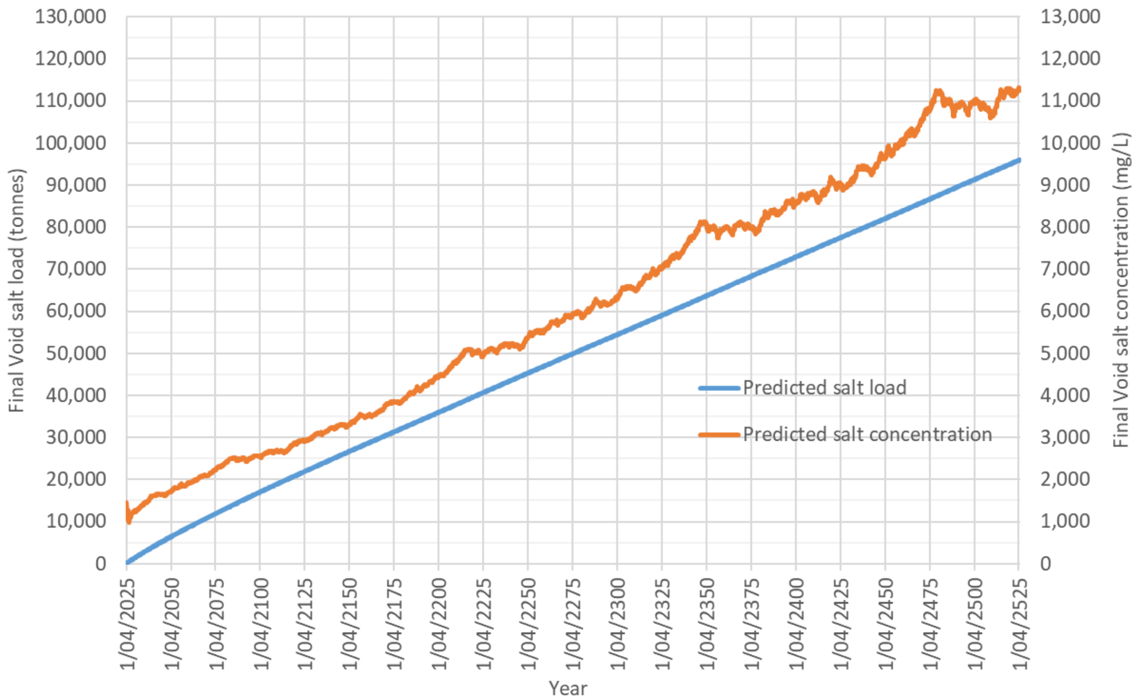

Figure 3.5 Modelled long-term final void salinity

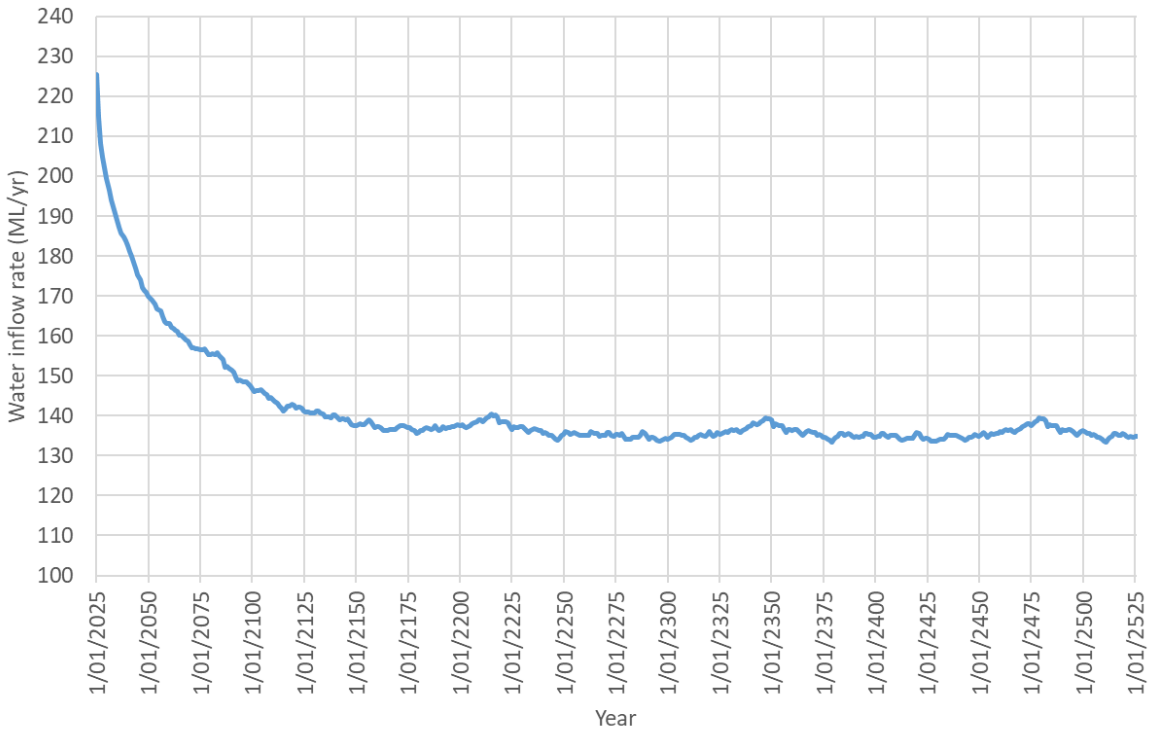

Figure 3.6 Modelled long-term groundwater inflow

4 CONCLUSIONS

Flood modelling of the Tarrawonga Coal Mine final landform shows that:

- The final void is outside the main landform drainage paths up to the PMF event.
- The bund crest level along the main landform drainage path adjacent to the final void has a height of 2 m and 6 m above the drain bed level. To provide freeboard and allow for potential landform consolidation over time, a minimum bund height of 3 m above the channel bed level is recommended for the detailed design stage of the final landform.
- The void spill level is just above 285 mAHD which is higher than the adjacent PMF level in Goonbri Creek. This confirms that the final void is immune to flooding from Goonbri Creek in the PMF.
- The main drain bed level falls approximately 25 m along the perimeter of the final void with a gradient of approximately 1.6%. A reduction in bed level along the drain of up to 2 m associated with consolidation of spoil would not represent a significant reduction in gradient and allow the drain to continue to function in preventing inflow to the final void.
- Velocities at the outlet of the pond at the end of the main landform drain reduce with distance downstream, reducing to approximately 1 m/s or less at the mining lease boundary. The configuration of the pond outlet channel will be refined through detailed design to ensure discharges from the site are conveyed at non-erosive velocities.

The results of water balance modelling of the Tarrawonga final void show:

- The final void water level rises from its starting level (160 mAHD) to an equilibrium level of approximately 214 mAHD over a period of approximately 150 years.
- The maximum modelled water level in the final void is approximately 70 m below the pit overflow level of 285 mAHD.
- The long-term average water volume within the final void is approximately 8,000 ML.
- Modelled long-term salinity of water within the final void rises slowly over time due to the void being a sink for groundwater flow. There is no net outflow from the void to remove salt load.
- The long-term equilibrium groundwater inflow to the final void is approximately 135 ML/yr.

The model results presented in this report are based on data derived from historical climate records. The sensitivity of these results to future climate change should be considered in the detailed design assessment of the final landform.

5 REFERENCES

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QUDM, 2016	'Queensland Urban Drainage Manual, Fourth edition 2016', Institute of Public Works Engineering Australia (IPWEA) Queensland Division, 2016.
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WHC, 2023	'Tarrawonga Coal Mine: Water Management Plan', Whitehaven Coal Ltd, Rev. 8, August 2023.
WRM, 2023	'2022 Annual Review, Tarrawonga Coal Mine', Report prepared for Whitehaven Coal Ltd, Ref. 1068-40-B4, 30 March 2023
WRM, 2024	'Tarrawonga Coal Mine: Goonbri Creek – flood impact assessment', Report prepared by WRM Water & Environment Pty Ltd for Whitehaven Coal Ltd, Ref. 1068-43-B2, 20 May 2024

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Appendix B

Tarrawonga Coal Mine Final Void and Mine Closure Plan (FVMCP) – Preliminary Groundwater Component Assessment

Memorandum

Project number	TAR5001.001
To	Matt Hollis
Company	Whitehaven Coal Limited
From	Amy White, Dr Tariq Laattoe, Dr Rodrigo Rojas
Date	19 December 2024

RE: Tarrawonga Coal Mine Final Void and Closure Plan (FVMCP) – Preliminary Groundwater Component Assessment

1 Introduction

This document describes the work commissioned by Whitehaven Coal Limited (Whitehaven) and completed by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to support a Final Void and Mine Closure Plan (FVMCP) for Tarrawonga Coal Mine. The updated FVMCP will be submitted to the Resources Regulator at the end of December 2024. According to Condition 65, Schedule 3 of the Project Approval (PA 11_0047), the FVMCP must be subject to independent review and verification by suitably qualified, experienced and independent person/s whose appointment has been approved by the Secretary. A draft FVMCP plan was submitted in 2019 (Whitehaven Coal, 2019) and Whitehaven advised that no material change had been made to the final landform at Tarrawonga since that time. AGE was therefore tasked with providing estimates for the groundwater inflow component at different pit lake stage elevations into the final void of the proposed landform at Tarrawonga Coal Mine using the best available information.

Tarrawonga Coal Mine, Boggabri Coal Mine and Maules Creek Coal Mine are adjacent coal mine operations which are termed collectively as the BTM-complex. The most recent (2024) groundwater model for the BTM complex synthesises all the available data relevant to groundwater flow proximal to Tarrawonga Coal Mine and consequently represents the best tool for estimating inflow to the final void. The BTM-complex model is presently being updated for use in simulating expansion projects at both Maules Creek Coal Mine and Boggabri Coal Mine. The predictions for closure at each mine in the complex were unavailable at the start of the present work with the model undergoing peer review of its latest calibration. An alternative to a complete closure simulation was therefore required to provide the predictions of groundwater inflow into the pit lake. This comprised of sequential steady-state simulations using the calibrated BTM-complex groundwater model with fixed stage elevations in the final void at Tarrawonga Coal Mine. The inflow estimates inform simulations that predict the likely steady-state final void stage elevation of the pit lake. In addition to providing the inflow estimates, AGE was also tasked with providing a qualitative assessment of the effects on groundwater from a different prediction for pit-stage elevation to that of the 2019 FVMCP.

The accompanying scope for the present work is listed below:

1. Provide a single look up or feed-in table inflows for the range of possible void water levels based on the best available information to inform the final void water balance modelling undertaken by the surface water specialist (WRM), including the provision of a list of assumptions made to develop the table.
2. Conduct a qualitative analysis of the potential groundwater changes since the 2019 FVMCP draft report based on the final void water level/s predicted by WRM.
3. Provision of a letter-style report or short technical memorandum to support the FVMCP.

2 Methodology

2.1 Table relating groundwater heads and (in/out) flows

The latest calibrated version (November 2024) of the BTM groundwater model was used to perform a series of steady-state simulations where hydraulic heads were set at 10.0 m increments in the final void that will become a pit lake for Tarrawonga mine. The stage levels were 160.0 mAHD at the base of the pit lake to 260.0 mAHD at the top, the latter of which approximates the pre-mining hydraulic heads for the same area. Net inflow rates to the area of the void were recorded for each simulation and collated into a table provided to Whitehaven for use in the modelling of the pit lake.

2.2 Qualitative assessment

A qualitative discussion of likely effects on the groundwater regime proximal to Tarrawonga Coal Mine was then written by comparing the 2019 FVMCP draft report outcomes with recent pit lake water balance modelling that incorporated the new groundwater inflow estimates. The discussion focused on the following salient points for the FVMCP:

1. Assumptions used in the groundwater flow model affecting the inflow component.
2. Source/sink behaviour of the final void, including extent (assume catchment area is the same).
3. Salinity trends compared to previous estimates, including scalding.
4. Potential for density-driven flow.
5. Implications for post-mining inflows relative to water licenses.

2.3 Reporting

Documenting Task 1 and Task 2 in a short letter / technical memorandum for submission to RS.

3 Results

3.1 Rates of simulated groundwater inflow

Table 3.1 presents the results of the simulated groundwater inflow rates at different stage elevations using the most recent calibration of the existing BTM-complex model (November 2024). Inflows decrease with increasing stage elevation of the pit lake. The rates are net, although it is noteworthy that only at 260 mAHD was there both inflow and outflow. Stage heights below 260 mAHD were inflow only.

Table 3.1 Simulated Groundwater inflow at different stage elevations

Stage (mAHD)	Inflow (KL/d)	Inflow ML/yr
260	96	35
250	170	61
240	230	84
230	290	110
220	350	130
210	400	140
200	450	160
190	490	180
180	540	200
170	580	210
160	620	230

It is noted that the inflow rates presented in Table 3.1 consider inflow only from the surrounding Permian aquifer and do not consider inflow derived from backfilled spoil. Recharge in the Permian itself is negligible relative to the spoil due to enhanced infiltration from the disturbed material. Precluding the effects of enhanced recharge in the spoil proximal to the pit void will reduce the estimates of groundwater inflow to the pit void. This limitation is a direct consequence of the development stage of the BTM-complex model when it was used to perform the present inflow analysis. Setup of the closure simulations, that include the effects of enhanced recharge in the spoil have not been developed previously and were scheduled for development and completion during early 2025 in line with the scheduled BTM complex model updates. Completing the necessary input files for the BTM-complex groundwater model closure simulations prior to the submission of the Tarrawonga FVMCP is not considered achievable. Consequently, the presented inflows are considered to be potential underestimates and subject to further revision following completion of the BTM complex model update during 2025.

It is further considered that the rates presented within Table 3.1 may also reflect an inconsistency between the groundwater model and the surface water model because as it is expected that the inflows will change once the effect of enhanced recharge through the spoil can be incorporated. Previous work by HydroSimulations (2019) showed that roughly 80% of groundwater inflow to the pit void could be derived from spoil. A repeat of the present inflow analysis including reconciliation with the surface model is therefore required once the BTM-complex model is completed in 2025.

3.2 Qualitative analysis

The analysis is aligned with the draft 2019 FVMCP, which notes the following regarding groundwater:

- The void will not be completely backfilled, facilitating the formation of a pit lake, reducing the potential for groundwater within the fill of the final void to discharge off-site.
- The final void is predicted to create a localised groundwater sink.
- The equilibrium level of the pit lake acting as the groundwater sink is expected to be between 255.0 mAHD and 261.0 mAHD.
- The accumulation of salts in the final void pit lake is not expected to trigger density-driven flow of groundwater off-site.
- Total inflow from the coal and interburden seams post-recovery is expected to be approximately 52.0 ML/year, which is less than the licenses held by Tarrawonga Coal Mine.

3.2.1 Assumptions for simulated groundwater inflow

1. The simulated steady-state inflows are a reasonable approximation of the expected groundwater inflow to the pit void, for any period greater than 50 years (18250 days), given an approximated groundwater system time constant (Domenico and Schwartz, 1998) of 14400 days. Transient effects are only readily apparent if the observation window is less than the system time constant. It is expected that rainfall interception and runoff will dominate inputs to the pit void initially causing it to rise rapidly and function as a source of groundwater rather than a sink, that is, there will be net outflow from the pit lake while at lower stage elevations during the early years following cessation of operations. The transient effect of the pit void as a source of groundwater will be considered when the BTM-complex model closure simulations are available.
2. Enhanced storage and inflow from backfilled mine spoil was not considered due to the reasons discussed in Section 3.1. The lack of groundwater inflows from backfilled spoil will contribute to a reduced equilibrium stage level for the pit void and a slightly slower recovery.
3. Closure at Boggabri Coal Mine and Maules Creek Coal Mine have negligible influence on the long-term inflows at Tarrawonga. Boggabri Coal Mine closure forecast precludes a long-term void with the entire void being backfilled. The backfilled spoil at Boggabri may form a groundwater mound (AGE, 2022) and act as a groundwater source. Maules Creek Coal Mine will have a pit void lake as part of its closure that may offset some of the influence of a groundwater mound at Boggabri. Consequently, the steady-state simulations assumed no long-term system stress at Boggabri and Maules.
4. Climate is assumed to not vary significantly from the past 20 years through closure. The steady-state simulations used a mean of the calibrated transient signal for recharge across the model. There is little to no recharge in the Permian sequences, with the bulk of recharge dominated by flow events in the alluvium. This is considered reasonable given the storage and permeability of the Permian relative to the alluvium.

3.2.2 Source/sink behaviour of final void

The final void recovery was simulated by WRM using the inflow-stage relationship from Table 3.1 to produce an estimation of the pit void stage progression. The equilibrium level of the void is predicted to be between 210 mAHD and 220 mAHD, which is significantly lower than previously estimated. The new equilibrium level is attributed to the reduced groundwater inflows from the absent spoil recharge. Furthermore, the surface water model's predicted long-term inflow from groundwater is reported at 135 ML/yr, which is noticeably less than the previous estimate of 240 ML/yr (HEC, 2019) correlated with stage equilibrium level of between 255 mAHD and 260 mAHD.

The timing associated with equilibrium in the pit void is in keeping with groundwater recovery simulations (AGE, 2022) for the Permian sequence hosting Tarrawonga Coal Mine. Approximately 75% of equilibrium recovery is in 50 years, with equilibrium established at around 150 years post-closure. The void will function as a groundwater sink with open water evaporation from the pit lake as the discharge process. The lower stage elevation suggests that the pit lake will function as a greater groundwater sink than was previously estimated.

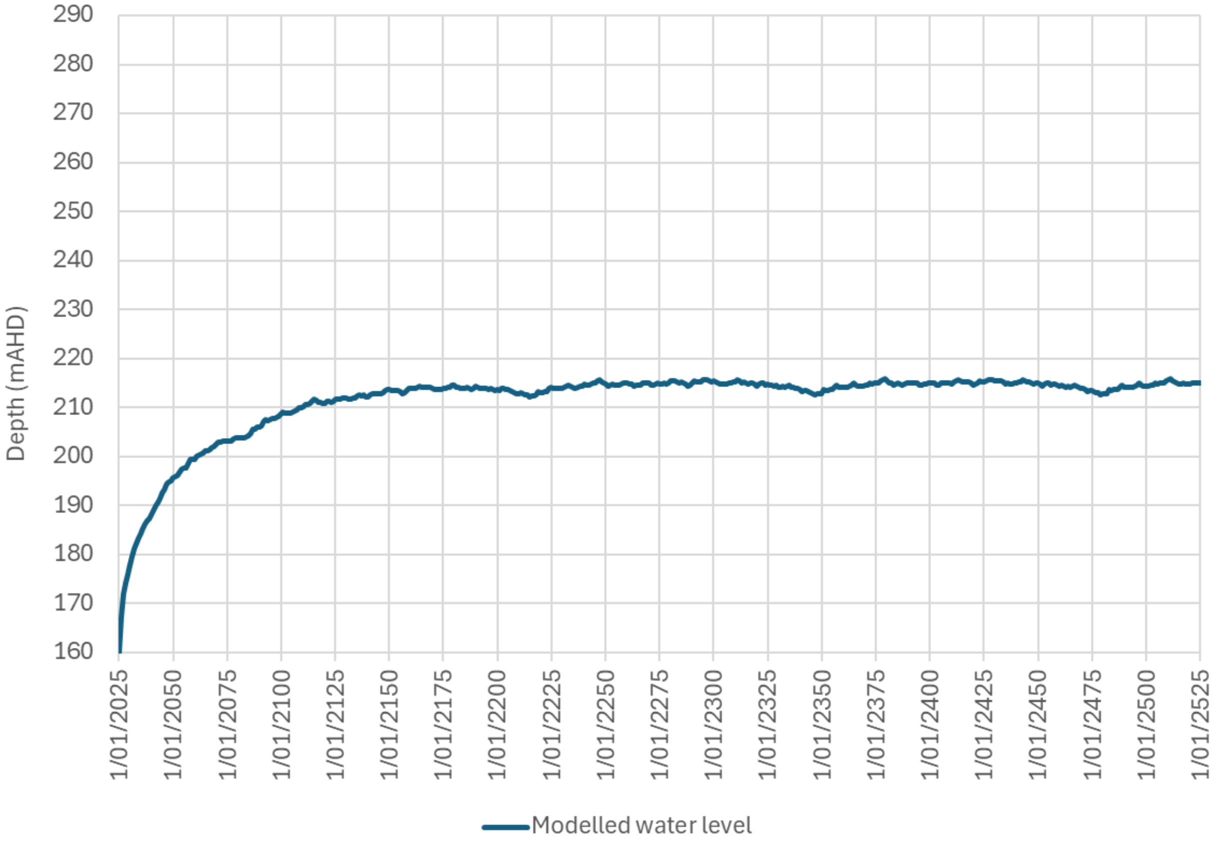

Figure 3.1 Estimated pit void stage progression during post-closure

3.2.3 Salinity trends and density-driven flow

Increased groundwater inflow has the potential to increase the annual salt load of the pit void lake. Estimated inflow from Table 3.1, at the predicted long-term stage elevation of the pit lake, is less than what was predicted previously. Note this assumes that the equilibrium level and inflows are aligned with those predicted by the surface water and groundwater model as presented in this document. Original estimates for long-term salinity of the pit lake were 1.02 tonne/m^3 with no change to hydraulic gradients. It is recommended that this analysis be repeated once the BTM-complex model is configured to account for spoil recharge in the pit inflow estimates and there is some attempt to reconcile the predictions made by both groundwater and surface water models.

3.2.4 Implications for post-mining inflow relative to water licenses

Under an assumption that inflows presented in Table 3.1 are valid, the lower stage elevation predicted by the surface water model will induce greater inflow estimated at between 125 ML/yr and 145 ML/yr, which remains less than the currently licensed groundwater take (300 ML). This may be considered a worst-case estimate because no consistency with the surface water model is considered using these values. The reduced equilibrium stage will produce a more extensive drawdown cone that may affect third-part water users. Given the reported discrepancy in equilibrium stage elevation from previous estimates, an assessment of drawdown extent is not recommended until improved estimates of inflow can be obtained from the BTM-complex model, which are reconciled with the surface water model.

The reduced stage is also likely to accompany a reduced surface area, which may be beneficial given the impetus to minimise the extent of the final void. Third-party water users abstract groundwater from the alluvial systems surrounding the BTM complex. Increased inflow to the pit lake will cause some increase in indirect take from managed water zones; however, this is not expected to impact third-party water users in any significant manner due to the contrasts in storage, recharge, and hydraulic properties of the alluvial and Permian hydrostratigraphy.

4 References

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