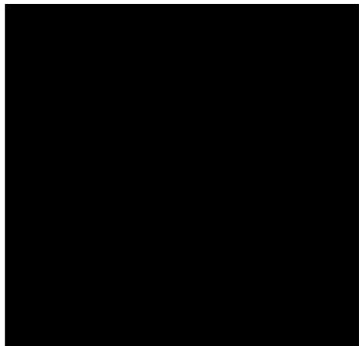
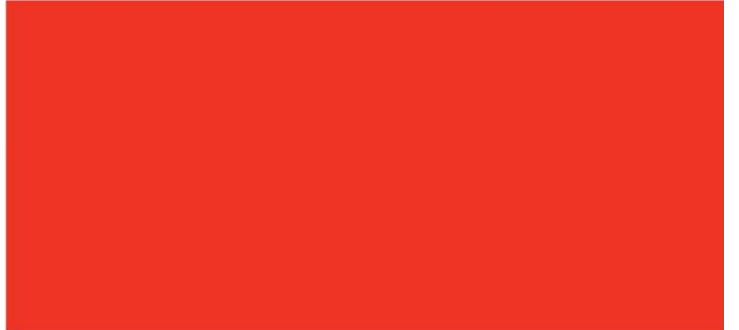
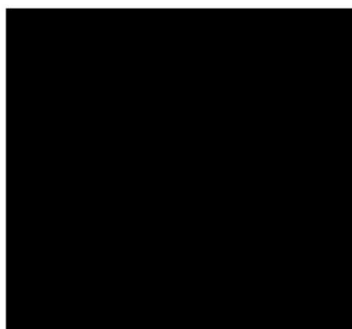
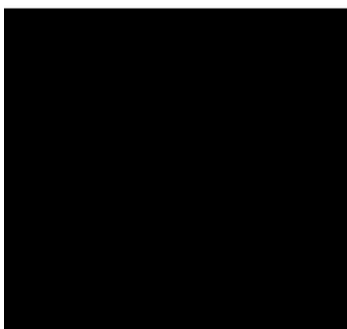




Yarrabee Coal Mine

Progressive Rehabilitation and Closure Plan



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Appendix T. *PRCP Risk Assessment* – ESG Consulting

GLOSSARY, ACRONYMS AND ABBREVIATIONS

		Baker	PJ baker and Assoc. Pty Ltd
		BC	Boundary Conditions
AASS	Actual Acid Sulphate Soil	BoM	Bureau of Meteorology
ABA	Acid Base Account	CEC	Cation exchange capacity
ACARP	Australian Coal Association Research Program	CHPP	Coal Handling and Preparation Plant
AEP	Annual Exceedance Probability	CHRC	Central Highlands Regional Council
AGE	Australasian Groundwater and Environmental Consultants Pty Ltd	cm	centimetre
AMD	Acid mine drainage	CMB	chloride mass balance
ANC	Acid neutralising capacity	CRD	Cumulative rainfall departure
ANZECC	Australia and New Zealand Environment and Conservation Council	CSIRO	Commonwealth Scientific and Industrial Research Organisation
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand	DAP	Diammonium Phosphate
AQP	Appropriately Qualified Person(s)	DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
ARF	Areal Reduction Factor	DD	Deep drainage
ARR	Australian Rainfall and Runoff	dS/m	decisiemens per metre
AS	Australian Standard	DES	Department of Environment and Science
ASC	Australian Soil Classification	DESI	Department of Environment, Science and Innovation
ASS	Acid sulphate soil	DETSI	Department of the Environment, Tourism, Science and Innovation
ATC Williams	ATC Williams Pty Ltd	DME	Department of Mines and Energy
AWBM	Australian Water Balance Model	DNRM	Department of Natural Resources and Mines
AWRA-L model	Australian Water Resources Assessment Landscape model	DNRME	Department of Natural Resources, Mines and Energy

DNRMMRRD	Department of Natural resources and Mines, Manufacturing and Regional and Rural Development	GAI	Geochemical abundance index
		GDE	Groundwater Dependent Ecosystem
DoR	Department of Resources	GHB	General Head Boundary
DSA	Design Storage Allowance	g/cm ³	grams per cubic centimetre
DSITIA	Department of Science, Information Technology, Innovation and the Arts	GSDM	Generalised Short Duration Method
DEM	Digital Elevation Model	GSI	Geological Strength Index
EA	Environmental Authority	GTSMR	Revised Generalised Tropical Storm Method
EAT	Emerson Aggregate Test	ha	hectares
EC	Electrical conductivity	HIL(C)	Health-based Investigation Levels
Engeny	Engeny Australia Pty Ltd		
EP Act	<i>Environmental Protection Act 1994</i>	HVR	High-value regrowth
		IA	Improvement Area
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	IFD	Intensity Frequency Duration
EP regulation	Environmental Protection Regulation 2019	INAP	International Network on Acid Prevention
EPC	Exploration Permit for Coal	Ke	Hydraulic conductivity
		K _{FC}	Field capacity
EQIF	Environmental Quality Inspection Forms	kg	kilograms
		K _h	horizontal hydraulic conductivity
ERA	Environmentally Relevant Activity	K _i	Interrill erodibility
ERC	Estimated Rehabilitation Cost	KLC	Kinetic Leach Column
ESP	Exchangeable sodium percentage	K _R	Rill erodibility
		km	kilometres
E2M	E2M Pty Ltd	km ²	square kilometres
FFA	Flood Frequency Analysis	kPa	kilopascal
FoS	factor of safety	Kv	vertical hydraulic conductivity
GALE	Guidelines for Agricultural Land Evaluation	L	litre

LiDAR	Light Detection and Ranging	mm/h	millimetres per hour
		m/s	metres per second
LOD	Land Outcome Documents	MP3DU	mod-PATH3DU
LoR	limit of reporting	Natural Resource Assessments	Natural Resource Assessments Pty Ltd
LSAT	Land Suitability Assessment Techniques	NAF	Non-acid forming
m	metres	NAPP	Net Acid Producing Potential
m/d	metres per day		
m/s	metres per second	NC Act	<i>Nature Conservation Act 1992</i>
mAHD	metres Australian Height Datum	NCST	National Committee on Soil and Terrain
mbgl	metres below ground level	NEPC	National Environmental Protection Council
ME	Multi-element	NP	Net percolation
MER	Mackie Environmental Research Pty Ltd	NUMA	Non-use Management Area
mg/L	milligrams per litre	PAF	Potentially acid forming
ML	Mining Lease	PASS	Potential acid sulphate soils
mm	millimetres	PAWC	Plant available water capacity
MM	Management Milestone	PDBs	Polychlorinated Biphenyls
mm/yr	millimetres per year	PGA	Peak ground acceleration
MNES	Matters of National Environmental Significance	PMF	Probable Maximum Flood
MPA	Maximum Potential Acidity	PMLU	Post-mining Land Use
MRL	Mandatory Reporting Level	PMP	Probable Maximum Precipitation
Mtpa	million tonnes per annum	PRC	Progressive Rehabilitation and Closure
m ³ /d	cubic metres per day	PRCP	Progressive Rehabilitation and Closure Plan
Mm ³	cubic Megametre	PSD	Particle size distribution
mm/hr	millimetres per hour	QA	Quality assurance
m ²	square metres	QC	Quality control
m ⁻¹	per metre		

QRT	Quantile Regression Technique	TSF	Tailings Storage Facility
RA	Rehabilitation area	UCS	Uniaxial Compressive Strength
RCM	Rangal Coal Measure	UMA	Unique Mapping Area
RE	Regional Ecosystem	VSP	Vertical seismic profiling
RFFE	Regional Flood Frequency Estimation	VWC	Volumetric water content
RGS	RGS Environmental Consultants Pty Ltd	W	Watts
RL	Reporting level	WBNM	Watershed Boundary Network Model
RM	Rehabilitation Milestone	WEPP	Water Erosion Prediction Program
RMP	Rehabilitation Management Plan	WoNS	Weeds of National Environmental Significance
ROM	Run-of-mine	y	Year
SA	Source-Area	Yancoal	Yancoal Australia Limited
SALS	Soils and Land Suitability	Yarrabee Mine	Yarrabee Coal Mine
SCR	Chromium Reducible Sulphur	YCC	Yarrabee Coal Company Pty Ltd
SILO	Scientific Information for Landowners	%	percent
SLR	SLR Consulting Pty Ltd	°C	degrees Celcius
SPC	Soil profile class	>	greater than
SWCC	Soil water characteristics curve	<	less than
TEC	Threatened ecological communities	≤	Less than or equal to
TDS	Total dissolved solids	τ _c	Rill initiation
The Queensland Plan	The Queensland Plan: Queenslanders' 30-year Vision	μS/cm	Microsiemens per centimetre
t/ha/y	tonnes per hectare per year		
t/ha	tonnes per hectare		
t/ha	tonnes per hectare		
t/ha/y	tonnes per hectare per year		
t/m ³	tonnes per cubic metre		

1 PROJECT PLANNING

1.1 INTRODUCTION

On 20 December 2021 the then Queensland Department of Environment and Science (DES) (now Department of the Environment, Tourism, Science and Innovation (DETSI), pursuant to section 754 of the *Environmental Protection Act 1994* (the EP Act), issued Yarrabee Coal Company Pty Ltd (YCC) a Progressive Rehabilitation and Closure Plan (PRCP) Transition Notice. The PRCP Transition Notice required the preparation of a PRCP for the Yarrabee Coal Mine (Yarrabee Mine) that satisfied the requirements of sections 126C and 126D of the EP Act, to be submitted by 2 December 2024. The Yarrabee Mine PRCP was submitted to DETSI on 28 November 2024 and YCC were subsequently issued with a *Notice – Not Properly Made Application (the Notice)* on 12 December 2024. *The Notice* requires a response to be submitted to DETSI by 12 September 2025. This has been extended to 3 October 2025.

The Yarrabee Mine is located in the Bowen Basin coal fields in Central Queensland, approximately 40 kilometres (km) north-east of Blackwater (Figure 1-1). The Yarrabee Mine is owned and operated by YCC, a wholly owned subsidiary of Yancoal Australia Ltd (Yancoal).

Yarrabee Mine's Environmental Authority (EA) EPML00844613 (Appendix A) authorises the extraction of up to 4 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. EA EPML00844613 includes conditions relating to rehabilitation of the Yarrabee Mine, and the relevant mining leases (ML) that this PRCP relates to (Table 1-1).

Table 1-1: EA EPML00844613 Relevant Mining Leases and Conditions

Relevant MLs	Condition Number	Condition
ML 1770 ML 80049 ML 80050 ML 80096 ML 80104 ML 80172 ML 80195 ML 80196 ML 80197 ML 80198	C68	Before surrendering this environmental authority, the site must be rehabilitated to achieve a safe, stable, non-polluting landform and the final land use as required by final landform design plan in Condition F20.
	F2	Topsoil Topsoil must be strategically stripped ahead of mining and managed for effective use to progressively rehabilitate over time, in accordance with a Topsoil Management Plan.
	F3	Rehabilitation Land disturbed by the authorised mining activities must be rehabilitated to a safe, stable and non-polluting landform, with a self-sustaining vegetation cover and in accordance with: (a) Figure 5: Final Land Use; (b) Table F2: Post-mining Land Use Areas and Non-Use Management Areas; (c) Landform design criteria, including end of mine design as per Condition F20; and (d) Attachment 1: Rehabilitation Requirements.
	F5	NUMA outcome NUMAs must comply with the following outcomes: (a) NUMAs must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the NUMA itself and subject to any other condition within this environmental authority; (b) NUMAs must comply with Table F1: Non-Use Management Area Design and Figure 3: Void Outcomes; (c) Final landform of NUMAs must comply with design plan in Condition F20; and (d) Rehabilitation requirements for NUMAs are to comply with Attachment 1: Rehabilitation requirements.
	F7	Rehabilitation Monitoring Program The holder of the environmental authority must conduct a Rehabilitation Monitoring Program on a yearly basis, which must include sufficient spatial and temporal replication to enable statistically valid conclusions as established under the rehabilitation program.
	F8	The Rehabilitation Monitoring Program must be developed and implemented by a suitably qualified person.
	F9	The Rehabilitation Monitoring Program, including results, must be made available to the administering authority upon request and reviewed every three (3) years, describing: (a) how the rehabilitation objectives in Attachment 1: Rehabilitation requirements will be achieved; and (b) verification of rehabilitation success by monitoring completion criteria in Attachment 1: Rehabilitation requirements.
	F10	Post Closure Management Plan A Post Closure Management Plan for the site must be prepared at least eighteen (18) months prior to the final coal processing on site and implemented for a nominal period of: (a) at least thirty (30) years following final coal processing on site; or (b) a shorter period if the site is proven to be geotechnically and geochemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants from the site will result in environmental harm.

Table 1-1 (Continued): EA EPML00844613 Relevant Mining Leases and Conditions

Relevant MLs	Condition Number	Condition
ML 1770 ML 80049 ML 80050 ML 80096 ML 80104 ML 80172 ML 80195 ML 80196 ML 80197 ML 80198	F15	Reference Sites A range of reference sites are to be chosen to assess the applicable criteria in Attachment 1: Rehabilitation requirements. The reference sites must be: (a) Located outside of rehabilitation zone and recorded to have latitude and longitude coordinates (GDA94); (b) Provide a useful comparison of rehabilitation requirements for each mine domain/secondary domain and land uses in Attachment 1: Rehabilitation requirements; (c) Have similar conditions and circumstances to facilitate the comparison such as natural sites, grazing sites and listed regional ecosystems (REs); (d) Have similar geographical location and landform to the mine domain/secondary domain and land uses in Attachment 1: Rehabilitation requirements and landform to minimise any differences due to weather/rainfall, climate, aspect and year-to-year naturally occurring regular and irregular climatic events; (e) Have similar physical factors and landform including topography, slope length and gradient to ensure comparison is as representative as possible; and (f) Have similar other relevant factors such as soil type, chemical, biological, ecological and erosional factors to ensure comparison is as representative as possible.
	F17	Flood Protection Structures Design requirements for the flood protection structures and adjacent mining excavation at final land use must meet the following: (a) the design level of the flood protection structures crest must be at least 1 in 1,000 AEP flood event for Twelve Mile Creek and other adjacent watercourses; and (b) final landform slopes of flood protection structures must remain stable and are to be designed with a factor of safety of 1.2 or above (calculated from the flood protection structure toe) based on a certified stability analysis in the final landform design plan as per Condition F20. <i>Note: Flood protection structures are a final land use and do not include temporary levees or regulated structures during operation.</i>
	F19	As part of rehabilitation details in Attachment 1: Rehabilitation requirements the flood protection structures are to be retained and developed into a landform that supports a final land use of native vegetation and/or grazing.
	F20	Final Landform Design Plan A final landform design plan must be developed, implemented and reviewed by a suitably qualified and experienced person(s). The final landform design plan must: (a) include final landform design criteria including end of mine design resulting from Conditions F4 and F6; (b) achieves the final landforms and final land uses in Table F2: Post-mining Land Use Areas and Non-Use Management Areas, Attachment 1: Rehabilitation requirements, Figure 4: Mine Domains and Final Land Uses and Figure 5: Final Land Use; (c) be based on a risk assessment of failure, effectiveness of control measures and any potential contamination issues that may impact environmental values. (d) include an assessment of risks and requirements needed to incorporate any current or future regulated structure into the landform and final land use in Attachment 1: Rehabilitation requirements including flood protection structures in Condition F17; and (e) be reviewed following a material change in mine planning or mining sequence. <i>Note: This does not include areas completed before 30 September 2021.</i>

Note: All coordinates included in this PRCP are provided in GDA2020 at the request of DETSI.

NUMA = Non-Use Management Area; GDA = Geocentric Datum of Australia; AEP = Annual Exceedance Probability;

RE = Regional Ecosystem.

1.2 RELEVANT LEGISLATION AND GUIDELINES

This PRCP has been developed in accordance with sections 126C and 126D of the EP Act and the *Guideline – Progressive rehabilitation and closure plans (ESR/2019/4964)* (PRCP Guideline) (DESI, 2024a). The PRCP consists of two parts:

1. the rehabilitation planning part (PRCP, this document), which details how progressive rehabilitation and closure will be carried out over the entire Yarrabee Mine life; and
2. the Progressive Rehabilitation and Closure (PRC) Schedule, which, once approved, becomes a legally binding enforceable instrument with which YCC must comply.

This PRCP supersedes the *Yarrabee Rehabilitation Management Plan* (YCC, 2021). The relevant legislation and guidelines are discussed in Sections 1.2.1 to 1.2.3.

1.2.1 Environmental Protection Act 1994

Table 1-2 provides a reconciliation of the relevant requirements of sections 126C (*Requirements for PRC plan*) and 126D (*Requirements for Proposed PRCP schedule*) of the EP Act and where they have been addressed in this PRCP.

Table 1-2: Reconciliation of Sections 126C and 126D of the *Environmental Protection Act 1994*

Sections 126C and 126D of the EP Act	Section of this PRCP
Section 126C – Requirements for PRC plan	
(1) A proposed PRC plan must –	-
(a) be in the approved form; and	This PRCP
(b) describe the following –	-
(i) each resource tenure, including the area of each tenure, to which the application relates;	Section 1.3.1
(ii) the relevant activities to which the application relates;	Section 1.3.1
(iii) the likely duration of the relevant activities; and	Section 1.3.3
(c) include –	-
(i) a proposed PRCP Schedule that complies with section 126D; and	Appendix A
(ii) a detailed description, including maps, of how and where the relevant activities are to be carried out; and	Sections 2.14, Figure 2-11, Figure 2-12, and Appendix A
(iii) details of the consultation undertaken by the applicant in developing the proposed PRC plan; and	Section 3.3
(iv) details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan; and	Section 3.1
(d) state the extent to which each proposed post-mining land use for land, or non-use management area, identified in the proposed PRCP schedule for the plan is consistent with –	-
(i) the outcome of consultation with the community in developing the plan; and	Sections 4.3 and 5.3
(ii) any strategies or plans for the land of a local government, the State or the Commonwealth; and	Sections 4.2 and 5.2

Table 1-2 (Continued): Reconciliation of Sections 126C and 126D of the *Environmental Protection Act 1994*

Sections 126C and 126D of the EP Act	Section of this PRCP
(e) for each proposed post-mining land use for land, state the applicant's proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP schedule; and	Section 6
(f) identify the risks of a stable condition for land mentioned in paragraph (e) not being achieved, and how the applicant intends to manage or minimise the risks; and	Section 7
(g) for each proposed non-use management area, state the reasons the applicant considers the area can not be rehabilitated to a stable condition because of a matter mentioned in section 126D(2); and	This PRCP has been developed to reflect the pre-approved PMLUs and NUMAs detailed in the Land Outcome Documents, which are being transitioned into the PRCP. Therefore, justification is not required.
(h) for each matter mentioned in paragraph (g), include copies of reports or other evidence relied on by the applicant for each proposed non-use management area; and	EA (EPML00844613) Rehabilitation Management Plan (RMP)
(i) for each proposed non-use management area, state the applicant's proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP schedule for the area; and	Section 5
(j) include the other information the administering authority reasonably considers necessary to decide whether to approve the PRCP schedule for the plan.	This PRCP
(2) The matters mentioned in subsection (1), other than the matter mentioned in subsection (1)(c)(i), are the rehabilitation planning part of the proposed PRC Plan.	-

Table 1-2 (Continued): Reconciliation of Sections 126C and 126D of the *Environmental Protection Act 1994*

<i>Section 126D – Requirements for proposed PRCP schedule</i>	
(1) A proposed PRCP schedule must—	Attachment 1
(a) for the area of each resource tenure described in the PRC plan, state—	
(i) the proposed post-mining land use for the land; or	
(ii) that the applicant considers the land to be a non-use management area; and	
(b) for each proposed post-mining land use mentioned in paragraph (a)(i), state—	
(i) each rehabilitation milestone required to achieve a stable condition for the land; and	
(ii) when each rehabilitation milestone is to be achieved; and	
(c) for each non-use management area mentioned in paragraph (a)(ii), state—	
(i) each management milestone for the area; and	
(ii) when each management milestone is to be achieved; and	
(d) include maps showing the land mentioned in paragraphs (a), (b) and (c).	
(2) The PRCP schedule may state that land is a non-use management area only if—	NA ¹
(a) carrying out rehabilitation of the land would cause a greater risk of environmental harm than not carrying out the rehabilitation; or	NA ¹
(b) both of the following apply—	NA ¹
(i) the risk of environmental harm as a result of not carrying out rehabilitation of the land is confined to the area of the relevant resource tenure;	NA ¹
(ii) the applicant considers, having regard to each public interest consideration, that it is in the public interest for the land not to be rehabilitated to a stable condition.	NA ¹
(3) Despite subsection (2), if land the subject of the proposed PRCP schedule will contain a void situated wholly or partly in a flood plain, the schedule must provide for rehabilitation of the land to a stable condition.	NA ^{1, 2}
(4) For subsection (1)(b)(ii), the PRCP schedule must provide for each rehabilitation milestone to be achieved as soon as practical after the land to which it relates becomes available for rehabilitation.	Section 8.1 and Attachment 1
(5) For subsection (4), land is available for rehabilitation if the land is not being mined, unless—	Attachment 1
(a) the land is being used for operating infrastructure or machinery for mining, including, for example, a dam or water storage facility; or	
(b) the land is identified in the proposed PRCP schedule or the application for an environmental authority for relevant activities to which the schedule relates as containing a probable or proved ore reserve that is to be mined within 10 years after the land would otherwise have become available for rehabilitation; or	
(ba) the land is required for the mining of a probable or proved ore reserve mentioned in paragraph (b); or	
(c) the land contains permanent infrastructure identified in the proposed PRCP schedule as remaining on the land for a post-mining land use.	

Note: PMLU = Post-mining Land Use.

1 In accordance with section 754(3) of the EP Act, YCC is not required to comply with a requirement under section 126C(1)(g) or (h) or 126D(2) or (3) for the proposed PRCP Schedule for the plan in relation to land as an outcome for the land has been identified under a land outcome document (EA EPML00844613), and the outcome for the land is the same as, or substantially similar to, the outcome for the land if it were a NUMA under a PRCP Schedule.

2 The Yarrabee Mine, in accordance with EA EPML00844613 and section 126C(1)(i) of the EP Act, has pre-approved NUMAs and therefore section 126D (3) does not apply to this PRCP.

1.2.2 Environmental Protection Regulation 2019

Schedule 8A of the *Environmental Protection Regulation 2019* (the EP Regulation) outlines the objective assessment for particular PRCP Schedule decisions. The administering authority must consider whether the PRCP Schedule achieves each objective stated in Part 3 of Schedule 8A of the EP Regulation.

Based on the definitions provided in section 750 of the EP Act, the EA for the Yarrabee Mine (EA EPML00844613) and the *Yarrabee Rehabilitation Management Plan* (YCC, 2021) are Land Outcome Documents (LOD). Accordingly, section 213 of the EP Regulation outlines the following transitional provisions that apply:

(213) Carrying out PRCP objective assessment for particular PRCP schedule decision

(1) This section applies if, under section 754 of the Act, the administering authority has given a mining EA holder a notice requiring the holder to give the administering authority a proposed PRC plan.

(2) Schedule 8A, part 3, table 1 does not apply for conducting a PRCP objective assessment of the proposed PRCP schedule for the plan to the extent that—

(a) a land outcome document provides for an outcome for the land the subject of the proposed PRCP schedule; and

(b) the outcome for the land is the same as or substantially similar to the outcome for the land as if it were a post-mining land use or non-use management area under the plan.

(3) Also, the PRCP objective and PRCP performance outcomes stated in schedule 8A, part 3, table 2, entry for 'Rehabilitation Milestones' do not apply for conducting a PRCP objective assessment of the proposed PRCP Schedule for the plan to the extent that—

(a) a land outcome document states criteria for achieving an outcome provided for in the document for land; and

(b) the same or substantially similar criteria are proposed in the plan for the outcome.

(4) In addition, the PRCP objective and PRCP performance outcomes stated in schedule 8A, part 3, table 3, entry for 'Management Milestones' do not apply for conducting a PRCP objective assessment of the proposed PRCP schedule for the plan to the extent that—

(a) a land outcome document states criteria for achieving an outcome provided for in the document for land; and

(b) the same or substantially similar criteria are proposed in the plan for the outcome.

In summary, the land outcomes, and associated criteria for achieving these outcomes are identified in EA EPML00844613 and the *Yarrabee Rehabilitation Management Plan* (YCC, 2021). As a result, they are not subject to assessment under the EP Regulation in this PRCP; as the land outcomes provided in this PRCP are the same as, or substantially similar to, those outlined in the LODs.

1.2.3 Progressive Rehabilitation and Closure Plans Guideline

The PRCP Guideline assists applicants in developing a PRCP as part of a site-specific application for a new mining activity and for existing EA holders who are required to develop a PRCP under section 754 of the EP Act.

The PRCP (this document) must meet the information requirements in section 126C of the EP Act (unless otherwise stated) (Table 1-3) and must be written in accordance with the PRCP Guideline.

The PRCP Schedule (Attachment 1) must meet the information requirements in section 126D of the EP Act (unless otherwise stated) (Table 1-3) and must be developed in accordance with the PRCP Guideline. The PRCP Schedule operates separately to the EA and contains milestones and conditions that relate to the completion of progressive rehabilitation and mine closure. Both the EA and the PRCP Schedule apply to the entire life of mine, irrespective of when the underlying tenure expires. As per section 202E of the EP Act, where there is an inconsistency between an EA and a PRCP Schedule, the EA prevails to the extent of the inconsistency.

Table 1-3: Progressive Rehabilitation and Closure Plan – Guideline Checklist

PRCP Requirement ¹	Requirement Met? (Yes/NA ²)	Relevant Section Number	Justification
Project Description			
Describe the following:	-	-	-
Each resource tenure, including the area of each tenure to which the application relates.	Yes	Section 1.3.1	-
The relevant activities to which the application relates.	Yes	Section 1.3.2	-
The likely duration of the relevant activities.	Yes	Section 1.3.3	-
How and where the relevant activities are to be carried out, including maps.	Yes	Section 2.14, Figure 2-12, Figure 2-13, Figure 4-1, and Attachment 1	-
Consultation			
Include details of the consultation undertaken by the applicant in developing the proposed PRCP.	Yes	Section 3.3	-
Include details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.	Yes	Section 3.1	-
PMLU			
State the extent to which each proposed PMLU identified in the proposed PRCP Schedule for the plan is consistent with the outcome of consultation with the community in developing the PRCP.	Yes	Section 4.3	-
State the extent to which each proposed PMLU identified in the proposed PRCP Schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	Yes	Section 4.2	-
NUMA³			
State the extent to which each proposed NUMA identified in the PRCP Schedule for the plan is consistent with the outcome of consultation with the community in developing the PRCP.	Yes	Section 5.3	-
State the extent to which each NUMA identified in the PRCP Schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	Yes	Section 5.2	-

Table 1-3 (Continued): Progressive Rehabilitation and Closure Plan – Guideline Checklist

PRCP Requirement ¹	Requirement Met? (Yes/NA ²)	Relevant Section Number	Justification
For each proposed NUMA, state the reasons the applicant considers the area cannot be rehabilitated to a stable condition because of a matter mentioned in section 126D(2).	NA	-	This PRCP has been developed to reflect the pre-approved PMLUs and NUMAs detailed in the LODs, which have been transitioned into this PRCP. Therefore, justification is not required.
For each matter mentioned in the requirement above, include copies of reports or other evidence relied on by the proponent for each proposed NUMA.	Yes	EA EPML00844613 (Appendix A). RMP (Appendix B).	EA EPML00844613. RMP.
Rehabilitation and Management Methodology⁴			
For each PMLU, state the applicant's proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP Schedule.	Yes	Section 6	-
For each NUMA, state the applicant's proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP Schedule for the area.	Yes	Section 6	-
Risk Assessment			
Identify the risks of a stable condition for land described as a PMLU not being achieved, and how the applicant intends to manage or minimise the risks.	Yes	Section 7	-
PRCP Guideline			
Include any other information prescribed by the administering authority in the PRCP Guidelines.	Yes	This PRCP	-
Include the spatial information required in the PRCP Guideline.	Yes	Section 2.14, Figure 2-11, Figure 2-12, Figure 2-13, Figure 4-1, and Figure 6-1.	-

Table 1-3 (Continued): Progressive Rehabilitation and Closure Plan – Guideline Checklist

PRCP Requirement ¹	Requirement Met? (Yes/NA ²)	Relevant Section Number	Justification
Other Information			
Include the other information the administering authority reasonably considers necessary to decide whether to approve the PRCP Schedule.	Yes	This PRCP	-
PRCP Schedule⁵			
Include a PRCP Schedule prepared using the <i>PRCP Schedule template (ESR/2019/5103)</i> (DESI, 2024b).	Yes	Section 2.14, Figure 2-12, Figure 2-12, Figure 2-13, Figure 4-1, and Attachment A	-
Include maps showing all of the land mentioned in the PRCP schedule, as it relates to being progressively rehabilitated.	Yes	Figure 4-1	-

¹ As per the requirements of Submission of a *Progressive Rehabilitation and Closure Plan (ESR/2019/4957)* (DESI, 2024c).

² Justification must be provided for any requirements for which the response is Not Applicable (NA).

³ Note for Transitional PRCPs: The holder is not required to comply with the requirements under section 126C(1)(g) or (h) or 126D(2) or (3) for the proposed PRCP Schedule for the plan in relation to land if a land outcome document identifies the outcome for the land as the same, or substantially similar to, the outcome for the land if it were a NUMA.

⁴ Section 3.5 of the PRCP Guideline outlines the range of information that must be included as appendices to the rehabilitation planning part of the PRC plan.

⁵ The proposed PRCP Schedule must comply with section 126D of the EP Act, and be written in accordance with the PRCP Guideline. The administering authority will assess the proposed PRCP Schedule in conjunction with the rehabilitation planning part of the PRCP and other application documents, and decide whether to approve the proposed PRCP Schedule, with or without conditions, or refuse the proposed PRCP Schedule.

1.3 PROJECT DESCRIPTION

Yarrabee Mine has been operational for more than 40 years, following the granting of the initial ML (ML 1770) in 1976. Since then, additional MLs have been granted to facilitate the progression of mining (Table 1-4). Yarrabee Mine produces up to 4 Mtpa of ROM coal for the metallurgical market.

1.3.1 Mining Tenements

The Yarrabee Mine tenements and their status are listed in Table 1-4. Table 1-4 also identifies the overlapping Exploration Permit for Coal (EPC) tenures. All overlapping EPC tenures are held by YCC. In addition to the overlapping mining tenures, the Yarrabee Mine has overlapping petroleum tenements, as shown in Table 1-5.

Table 1-4: Mining Tenements

Permit	Holder	Granted	Expiry	Area (hectare [ha])	Overlapping EPC Tenure
ML 1770	YCC	25 March 1976	31 March 2037	1292	EPC 621 EPC 717
ML 80049	YCC	24 June 1999	30 June 2039	133	-
ML 80050	YCC	1 October 1998	31 October 2038	1223	-
ML 80096	YCC	20 June 2002	30 June 2038	101	EPC 621
ML 80104	YCC	4 September 2003	30 September 2023*	648	EPC 621
ML 80172	YCC	4 October 2012	31 October 2042	1987	EPC 717
ML 80195	YCC	1 April 2014	30 April 2044	2356	EPC 1429 EPC 717
ML 80196	YCC	1 April 2014	30 April 2044	80	EPC 621
ML 80197	YCC	7 May 2014	31 May 2044	413	EPC 621
ML 80198	YCC	1 April 2014	30 April 2044	50	EPC 621

Note: * Renewal Lodged 29 March 2023.

Table 1-5: Overlapping Petroleum Tenements

Petroleum Tenure	Holder	Granted	Expiry	Overlapping Yarrabee Mine MLs
PCA 261	Bow CSG Pty Ltd	8 May 2020	7 May 2035	ML 80104
ATP 1025	Bow CSG Pty Ltd	24 February 2009	28 February 2033	ML 80104

Note: PCA = Potential Commercial Area; ATP = Authority to Prospect (Petroleum).

1.3.2 Type of Mining Operation

Yarrabee Mine is an open cut coal mine. Overburden and ROM coal are extracted using standard truck and shovel mining techniques. ROM coal is processed on site at the Coal Handling and Preparation Plant (CHPP) or the YEN Bypass Pad. Tailings are currently disposed of in-pit at DOM1 and were historically disposed in DE-Pit. Product coal is hauled via a private haul road to the Boonal Train Load-out Facility, which is shared facility with Jellinbah Mine, and operated by YCC under a separate EA and is therefore not within the scope of this PRCP.

1.3.3 Duration of Mining Operations

Open cut mining is currently undertaken in YEN-Pit, DOM2N and DOM5, with mining in YES-Pit expected to commence in 2026. Mining is expected to cease in 2052.

1.3.4 Primary Mine Features and Infrastructure

The primary mine features and infrastructure associated with the Yarrabee Mine include:

- Site administration offices and workshop.
- Processing of ROM coal at the CHPP.
- Four open cut mining areas located on the northern side of Twelve Mile Creek.
- Ten open cut mining areas located on the southern side of Twelve Mile Creek.
- In-pit and out-of-pit waste rock emplacements.

Two Tailings Storage Facilities (TSFs):

- DOM1 is currently operational and utilised for tailings disposal. It will be utilised for the remaining mine life until closure, when it will be backfilled, capped, and rehabilitated.
- DE-Pit has been historically backfilled with waste material and the coincident aboveground TSF is currently being prepared for capping and rehabilitation.

Other ancillary infrastructure include but are not limited to:

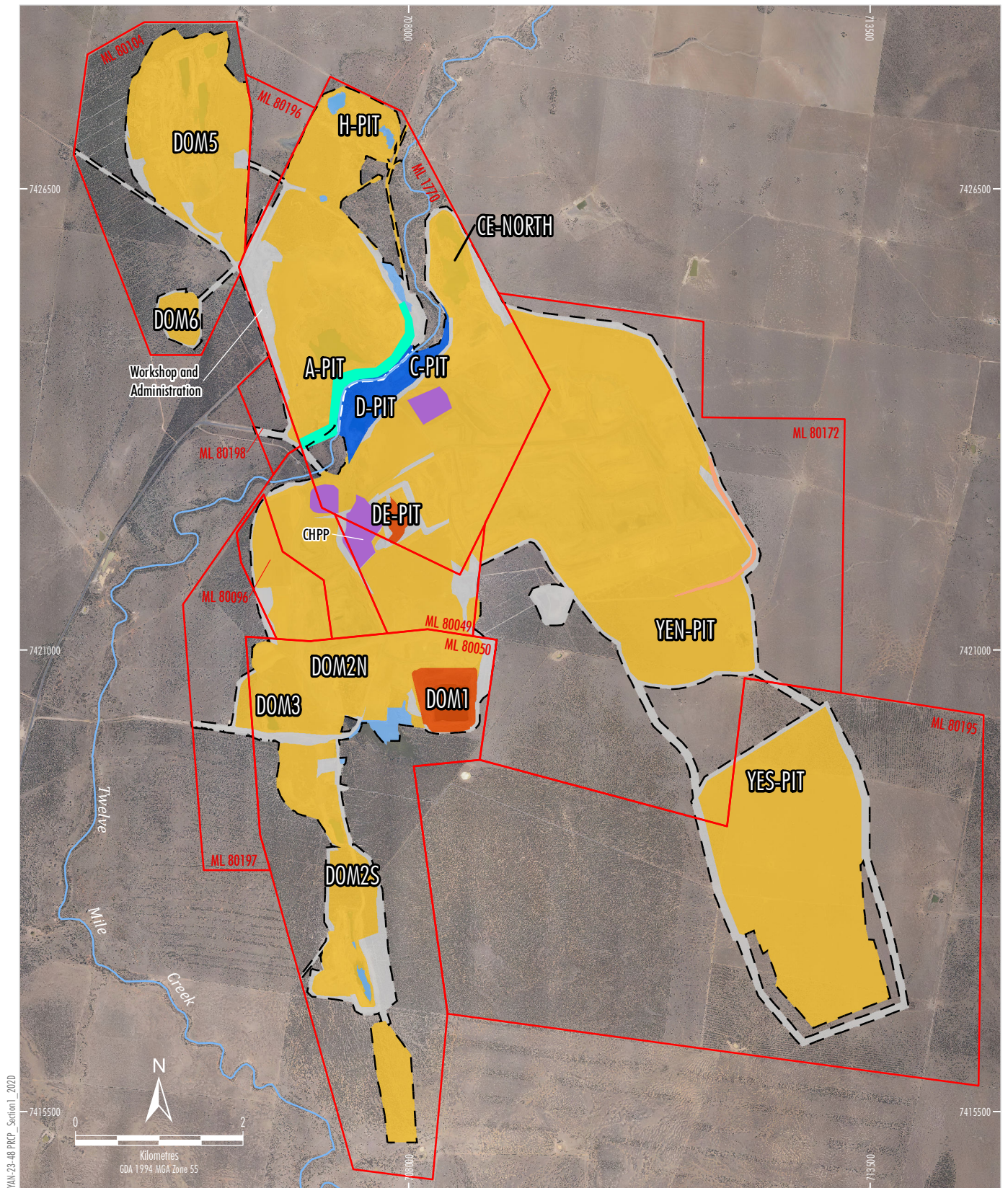
- haul roads;
- access roads/tracks;
- ROM Pads;
- ROM and product stockpiles;
- water management;
- electricity supply;
- explosive magazines; and
- hardstand and laydown areas.

Table 1-6 provides a summary of each mine pit, their current operational status, and their proposed rehabilitation treatment. The mine layout, including the locations of in-pit and out-of-pit waste rock emplacements, is shown in Figure 1-2 and the mine disturbance footprint is presented in Figure 1-3.

Table 1-6: Mine Pit Status

Mine Pit	Activity Status	Proposed Residual Void Treatment	North or South of Twelve Mile Creek
DOM3	In-active	Backfilled	South
C-Pit		To be backfilled	South
DE-Pit	In-active Tailings Storage	Backfilled	South
CE-North	In-active Active Water Storage	NUMA	South
H-Pit		To be backfilled	North
A-Pit		NUMA	North
DOM5 ¹		NUMA	North
D-Pit		To be backfilled	South
YEN-Pit	Active	NUMA	South
DOM2N		NUMA	South
DOM2S		NUMA	South
DOM1	Active Tailings Storage	To be backfilled	South
YES-Pit	Not Yet Commenced	NUMA	South
DOM6		NUMA	North

¹ The extent of the DOM5 mine void includes the consolidated extent of DOM5N, DOM5S and DOM4.



Source: The State of Queensland (2024); Yancoal Australia (2025)
Orthophoto: Yancoal Australia (2023)

LEGEND	
	Mining Lease Boundary
	Yarrabee Disturbance Footprint
	Temporary Twelve Mile Creek Diversion
	A-Pit Levee
	YEN-Pit Levee
	ROM Pad
	Mine Domains*
	In-pit and Out-of-Pit Waste Emplacement
	Infrastructure Areas
	Tailing Storage Facility (TSF)
	Twelve-mile Creek Diversion
	Water Management Infrastructure

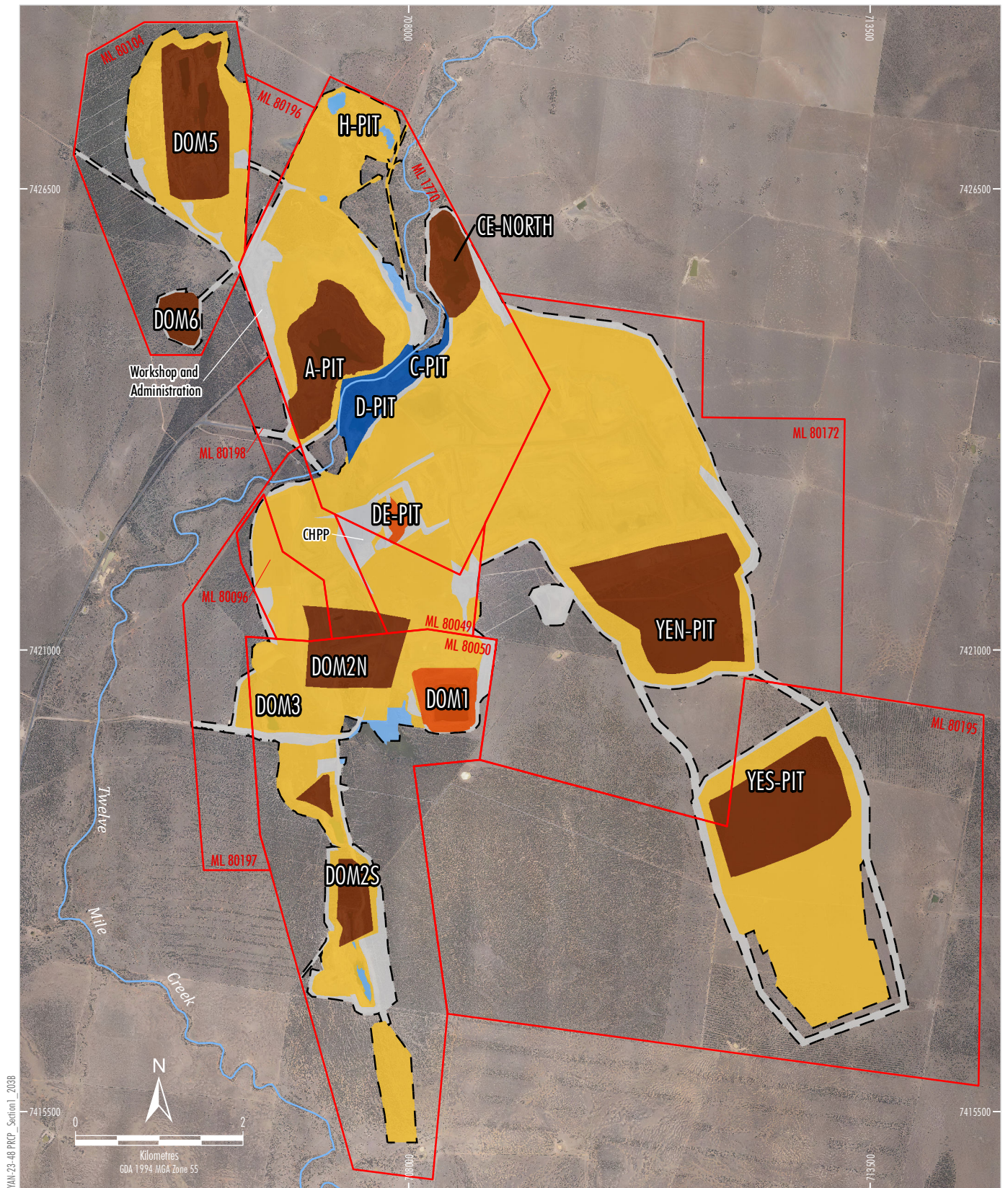
*Domains will change over the life of the mine and are indicative of the domain active at the cessation of mining at any given location (e.g. Infrastructure may be established over In-pit and Out-of-pit Waste Emplacement during operations).



YARRABEE COAL MINE

Yarrabee Coal Mine General Arrangement

Figure 1-2



LEGEND

- Mining Lease Boundary
- Yarrabee Disturbance Footprint
- Approved Non-use Management Area (EA EPML00844613)
- In-pit and Out-of-Pit Waste Emplacement
- Infrastructure Areas
- Tailing Storage Facility (TSF)
- Twelve-mile Creek Diversion
- Water Management Infrastructure

Source: The State of Queensland (2024); Yancoal Australia (2025)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE
Yarrabee Coal Mine
Disturbance Footprint

Figure 1-3

1.4 ENVIRONMENTALLY RELEVANT ACTIVITIES

Environmentally Relevant Activities (ERAs) (defined under the EP Act) are activities that release or have the potential to release contaminants into the environment which may cause environmental harm. In accordance with EA EPML00844613, the Yarrabee Mine is approved to conduct the ERAs listed in Table 1-7.

Table 1-7: Approved Environmentally Relevant Activities

Relevant MLs	ERA	Description
ML 1770 ML 80049 ML 80050 ML 80096 ML 80104 ML 80172 ML 80195 ML 80196 ML 80197 ML 80198	ERA 8	Ancillary – Chemical Storage 1 Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a).
	ERA 8	Ancillary – Chemical Storage 3 Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).
	ERA 13	Schedule 3 – Mining black coal
	ERA 63	Ancillary – Sewage Treatment 1 Operating sewage treatment works, other than no release works, with a total daily peak design capacity of, (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.
	ERA 60	Ancillary – Waste disposal 2 Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1) (b), (a) less than 2000t.
	ERA 31	Ancillary – Mineral processing 2 Processing, in a year, the following quantities of mineral products, other than coke, (b) more than 100,000t.

Note: t = tonnes; AS = Australian Standard.

2 BASELINE INFORMATION

2.1 SITE TOPOGRAPHY

The topography of Yarrabee Mine and its surrounds are characterised by generally flat to gently undulating land with less than 3 percent (%) gradients, with some areas of modified landscapes associated with other nearby coal mines. Regionally, steeper topography is associated with the Blackdown Tablelands and Arthur's Bluff, located approximately 30 km to the south of Yarrabee Mine.

2.2 CLIMATE

Yarrabee Mine is located in Central Queensland where the regional climate is subtropical, with an average annual rainfall of 565 millimetres (mm) and evaporation of 69.5 mm (Bureau of Meteorology [BoM], 2025a). Rain is summer-dominant and highly variable, with dry periods being common. Extended periods of below average rainfall can be broken by weather events (storms/rain depressions) that deliver significantly higher than average rainfall. These weather events can deliver higher intensity rainfall over relatively short periods that can result in the generation of significant overland water flow events. Table 2-1 summarises the average monthly climatic data at the nearest BoM weather stations with the most current data sets available (BoM, 2025a and BoM, 2025b).

Table 2-1: Climate Data Summary

Period of Record	Average Rainfall (mm)	Average Minimum Temperature (°C)	Average Maximum Temperature (°C)	Average Monthly Pan Evaporation (mm)
	Emerald Airport (35264)	Emerald Airport (35264)	Emerald Airport (35264)	Rockhampton Aero (39083)
	1992 to 2025	1992 to 2025	1992 to 2025	1951 to 2022
January	82.6	22.3	34.7	7.4
February	84.9	22.1	33.8	6.7
March	60.6	20.6	32.9	6.3
April	31.6	17.1	30.0	5.3
May	20.9	13.1	26.4	4.2
June	29.3	10.3	23.5	3.5
July	19.2	9.2	23.4	3.6
August	21.2	10.2	25.6	4.4
September	24.7	13.6	29.1	5.8
October	46.8	17.2	32.1	6.9
November	58.5	19.6	33.5	7.6
December	82.3	21.4	34.5	7.8
Annual Average	565.3 [562.6]	16.4	30.0	69.5

Source: (BoM, 2025a and 2025b).

Note: °C = degrees Celsius; [] = Sum of average monthly records, discrepancy with annual averages is based on BoM historical records.

Temperatures can fluctuate up to 45°C across a yearly cycle, from minimums near freezing in the winter months to maximums in the high forties in the summer months. Temperature data for the Emerald Airport weather station indicates the greatest fluctuations generally occur in September with minimum and maximum recorded temperatures ranging between 13.6°C and 29.1°C. Figure 2-1 outlines an overview of the minimum and maximum average monthly temperatures recorded at the Emerald Airport weather station (BoM, 2025a).

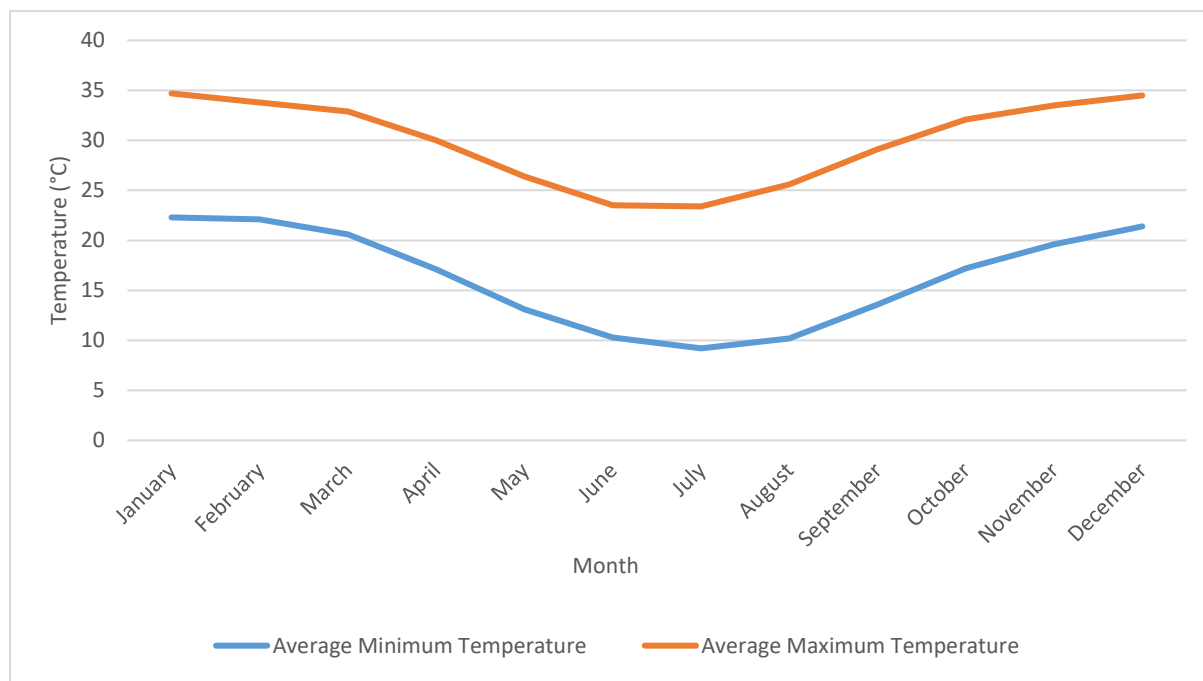


Figure 2-1: Average Monthly Minimum and Maximum Temperatures Reported at the Emerald Airport Weather Station (BoM, 2025a)

Average temperatures are expected to rise in Central Queensland, with temperatures projected to reach 1.0°C to 3.8°C above the climate of 1986 to 2005 by 2070 (Queensland Government, 2019). There is likely to be an increase in the temperature reached on the hottest days, a decrease in the frequency of frost risk, and harsher fire weather across the region. However, rainfall projections show little change, with a decrease in rainfall during the winter and spring months, and the average pan evaporation predicted to increase. The intensity of heavy rainfall events is likely to increase. For all of Queensland, fire seasons are expected to be longer, with approximately 40% more very high fire danger ratings, and extreme rain events are projected to become more intense (Climate Change in Australia, 2024).

2.3 GEOLOGICAL SETTING

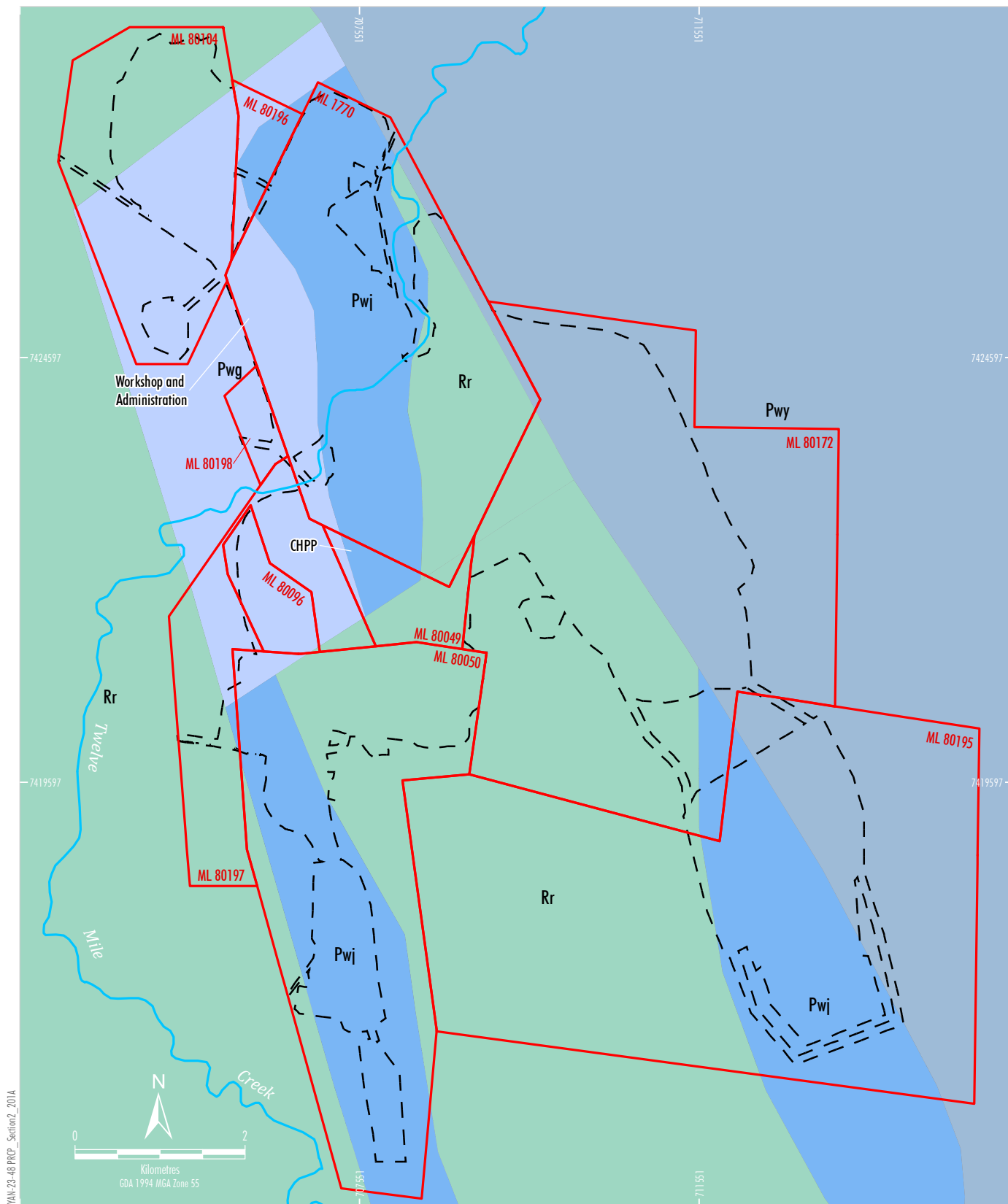
Yarrabee Mine is located in a structurally complex area on the eastern limb of the Permo-Triassic Bowen Basin, within the Jellinbah Thrust Belt known locally as the Yarrabee Fault Complex. The basin axis is oriented north-northwest to south-southeast, roughly parallel to the Palaeozoic continental margin. The basin is divided into multiple tectonic units comprising north-northwest to south-southeast trending platforms or shelves, separated by sedimentary troughs.

The strata of the region surrounding Yarrabee Mine is typically comprised of between 2 metres (m) and 25 m of sandy alluvium and basal Tertiary clays near the surface, followed by approximately 25 m of weathered sedimentary rock (interbedded sandstone, siltstone, and mudstone). An upper zone of weathered rock (regolith) is present across the subcropping solid geology and has an average depth of 23 m below ground level across the Yarrabee Mine. A layer of mudstone, siltstone, coal, and shale makes up the material between the weathered rocks and the coal deposit that is located approximately 20 m to 70 m below the surface (SMG, 2017). The key Stratigraphic Units within the Yarrabee Mine MLs are presented in Figures 2-2 and 2-3, and include:

- Burngrove Formation.
- Gylanda Formation.
- Rangal Coal Measures.
- Rewan Formation.

The Yarrabee deposit is located within the Rangal Coal Measures (RCM) of the Blackwater Group. The deposit contains areas of significant structural complexity with multiple thrust faults causing discontinuous deposits, with steeply dipping seams, multiple seam repeats and seam overturning.

The mineable resource occurs across seven coal seams: Cancer, Aries, Castor Upper, Castor Lower, Pollux, Orion, and Pisces. The coal measures include weak interbedded siltstones and fine sandstones with minor mudstones adjacent to the seam contacts. The economic coal seams typically range from 3.25 m to 4.0 m in thickness; however, thicker intersections occur due to the overthrust faulting. The economic depth of open cut mining varies with coal thickness (as well as market conditions) and is generally not expected to exceed 160 m.



YAN-23-48-PRCP_Section2_201A

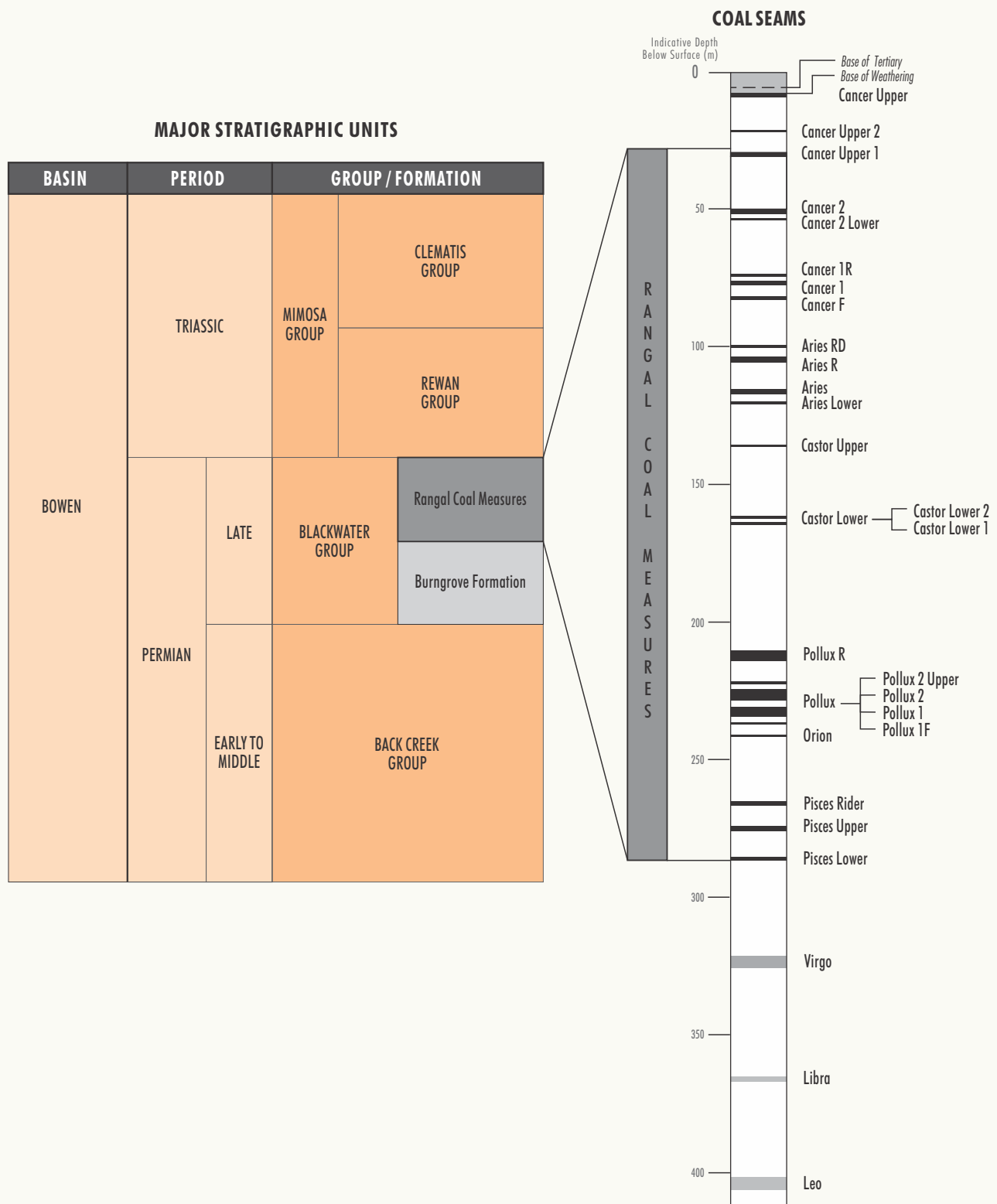
Source: The State of Queensland (2024); Yancoal Australia (2024)

- LEGEND**
- Mining Lease Boundary
 - Yarrabee Disturbance Footprint
 - Stratigraphic Units**
 - Pwg Burngrove Formation
 - Pwy Gyranada Subgroup
 - Pwj Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures
 - Rr Rewan Formation



YARRABEE COAL MINE
Regional Geology

Figure 2-2



Source: Xenith (2024)



YARRABEE COAL MINE
Representative Stratigraphic Column

Figure 2-3

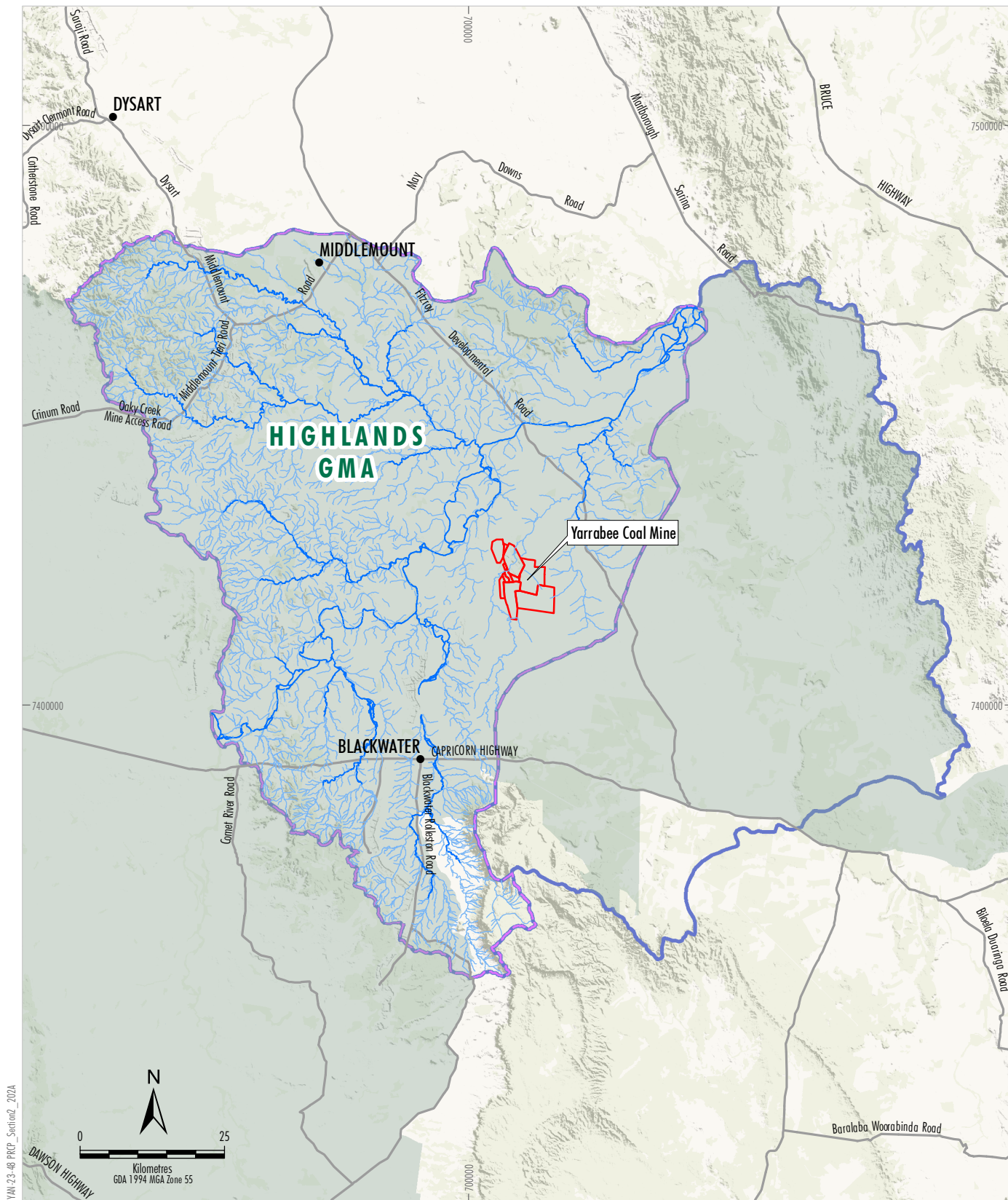
2.4 SITE HYDROLOGY AND FLUVIAL NETWORKS

Yarrabee Mine is located within the Mackenzie River catchment of the Fitzroy Basin (Figure 2-4). The Mackenzie River flows north-east, 5.5 km north-west of the site. The Mackenzie River is a major contributor to the greater Fitzroy Basin including the Fitzroy River, which has a total catchment area to the coast of approximately 140,000 kilometres squared (km²) making it the second largest seaward draining basin in Australia. The Mackenzie River floodplain is a broad, relatively flat, floodplain up to 10 km wide with elevations in the range of 115 to 125 metres Australian Height Datum (mAHD). Yarrabee Mine is located outside of this floodplain.

Twelve Mile Creek is a second order ephemeral tributary of the Mackenzie River that runs through the Yarrabee Mine, with open cut pits located on both sides of the creek (Figure 1-2). A narrow riparian margin (less than 20 m wide) has been left along much of the banks of Twelve Mile Creek. A section of Twelve Mile Creek has historically been diverted under a current licence and a permanent diversion is being designed. The Twelve Mile Creek Diversion is discussed further in Section 6.9.1.

The catchment area upstream of the Yarrabee Mine is approximately 25,120 ha. All run-off associated with this catchment drains to Twelve Mile Creek which runs in a north-easterly direction. Approximately 20 km downstream of the Yarrabee Mine, Twelve Mile Creek receives waters from South Creek (another ephemeral stream), before entering Mackenzie River approximately 32 km downstream of the Yarrabee Mine.

Generally ephemeral watercourses within the Fitzroy Basin, including Twelve Mile Creek, experience higher velocity, pulsed flows throughout the wet season. These flows are generally highly sediment laden and turbid, reducing the ability for sunlight to penetrate the water column. The quality of receiving waters is monitored regularly as required by the Yarrabee Mine EA, including the Receiving Environment Monitoring Program (REMP).



YAN-23-46-PRCP_Section2_2024



- LEGEND**
- Mining Lease Boundary
 - Highlands Groundwater Management Area
 - Minor Watercourse (Order 1 and 2)
 - Major Watercourse (Order 3 - 8)
 - Fitzroy Basin
 - Mackenzie River Subcatchment
 - Upper Mackenzie River Catchment

Source: The State of Queensland (2023, 2024);
Geoscience Australia (2018)



YARRABEE COAL MINE
Regional Fluvial Network

Figure 2-4

2.5 HYDROGEOLOGY

2.5.1 Groundwater Presence

The three main geological units within Yarrabee Mine that have the greatest potential to store and transmit quantities of groundwater are:

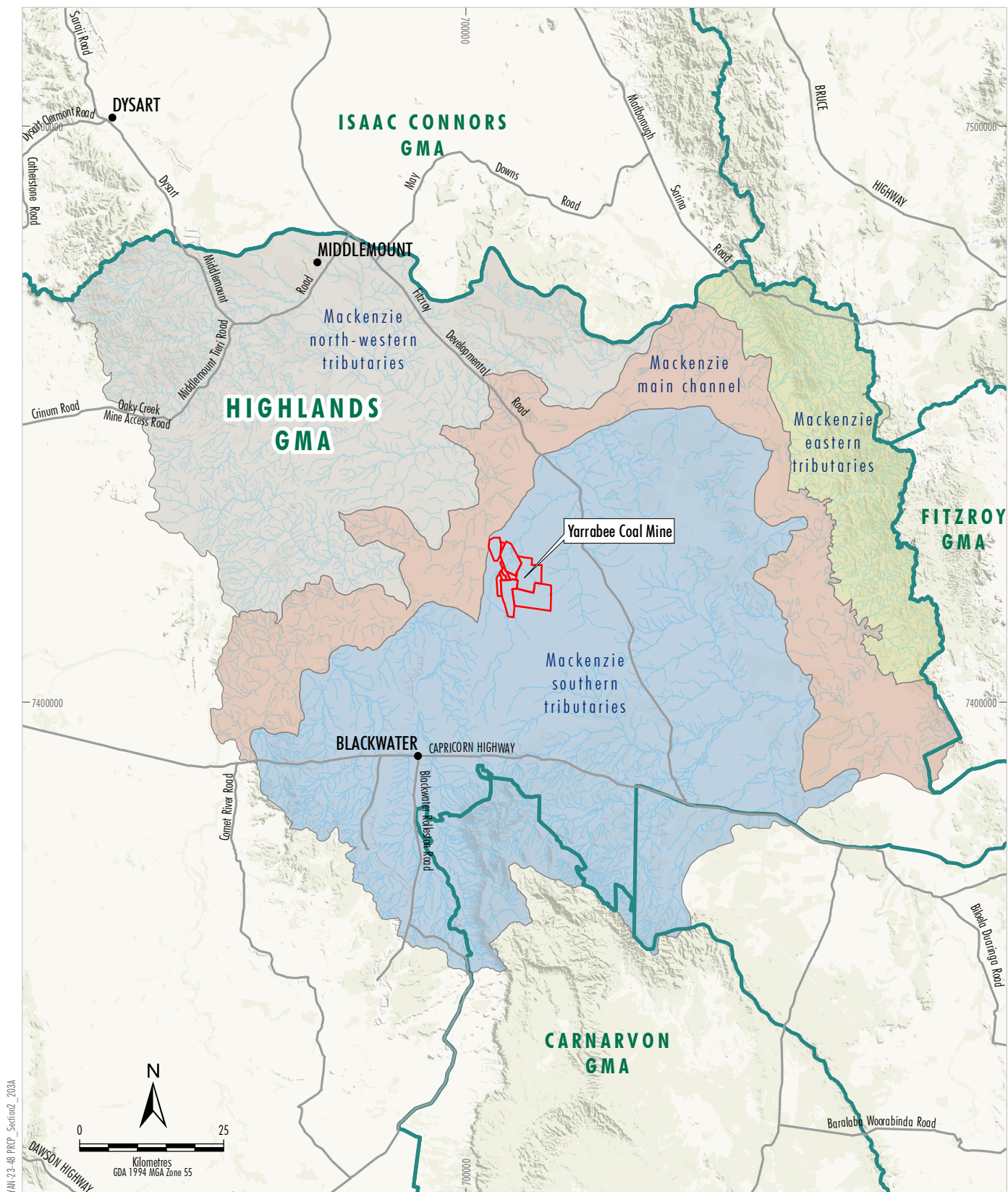
- Quaternary alluvium primarily associated with the Mackenzie River, and potentially the Late Tertiary/Quaternary alluvium where it thickens west and north-west of Yarrabee Mine and contains permeable horizons.
- Regolith, the upper weathered rock horizon where the water table typically fluctuates towards the base of this zone, is present across all the consolidated formations where they naturally outcrop/subcrop.
- Coal seams within the Permian coal measures, which are of low permeability, but typically the most permeable horizons within the coal measures strata.

Based on government data sets and regional mapping, groundwater aquifers are not highly charged and are generally at similar depths of approximately 40 m (Figure 2-5). The Rewan and Burngrove formations and Gylanda Subgroup are considered aquitards, so too are thick sequences of the Permian coal measures interburden where they comprise siltstones and mudstones (Figure 2-2).

Groundwater levels across Yarrabee Mine within the RCM, broadly fall from south to north towards the Mackenzie River floodplain. The highest groundwater levels are observed in the southern end of the site around 127 to 121 mAHD and then generally fall to the north with levels in the centre of the site in the range 115 to 105 mAHD. To the northern end of the site monitoring indicates a level of around 101 mAHD. The RCM at Yarrabee Mine are heavily faulted resulting in compartmentalisation of the coal seams i.e. they do not form continuous pathways for the movement of groundwater.

Three monitoring bores installed to the base of the Late Tertiary/Quaternary alluvium along Twelve Mile Creek have all been recorded as dry. Groundwater levels in the RCM at bores near Twelve Mile Creek show the saturated water table is between 13 m and 18 m below the elevation of the channel.

There is no direct take of groundwater or need for active management. Pit dewatering with pumps in advance of mining has never been required at Yarrabee Mine and there are no known areas where groundwater interacts with surface waters.



YAN-23-48-PRCP_Section2_2024



- LEGEND**
- Mining Lease Boundary
 - Fitzroy Basin Water Plan
 - Groundwater Management Area (GMA)
 - Watercourse
 - Sub-catchment Areas of the Mackenzie River Catchment
 - Mackenzie eastern tributaries
 - Mackenzie main channel
 - Mackenzie north-western tributaries
 - Mackenzie southern tributaries

Source: The State of Queensland (2023, 2024);
Geoscience Australia (2018)



YARRABEE COAL MINE
Groundwater Within Stratigraphy

Figure 2-5

2.5.2 Groundwater Quality

This low mobility of groundwater within the RCM at Yarrabee Mine is evidenced by the very high salinity, even in shallow bores, indicating long residence times and low recharge. Salinity can be a key constraint to water management and groundwater use and is assessed by Total Dissolved Solids (TDS) concentrations, or by electrical conductivity (EC).

Table 2-2 presents TDS concentrations for the RCM and Rewan bores across Yarrabee Mine against livestock drinking water standards as this is one of the most common uses for rural groundwater when quality permits.

Table 2-2: Total Dissolved Solids – Livestock Water Quality Guidelines and Yarrabee Groundwater Quality

Livestock	Total Dissolved Solids (mg/L)		
	No adverse effects expected	Animals may have initial reluctance to drink, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef Cattle	0 – 4,000	4,000 – 5,000	5,000 – 10,000
Dairy Cattle	0 – 2,400	2,400 – 4,000	4,000 – 7,000
Sheep	0 – 4,000	4,000 – 10,000	10,000 – 13,000
Horses	0 – 4,000	4,000 – 6,000	6,000 – 7,000
Pigs	0 – 4,000	4,000 – 6,000	6,000 – 8,000
Poultry	0 – 2,000	2,000 – 3,000	3,000 – 4,000
Formation	Total Dissolved Solids (mg/L)		
RCM (28 samples)	Twentieth percentile concentration 12,760	Fiftieth percentile concentration 39,550	Eightieth percentile concentration 44,000
Rewan Formation (2 samples)	Minimum concentration 45,600	Mean concentration. 47,200	Maximum concentration 48,800

Source: (Appendix G).

Salinity is generally very high with even the twentieth percentile TDS value for the RCM samples exceeding all but the upper range guideline for the most salinity tolerant stock (sheep). Average TDS concentrations in the RCM are well beyond the tolerable ranges for livestock. Whilst the available data may not be considered representative due to the limited availability of groundwater samples for the Rewan Formation at Yarrabee Mine, the salinities are again very high and well beyond the tolerable range for all livestock.

2.5.3 Groundwater Use

A search of the Queensland Government's Registered Groundwater Bore Database (GWDB) (DRDMW, 2024) was carried out for registered bores within 10 km of Yarrabee Mine. Excluding exploration and mine monitoring bores, the search returned the following results listed in Table 2-3.

Table 2-3: Registered Groundwater Bores within 10 km of Yarrabee Mine

Bore Category	Bore Status	Number of Bores
Decommissioned	Abandoned and destroyed	5
Unknown	Existing	2
Water Resource Investigation	Existing	1
Water Supply	Existing	1

Source: (Appendix G).

The four bores listed as "Existing" are located 7 to 10 km east of Yarrabee Mine. The bore listed as a "Water Supply" bore is located 10 km east of Yarrabee Mine. Given the distance and position of the "Existing" bores from the site, the changes in geology to the east and the general northerly direction of groundwater flow towards the Mackenzie River, it is considered that there is no plausible groundwater pathway between the mine and the location of these bores.

Given the salinity of groundwater and the low permeability of the local geology, groundwater use in the vicinity of Yarrabee is very limited. None of the surrounding pastoral operations rely on groundwater for stock watering or domestic use due to its limited availability and high salinity.

2.6 SOILS AND OVERBURDEN MATERIALS

The principal soil types identified across the Yarrabee Mine are outlined in Table 2-4. Figure 2-6 outlines the location and extent of the mapped soils (Baker, 2010).

These soils generally exhibit moderate to high salinity and sodicity from variable depths below 40 centimetres (cm). The gilgai clay soils are neutral to moderately alkaline at the surface, with acidity generally increasing at depths below 40 cm. The upper soil profile may include moderate soft carbonate. Surface and internal drainage is very poor with water retained in gilgai depressions for considerable periods.

Fertility in the surface root zone is variable but is generally considered low. High pH and chloride levels are potentially limiting for seedling development and plant establishment. These soils are described as being suitable to grazing with very marginal potential for opportunistic cropping on the limited areas of the undulating Brigalow clays (Baker, 2010).

In general, the naturally occurring overburden materials are (Soil Conservation and Environmental Services, 1990; Natural Resource Assessments, 1997; ESys, 2003; Baker, 2010; Appendix K) characterised as:

- non-acid forming with a high neutralising capacity;
- non-toxic with respect to metals;
- typically saline to highly saline;
- dispersive; and
- infertile.

Landloch (Appendix K) confirmed that overburden material is generally alkaline, saline and sodic in nature:

- The mudstone is typically alkaline with high salinity (EC) and high chloride concentration and is more resistant to erosion than the sandstone.
- The sandstone is consistently more saline than the mudstone (especially when chloride concentration is considered rather than just EC) and is strongly sodic.

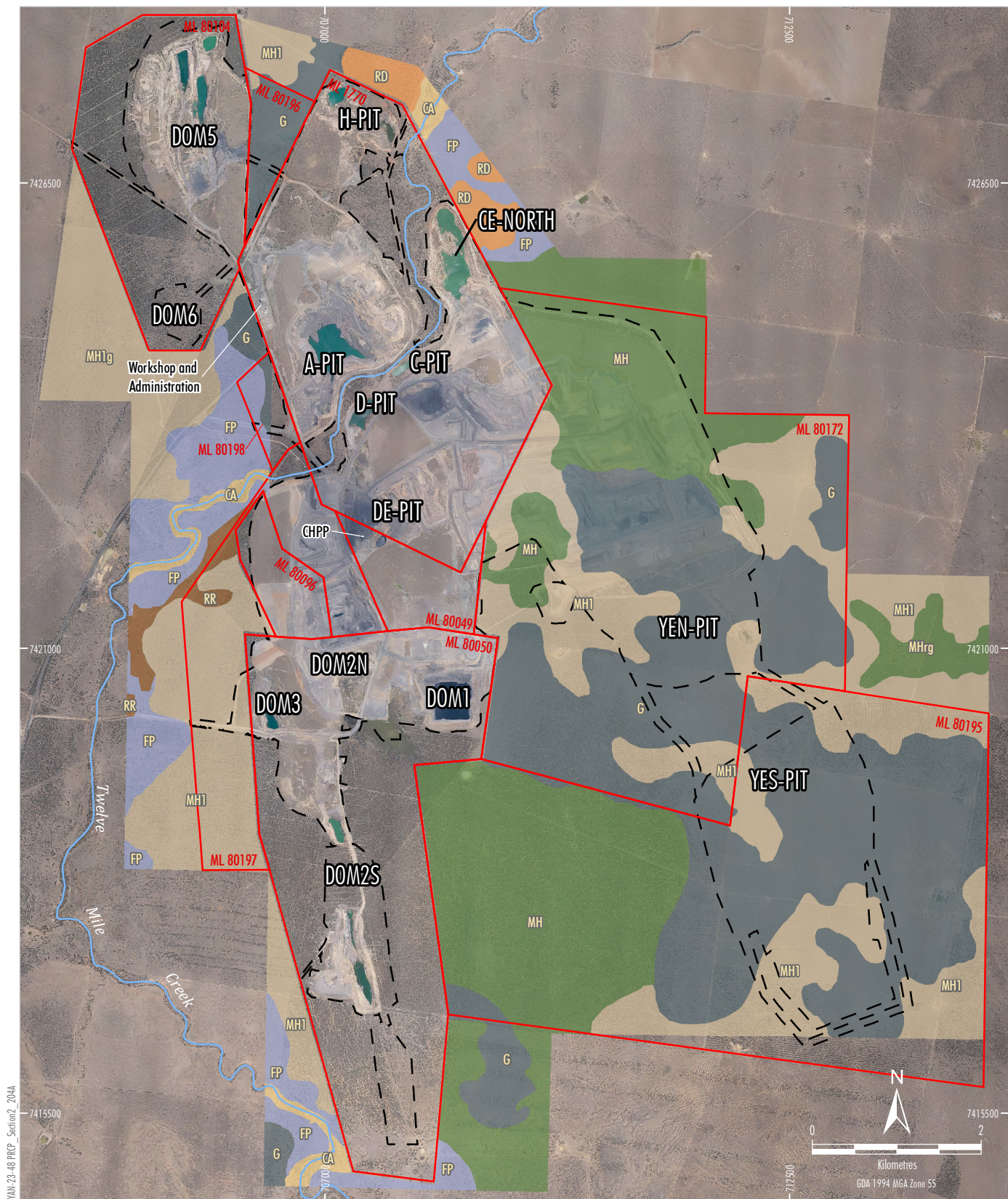
The high salinity and sodicity of the overburden are reflected in the overlying subsoils, with the highest levels of salinity and sodicity found in subsurface clays (at 2 to 4 m), predominantly in the south of the Yarrabee Mine area (Appendix K).

Section 6.6.2 provides a discussion of a soils and land suitability assessment undertaken in 2024.

Table 2-4: Principal Soil Types

Soil ID	Soil Type	Concept	Soils Description
CA	Sandy texture contrast soils	Sandy clay alluvia associated with active drainage lines and riparian zones.	Variable soils from deep sandy loams to uniform sandy clays alongside Twelve Mile Creek and in minor drainage lines throughout the area. Clays usually become coarser and harder with depth.
FP	Non-cracking clays	Deep clay soils associated with relic floodplains.	Generally non-cracking and hard setting brown, sandy uniform clays with no, or only minor gilgai.
RR	Red earths	Deep sandy soils associated with relic floodplains.	Local rises on the floodplains of Twelve Mile Creek characterised by red brown sandy gradational or duplex profiles.
G	Weakly gilgaied clays	Lightly to moderately gilgaied clays.	Brown cracking clay with a generally lower gilgai intensity and/or better structured soil than MH and MH1 soils.
MH	Shallow melon hole clays	Extensively melon-holed clays.	Brown to grey-brown cracking clay with acidic reaction trend, very coarse and hard subsoils dominated by extensive melon hole development. Subsoils are saline and sodic.
MH1	Deep melon hole clays	Moderately melon-holed clays.	Similar soil to MH but with higher buffel growth potential as a result of less intense melon hole intensity or improved soil physical or chemical attributes.
RD	-	Sandy red earths on elevated rises.	Red earths mostly cleared of vegetation.

Source: (Baker, 2010).



LEGEND



Mining Lease Boundary

Yarrabee Disturbance Footprint

Active alluvial channels and floodplains



Deep red and red brown sandy alluvia on floodplains



Riverine deep hard setting uniform to duplex sandy clays



Sandy clay alluvia associated with active drainage lines and the riparian zone



Partially intact remnant of the Tertiary land surface



Elevated rises of red sandy earths



Depositional plains of Tertiary clays



Heavily melon holed lowlands of very hard and poorly drained clay soils. (MHrg - red gravelly variant)



Productive grazing land on gently undulating plains improved pasture on Brigalow clays



Similar to MH but with less extreme soil attributes or lower melon hole component (MH1g - grey variant)



Similar to MH but with less extreme soil attributes or lower melon hole component (MH1g - grey variant)

Source: The State of Queensland (2024); Yancoal Australia (2021, 2024)
Orthophoto: Yancoal (2023)



YARRABEE COAL MINE

Soil Type

Figure 2-6

2.7 VEGETATION COMMUNITIES AND ECOLOGICAL DATA

Most of the EA approved disturbance footprint at Yarrabee Mine has already been cleared of remnant vegetation. Much of this clearance occurred prior to mining by previous landowners to create grassland for cattle grazing. The pre-mining, pre-agriculture, land at Yarrabee Mine would have been dominated by Brigalow and Brigalow/Dawson gum communities on clay soils with mixed riverine vegetation occurring on sandy clay soils along watercourses.

The current grassland vegetation species present include but are not limited to:

- *Aristida sp.* (Wire grass);
- *Bothriochloa sp.* (Bluegrass);
- *Chloris sp.*;
- *Panicum sp.* (Finger Panic grass);
- *Paspalidium sp.* (Brigalow grass); and
- *Pennisetum ciliare* (formerly *Cenchrus ciliaris*) (Buffel grass).

Desktop assessments and field surveys were undertaken in 2022 and 2023 (E2M, 2023; Appendix C) to identify vegetation present around the current EA approved disturbance footprint. The Study Area comprised all areas of the Yarrabee Mine MLs outside the EA approved disturbance footprint, an area of 4,256 ha. The comprehensive assessments and surveys have been used as a proxy to establish baseline vegetation across the entire mine site.

The assessments and surveying efforts found that vegetation comprises largely *Acacia harpophylla* (Brigalow) woodland and pastureland with Brigalow or Eucalypt regrowth, with areas of riparian vegetation and highly modified improved pasture also present. This is consistent with YCC's understanding that the land would have originally been dominated by Brigalow and Brigalow/Dawson gum communities on clay soils with mixed riverine vegetation occurring on sandy clay soils along watercourses.

2.7.1 Threatened Ecological Communities

The desktop assessment identified six Threatened Ecological Communities (TECs) as potentially occurring around the mine site. These potentially occurring TECs were subsequently ground-truthed during field surveys and only one TEC was confirmed as present (Brigalow [*Acacia harpophylla* dominant and co-dominant]).

The Brigalow TEC is predominantly concentrated in the southern undisturbed portion of the study area, with smaller patches identified to west of DOM5 and adjacent to Twelve Mile Creek in the northern extent of the study area.

The findings of the desktop assessment and field surveys are outlined in Table 2-5.

2.7.2 Regional Ecosystems

The desktop assessment also identified the following REs around the mine site (Table 2-6). These REs were ground-truthed during field surveys. The ground-truthed extent of remnant and high-value regrowth (HVR) REs are summarised in Table 2-6 and shown in Figure 2-7.

Table 2-5: Threatened Ecological Communities (EPBC Act)

Threatened Ecological Community	EPBC Act status	Desktop Assessment	Ground-truthed	Distribution
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant).	Endangered	Identified	Confirmed present	A total of 1,800.35 ha of Brigalow TEC was observed within the Study Area in association with remnant and HVR areas of RE 11.3.1, RE 11.4.8 and RE 11.4.9.
Coolibah – black box woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions.	Endangered	Identified	Not present	The Study Area is within the Brigalow Belt North bioregion and is outside of the distribution of this TEC (Threatened Species Scientific Committee, 2011).
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin.	Endangered	Identified	Not present	No vegetation communities with potential to contain this TEC occur within the Study Area.
Poplar box grassy woodland on alluvial plains.	Endangered	Identified	Not present	No vegetation communities with potential to contain this TEC occur within the Study Area.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions.	Endangered	Identified	Not present	No vegetation communities with potential to contain this TEC occur within the Study Area.
Weeping myall woodlands.	Endangered	Identified	Not present	No vegetation communities with potential to contain this TEC occur within the Study Area.

Note: HVR = High-value Regrowth; RE = Regional Ecosystem.

Table 2-6: Regulated Vegetation and Associated Regional Ecosystems (Queensland EP Act)

Regional Ecosystem	Vegetation Management Act 1999 Status	Biodiversity Status	Regional Ecosystem Description	Location in Study Area	Vegetation Type	Desktop Extent (ha)	Ground-truthed Extent (ha)
11.3.1	Endangered	Endangered	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains.	One patch located on the western bank of Twelve Mile creek.	Remnant	2	1
				Two patches located to the south of the site.	HVR	0.4	2
11.3.2	Of Concern	Of Concern	<i>Eucalyptus populnea</i> woodland on alluvial plains.	Not located.	HVR	0.2	0
11.3.3	Of Concern	Of Concern	<i>Eucalyptus coolabah</i> woodland on alluvial plains.	Not located.	Remnant	3	0
				Not located.	HVR	0.04	0
11.3.25	Least Concern	Of Concern	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines.	A narrow strip present along the length of twelve-mile creek.	Remnant	6	28
				Not located.	HVR	0.06	0
11.4.2	Of Concern	Of Concern	<i>Eucalyptus</i> spp. and/or <i>Corymbia</i> spp. Grassy or shrubby woodland on Cainozoic clay plains.	Two patches located the north-eastern corner of the Study Area.	Remnant	10	19
				Isolated patch present in the centre of the Study Area.	HVR	0	9
11.4.8	Endangered	Endangered	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains.	Narrow strip along the haul road.	Remnant	37	2
				Two isolated areas, one along Twelve Mile Creek in the north-east, and an isolated patch in the central Study Area.	HVR	0.2	35
11.4.9	Endangered	Endangered	<i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains.	Northeastern corner.	Remnant	7	42
				North, south, central, and west.	HVR	0.1	1,718
Non-remnant	NA	NA	NA	Throughout Study Area.	Non-remnant	4,178	2,401
Total						4,244	4,257

2.7.3 Threatened Flora

Three threatened flora species were also identified during recent field surveys as outlined in Table 2-7.

Table 2-7: Identified Threatened Flora Species

Scientific Name	EPBC Act Status	NC Act Status	Number of Stems	Number of Locations Identified
<i>Solanum adenophorum</i>	-	Endangered	219	27
<i>Solanum dissectum</i>	Endangered	Endangered	98	6
<i>Solanum elachophyllum</i>	-	Endangered	807	48

Note: NC Act = Nature Conservation Act 1992.

2.7.4 Pest Flora

Eight weed species listed as Weeds of National Environmental Significance (WoNS) or restricted matter under the Queensland *Biosecurity Act 2014* were recorded within the Study Area (Table 2-8).

Table 2-8: Pest Flora Species Identified in Study Area

Scientific Name	Common Name	WoNS	Biosecurity Act Status
<i>Bryophyllum x houghtonii</i>	Mother of millions hybrid	-	Category 3
<i>Bryophyllum delagoense</i>	Mother of millions	-	Category 3
<i>Cryptostegia grandiflora</i>	Rubber vine	WoNS	Category 3
<i>Harrisia martinii</i>	Harrisia cactus	-	Category 3
<i>Opuntia streptacantha</i>	Westwood pear	WoNS	Category 3
<i>Opuntia stricta</i>	Common prickly pear	WoNS	Category 3
<i>Opuntia tomentosa</i>	Velvet tree pear	WoNS	Category 3
<i>Parthenium hysterophorus</i>	Parthenium	WoNS	Category 3

Source: (Appendix C).

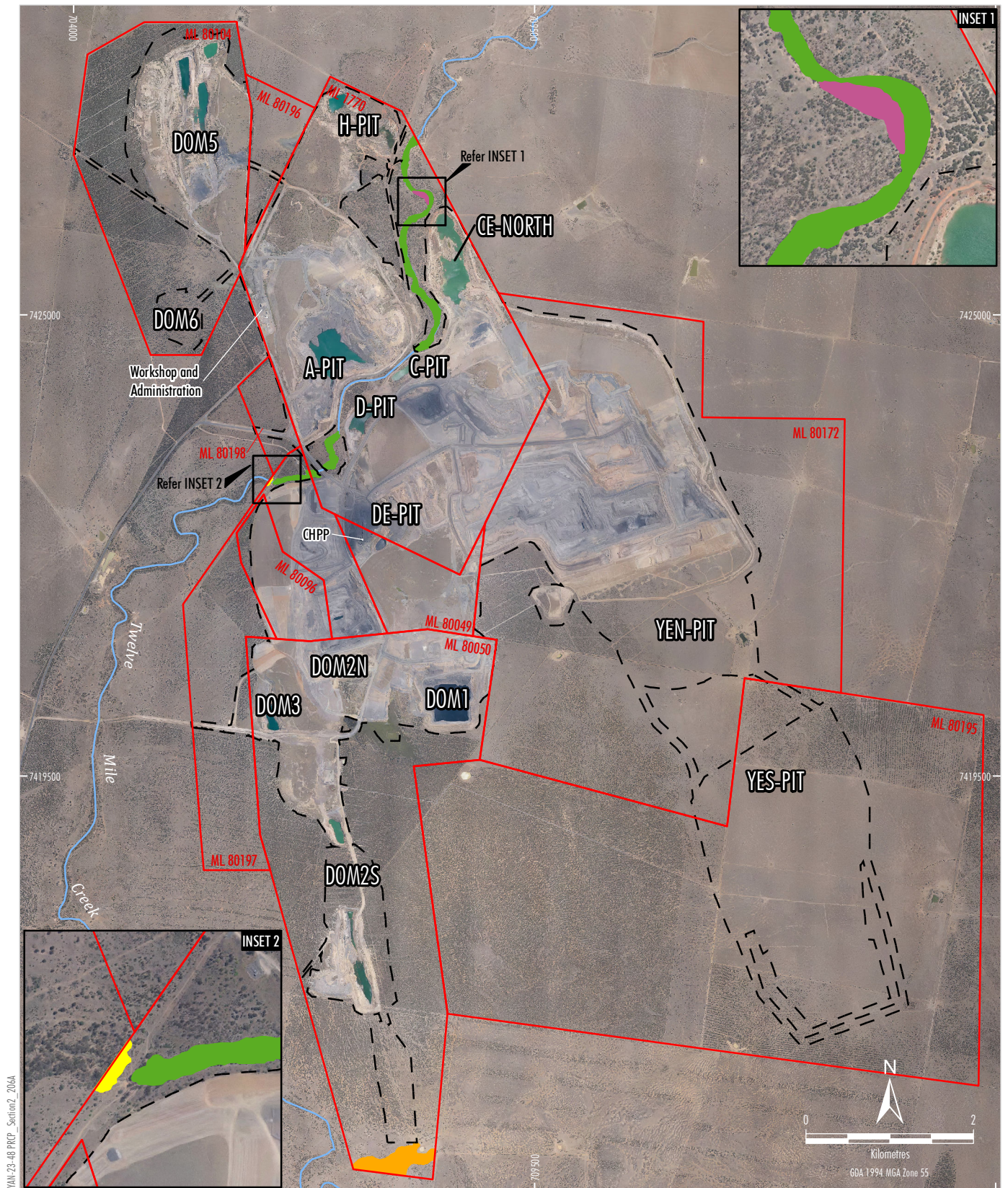
2.7.5 Corridors and Connectivity

Yarrabee Mine has a history of cattle grazing, with vegetation and habitats subject to historical clearing and modification, resulting in a disturbed and fragmented landscape. Primary connectivity values are located within the remnant riparian vegetation along Twelve Mile Creek and a large contiguous area of Brigalow regrowth in the central southern area of the site is likely to provide additional connectivity values for some species (Appendix C).

2.7.6 Groundwater Dependent Ecosystems – Terrestrial Vegetation

Groundwater dependent ecosystems (GDEs) are ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis (Richardson et al., 2011). The *Groundwater Dependent Ecosystems Atlas* (BoM, 2023) provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Areas of potential terrestrial GDEs have been mapped within the Yarrabee Mine MLs in association with watercourses (Appendix C). Potential GDEs cover a total of approximately 30 ha within the MLs (Figure 2-8) and include:

- 27.6 ha of remnant RE 11.3.25 (*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines);
- 1 ha of remnant RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains); and
- 1.9 ha of HVR RE 11.3.1 (*A. harpophylla* and/or *C. cristata* open forest on alluvial plans).



LEGEND

- Mining Lease Boundary
- Yarrabee Disturbance Footprint
- Remnant Vegetation
- Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains (11.3.1)
- Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines (11.3.25)
- High Value Regrowth Vegetation
- Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains (11.3.1)
- Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines (11.3.25)

Source: E2M (2022); The State of Queensland (2024); Yancoal Australia (2024)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE
Potential Groundwater
Dependent Ecosystems

Figure 2-8

2.8 FAUNA PRESENCE AND POPULATIONS

Yarrabee Mine, as a historic site lacks baseline fauna surveys undertaken prior to the commencement of mining. Current terrestrial ecological values at Yarrabee Mine have been identified through a combination of desktop assessments, and field surveys (Appendix C) completed in June 2023. These assessments and surveys encompassed a wider Study Area beyond the EA approved disturbance footprint and have been used to establish baseline fauna presence across the entire mine site.

The desktop assessment included a review of the following:

- Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool (PMST) (DCCEEW, 2023);
- Queensland Department of Environment, Science and Innovation (DESI) Matters of State Environmental Significance mapping (DESI, 2024d); and
- Queensland Government WildNet Database (Queensland Government, 2024).

The desktop assessment identified potential occurrences of Matters of National Environmental Significance (MNES) at the Yarrabee Mine and its surrounds. These include 29 threatened fauna species comprising 12 birds, 9 mammals, and 8 reptiles, as well as 16 migratory fauna species. The assessment also identified environmental values protected under Queensland legislation as potentially occurring within or in proximity to the Study Area. These include 28 threatened fauna species listed under the NC Act, comprising 12 birds, 8 mammals, and 8 reptiles. The field surveys identified the presence of MNES at Yarrabee Mine and its surrounds.

2.8.1 Threatened Fauna

137 terrestrial fauna species were recorded across the three surveying events. Of these, 130 are native and seven introduced. Three conservation significant fauna species were recorded during the surveys, namely:

- Ornamental Snake (*Denisonia maculata*) – vulnerable under the EPBC Act and NC Act;
- Golden-tailed Gecko (*Strophurus taenicauda*) – near threatened under the NC Act; and
- Short-beaked Echidna (*Tachyglossus aculeatus*) – special least concern under the NC Act.

One additional species, White-throated Needle-tail (*Hirundapus caudacutus*), is considered likely to occur within the Study Area, due to the presence of suitable habitat and wide-ranging nature of the species, however, no individuals were observed. No additional threatened fauna species are considered likely to occur within the Study Area (Appendix C).

2.8.2 Migratory Birds

16 bird species were identified during the desktop assessments as having the potential to occur within the Study Area. However, when evaluated against the likelihood of occurrence assessment criteria and the results of the field surveys, only three species were considered likely to occur:

- Fork-tailed Swift (*Apus pacificus*) – marine and migratory under the EPBC Act;
- Latham's Snipe (*Gallinago hardwickii*) – marine and migratory under the EPBC Act; and
- White-throated Needle-tail (*Hirundapus caudacutus*) – marine and migratory under the EPBC Act.

2.8.3 Pest Fauna

Seven pest fauna species were recorded within the Study Area during the field assessments. Evidence of habitat degradation was identified throughout field assessments, including damage around and within gilgai in Brigalow habitat and areas of Pig (*Sus scrofa*) uprooting. Cane Toads (*Rhinella marina*) were observed in abundance, including within Brigalow habitat. The pest fauna species identified were:

- Cane Toad (*Rhinella marina*);
- Cat (*Felis catus*);
- Common Myna (*Acridotheres tristis*);
- House Mouse (*Mus musculus*);
- Rabbit (*Oryctolagus cuniculus*);
- Pig (*Sus scrofa*); and
- Hare (*Lepus europaeus*).

2.9 PRE-MINING LAND USES AND CONDITIONS

Pre-mining, large areas of the Yarrabee Mine MLs were cleared for use as beef cattle grazing land. Surface erosion was mainly associated with watercourses and areas cleared for cattle grazing which contained Brigalow and other woodland species. Section 2.9.1 and Section 2.9.2 discuss the pre-mining land uses and pre-mining conditions of the land with the Yarrabee Mine MLs.

2.9.1 Pre-Mining Land Uses

Prior to the commencement of mining at Yarrabee Mine, much of the land that now comprises the Yarrabee Mine MLs was cleared and utilised for beef cattle grazing. As a result of this clearing, remnant vegetation within the Yarrabee MLs is limited and is predominantly restricted to a corridor along Twelve Mile Creek, with small isolated and scattered patches in the northern half of the MLs.

As discussed in Section 2.7, prior to clearing for cattle grazing, the area would have been dominated by Brigalow and Brigalow/Dawson gum communities on clay soils with poplar box and mixed riverine vegetation on sandy clay soils along watercourses.

2.9.2 Pre-Mining Conditions

Land Conditions

PJ Baker and Assoc. Pty Ltd (Baker) undertook a soil and land suitability assessment of unmined land within the Yarrabee MLs in 2010 (Baker, 2010).

Baker identified soils within the vicinity of Yarrabee Mine are moderately to heavily gilgaied, aside from the immediate riverine channel and riparian zone associated with Twelve Mile Creek (Baker, 2010). These soils are dominated by coarse structured clay with prominent gilgai micro-relief which include very coarse structured non-cracking and cracking clays, undulating plains, deep sandy loams and hard setting sandy clays in drainage lines (Baker, 2010).

The gilgaied clay soils are neutral to moderately alkaline at the surface and become slightly to extremely acidic at depths below 40 cm and generally exhibit moderate to high salinity and sodicity from depths below depths of 40 cm. Surface and internal drainage is generally very poor with water retained in gilgai depressions for considerable periods. Fertility in the surface root zone is variable but generally considered low.

Overburden Conditions

Natural Resource Assessments Pty Ltd (Natural Resource Assessments) undertook sampling and analysis of pre-mining overburden within the unmined areas of Yarrabee Mine in 1997. The assessment focused upon physical properties of overburden including dispersibility and erodibility (Natural Resource Assessments, 1997). Table 2-9 presents the results of the physical properties assessments undertaken by Natural Resource Assessments.

Overburden was identified as being the most dispersive by the R1 ratio and were also found to be dispersive by the R2 ratio. The low dispersion results for the R1 test yet high dispersion from the R2 test suggests that the coarse silt fraction is not dispersive or readily susceptible to slaking (Natural Resource Assessments, 1997). An indication of the dispersive characteristics of the overburden groups is presented the R1 and R2 dispersion ratios presented in Table 2-9 (Natural Resource Assessments, 1997).

Erodibility is the potential for material to be moved by the action of wind or water, with water being the primary erosion factor at Yarrabee Mine. As detailed in Table 2-9, all sample groups were found to have a high K factor, indicating high erodibility (Natural Resource Assessments, 1997). Natural Resource Assessments indicated rock fragments would occur within the spoil matrix. The hard sandstones would be expected to have a higher proportion of rock fragments leading to some additional protection against erosion. Upon weathering, the hard sandstone groups would be more likely to form a profile of higher permeability than the soft rock types. This higher permeability will also reduce erosion potential (Natural Resource Assessments, 1997).

Table 2-9: Physical Properties of Pre-Mining Overburden Samples

Parameter	Sample Groups*								
	A	B	C	D	E	F	G	H	I
Clay (%)	56	62	54	37	28	33	30	24	18
Silt (%)	19	25	29	28	24	33	21	26	16
Sand (%)	25	13	17	35	48	34	49	50	66
Texture	Clay	Clay	Silty Clay	Silty Clay Loam	Clay Loam	Silty Clay Loam	Clay Loam	Silty Clay	Loam
R1 Dispersion	0.49	0.55	0.47	0.44	0.38	0.45	0.41	0.37	0.31
R2 Dispersion	0.45	0.51	0.42	0.43	0.38	0.45	0.35	0.36	0.36
K Factor	0.050	0.045	0.048	0.047	0.047	0.049	0.048	0.047	0.045

Source: (Natural Resource Assessments, 1997).

Note: * Sample Groups: A, B and C – Surface soils and clays; D, E and F – Soft sandstones and siltstones; G, H and I – Hard sandstones.

2.10 UNDERLYING TENURE

The tenure which intersects with the Yarrabee MLs are listed in Table 2-10 and shown on Figure 2-9.

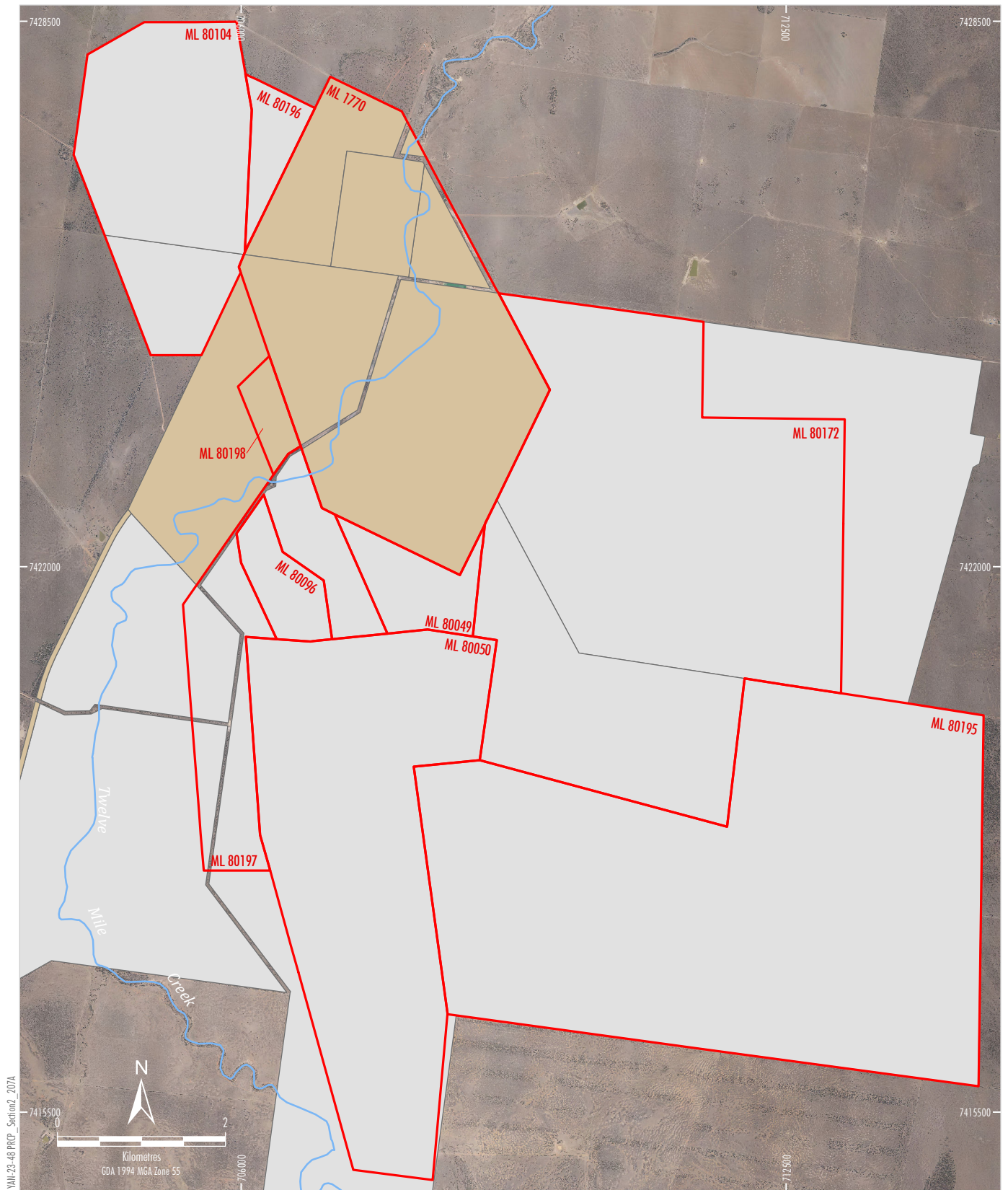
Table 2-10: Tenure Within Yarrabee Mine Mining Leases

Mining Lease	Lot on Plan	Landholder
ML 1770 ML 80104 ML 80197 ML 80198	12 LR104	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 1770	17 LR124	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 1770	18 LR124	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 1770 ML 80104 ML 80196	16 LR124	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 1770	15 LR125	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 1770	14 LR125	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 80049 ML 80172 ML 80197	15 LR125	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 80104 ML 80197 ML 80198	14 LR125	Land Lease Registered to Yarrabee Coal Company Pty Ltd
ML 80172	9 SP120831	Yarrabee Coal Company Pty Ltd
ML 1770 ML 80049 ML 80050 ML 80096 ML 80172 ML 80195 ML 80197	50 SP257934	Yarrabee Coal Company Pty Ltd
ML 1770 ML 80104 ML 80196	23 SP257935	Yarrabee Coal Company Pty Ltd

2.11 SENSITIVE RECEPTORS

There are six sensitive receptors in the form of residential homesteads within 10 km of Yarrabee Mine (Figure 2-10). These are (including distances from the edge of approved operations):

- Scrubbee Homestead (2.8 km).
- Yarrabee Homestead (3.4 km).
- Palmalmaal Homestead (5.0 km).
- Woodleigh Homestead (5.8 km).
- Lucie Homestead (6.0 km).
- Tarcoola Homestead (6.3 km).



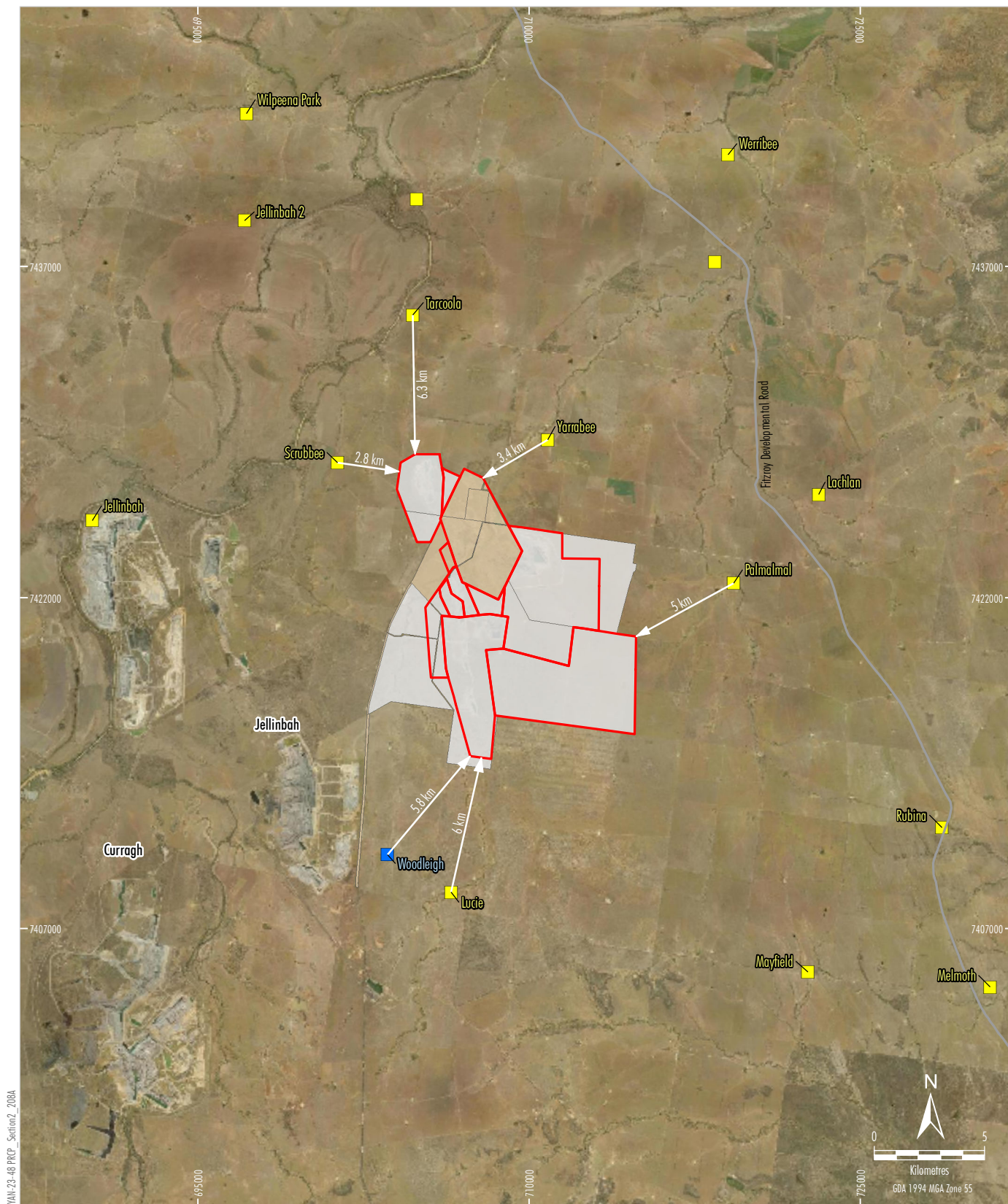
Source: The State of Queensland (2024); Yancoal Australia (2024)
Orthophoto: Yancoal Australia (2023)

- LEGEND**
- Mining Lease Boundary
 - Yarrabee-controlled Property - Freehold
 - Yarrabee-controlled Property - Land Lease



YARRABEE COAL MINE
Ownership of Land Underlying
Yarrabee Mining Tenures

Figure 2-9



YAN-23-48-PRCP_Section2_208A

- LEGEND**
- Mining Lease Boundary
 - Yarrabee-controlled Property - Freehold
 - Yarrabee-controlled Property - Land Lease
 - Homestead
 - Owned by Jellinbah Group
 - Privately Owned

Source: The State of Queensland (2024); Yancoal Australia (2024)
Orthophoto: The State of Queensland (2024)



YARRABEE COAL MINE
Yarrabee Mine Sensitive Receiver Locations

Figure 2-10

2.12 EXISTING REHABILITATION

Under section 126C(1)(j) of the EP Act, transitional PRCPs must include the following details about any existing rehabilitation undertaken to date:

- a description of rehabilitation works previously undertaken;
- when rehabilitation works commenced and were completed; and
- whether the rehabilitation has been applied for or approved as progressively certified under the EP Act.

Rehabilitation at Yarrabee Mine has been undertaken progressively over the last 20 years. As the understanding of rehabilitation has evolved through time, so have the methods and techniques utilised. For example, historical rehabilitation was completed through 'flat topping' spoil dumps with angle of repose batters which would have been common practice at the time.

470 ha of disturbed land has been rehabilitated to date (Table 2-11 and Figure 2-11). No Progressive Rehabilitation Certification has been applied for as of September 2025.

All rehabilitation areas are subject to ongoing monitoring and maintenance, some areas may also be subject to rework if not achieving their respective rehabilitation criteria (Section 8). Rehabilitation undertaken to date has had varying degrees of success, with learnings from success and failures informing subsequent rehabilitation practices. More recent rehabilitation adopts the standards and methods outlined within this PRCP, including the application of gypsum, fertiliser and/or manure, and topsoil for grazing areas.

320 ha of existing rehabilitation will be re-disturbed due to an updated mining and dumping schedule. These areas will be re-rehabilitated upon completion of activities and will form part of the cohesive final landform.

Table 2-11: Progressive Rehabilitation Undertaken to Date

Year	Area Rehabilitated (ha)	Cumulative Area Rehabilitated (ha)
Pre 2009	37	39
Pre 2018	190	227
2019	35	262
2020	NA	262
2021	108	370
2022	50	420
2023	50	470

Most of the rehabilitation undertaken to date has been rehabilitated to a grazing PMLU and are progressing well against the completion criteria (Appendix D and Appendix E). These areas were seeded with a mixture of native and pasture grasses, legumes, native trees, and shrubs. Some reprofiling and reseeded work has been undertaken to reduce slope angles in areas where sufficient groundcover has not established. A discussion of monitoring of existing rehabilitation is provided in Section 2.12.1.

2.12.1 Monitoring of Existing Rehabilitation

Existing rehabilitation undertaken at Yarrabee Mine has been assessed against the Yarrabee Mine rehabilitation monitoring completion criteria for both grazing and native vegetation PMLUs (Appendix D and Appendix E). Table 2-12 and 2-13 compare monitoring results for all rehabilitation areas surveyed in 2022 and 2023 against the completion criteria.

Grazing Sites

Monitoring conducted in 2022 indicated that the majority of sites progressed well against the key completion criteria, with a few notable exceptions including DOM2N, DOM3S Rehabilitation Area, and the YEN East Trial Site. Both DOM2N and DOM3S Rehabilitation Area were similar in that they have some areas close to meeting the completion criteria for grazing. However, they both have other large areas where suitable ground cover is absent, and topsoil has almost been completely lost, likely due to the land being too steep. In 2022, DOM2N and DOM3S Rehabilitation Area were both deemed to be candidates for a complete rework of the slope as they were not on an appropriate trajectory to meet the key completion criteria. Both require reprofiling of the slope, topsoil application, and additional seeding.

Monitoring in 2023 showed that numerous sites no longer meet the completion criteria for 30% living ground cover criteria. A number of other sites that were recorded to meet this criterion successfully were also close to failing, such as YEN East 5 which was recorded to have 31.8% pasture grass cover and therefore close to dropping below the 30% threshold. The decrease in sites meeting this criterion is largely a result of climatic conditions rather than a failing of the rehabilitation itself. Most sites were recorded to still be meeting the 70% overall ground cover criteria, but the increased cover of leaf litter was a result of extensive grass curing and resulted in the shift in how ground cover is classified.

Native Vegetation Sites

Monitoring conducted in 2022 and 2023 indicated that native vegetation sites on Yarrabee Mine were limited to the former A-Pit adjacent to the vehicle workshop. While thousands of tubestock were planted prior to the 2022 monitoring surveys, the survival rate of these plants was recorded to be very low. As a result, both monitoring sites and A-Pit rehabilitation was generally a long way from meeting the completion criteria for wooded stems per ha.

During the 2023 rehabilitation monitoring at Yarrabee Mine, it was recorded that the tubestock remained low compared with the initial amount planted, however, the overall stems per ha had not decreased from initial baseline monitoring data. Despite dry conditions and no follow up maintenance, the survival rate was reported to be similar to 2022. Poplar Box (*Eucalyptus populnea*) appeared to have been the most successful despite the low application rate. While the stem count remained stable for both A-Pit sites, they were both still significantly short of the completion criteria in stems per ha with very minimal new recruitment noted.

There are a few potential reasons for the failures of these plantings in both 2022 and 2023 including:

- Heavy clay soil.
- Lack of prior soil treatment and improvement.
- Inadequate hole preparation prior to planting.
- Little maintenance and watering after establishment.
- Inappropriate species selection.

For both the grazing and native vegetation existing rehabilitation sites, further rehabilitation work will be focussed on ensuring all sites meet all rehabilitation completion criteria. Learnings from these failures have been incorporated into updated rehabilitation practices, including ensuring that land to be rehabilitated to a PMLU of grazing has slopes <12.5%.

Groundcover

Total ground cover of the existing rehabilitation in 2023 showed mixed results across repeated survey sites with a near equal split in sites showing either improvement or decreases. Many of the sites that showed ground cover improvements simultaneously showed a decrease in pasture grass cover. This trend was largely a result of increased leaf litter cover across most sites as grass had gone through a considerable period of curing prior to surveys being conducted in 2023. Overall, the general trend following the 2022 surveys has been an increase in grass cover as rain continued in early 2023. This was followed by grass curing significantly over the following six months prior to the 2023 survey period.

Table 2-12: Native Vegetation Rehabilitation Completion Sites Compared to Completion Criteria

Site	Completion Criteria															
	Vegetation				Ground cover				Evidence of natural recruitment		Pest and weed density comparable to reference site		Soil nutrient concentrations comparable to reference sites		Erosion rates comparable to reference sites	
	>350 stems/ha		>8 species/ha		>30% living ground cover		>70% overall ground cover									
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
A-Pit 1																
A-Pit 2																

Source: (Appendix D and Appendix E).

Note: Green = site achieved the completion criteria; Red = site did not achieve the completion criteria.

Table 2-13: Grazing Rehabilitation Completion Criteria Compared to Rehabilitation Sites

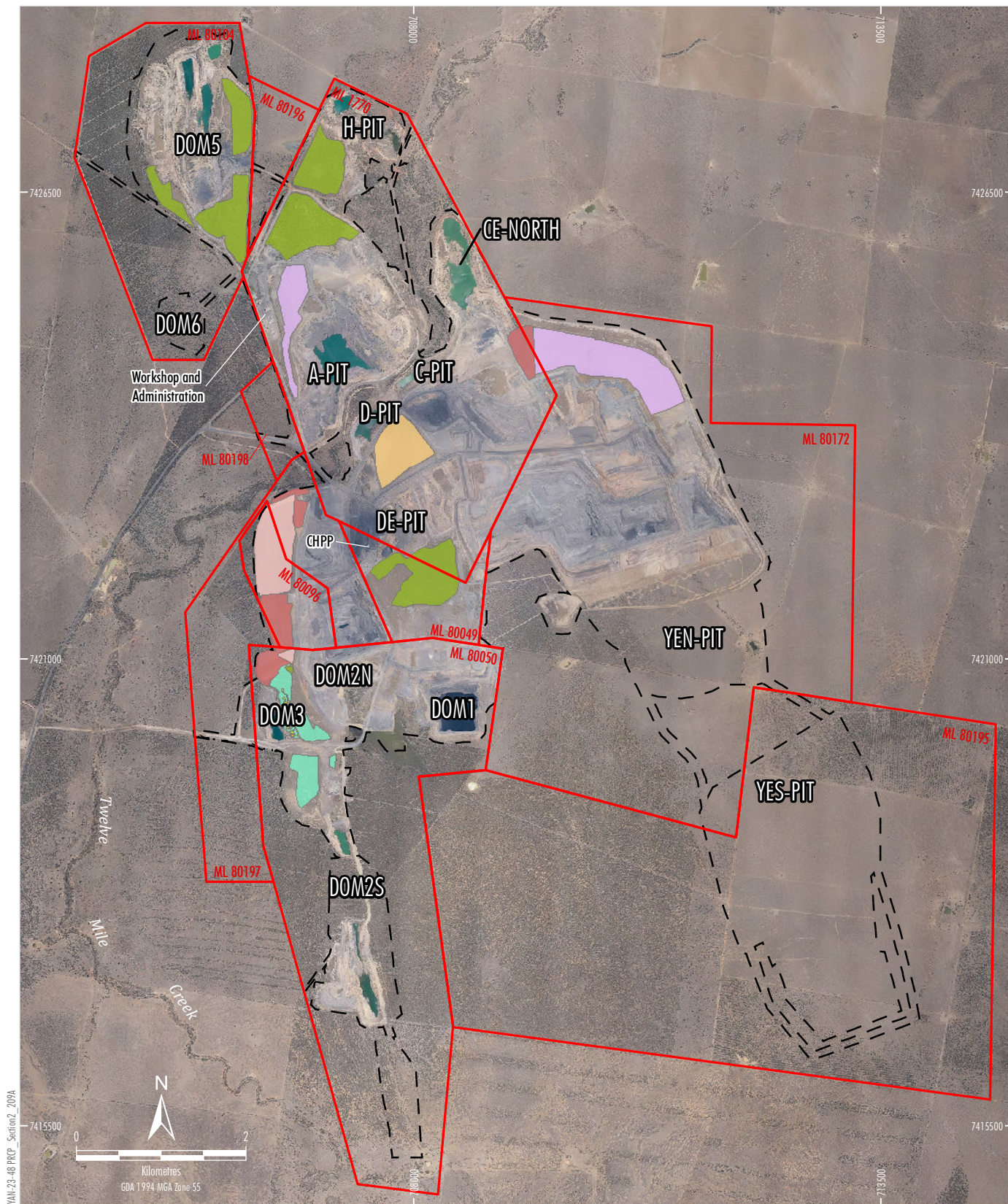
Site	Completion Criteria													
	Vegetation dominated by pasture grass and legumes		Ground cover				Evidence of natural recruitment		Pest and weed density comparable to reference site		Soil nutrient concentrations comparable to reference sites		Erosion rates comparable to reference sites	
			>30% living ground cover		>70% overall ground cover									
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
CHPP 1		NS		NS		NS		NS		NS		NS		NS
CHPP 2	NS		NS		NS		NS		NS		NS		NS	
CHPP 3	NS		NS		NS		NS		NS		NS		NS	
CHPP 4	NS		NS		NS		NS		NS		NS		NS	
DOM2N 1														
DOM2N 2											NA			
DOM2N 3	NS		NS		NS		NS		NS		NS		NS	
DOM2N 4	NS		NS		NS		NS		NS		NS		NS	
DOM3 1		NS		NS		NS		NS		NS		NS		NS
DOM3 2														
DOM3 3														
DOM3 4	NS		NS		NS		NS		NS		NS		NS	
DOM3 5	NS		NS		NS		NS		NS		NS		NS	
DOM3S 1		NS		NS		NS		NS		NS		NS		NS
DOM3S 2		NS		NS		NS		NS		NS		NS		NS
DOM3S 3											NA	NA		
DOM3S 4	NS		NS		NS		NS		NS		NS	NA	NS	
DOM4		NS		NS		NS		NS		NS		NS		NS
Radio Tower														
Radio Tower West		NS		NS		NS		NS		NS	NA	NS		NS
Radio Tower West 2	NS		NS		NS		NS		NS		NS	NA	NS	

Table 2-13 (Continued): Grazing Rehabilitation Completion Criteria Compared to Rehabilitation Sites

Site	Completion Criteria													
	Vegetation dominated by pasture grass and legumes		Ground cover				Evidence of natural recruitment		Pest and weed density comparable to reference site		Soil nutrient concentrations comparable to reference sites		Erosion rates comparable to reference sites	
			>30% living ground cover		>70% overall ground cover									
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
YEN-Pit East 1														
YEN-Pit East 2											NA			
YEN-Pit East 3											NA			
YEN-Pit East 4	NS		NS		NS		NS		NS		NS		NS	
YEN-Pit East 5	NS		NS		NS		NS		NS		NS		NS	
YEN East Trial Site 1											NA	NA		
YEN East Trial Site 2											NA	NA		
YEN East Trial Site 3	NS		NS		NS		NS		NS		NS		NS	
YEN-Pit West 1														
YEN-Pit West 2											NA			

Source: (Appendix D and Appendix E).

Note: Green = site achieved the completion criteria; Red = site did not achieve the completion criteria. NS = not surveyed; NA = not applicable



LEGEND

- Mining Lease Boundary
- Yarrabee Disturbance Footprint
- Established Rehabilitation
- Pre 2009
- Pre - 2018
- 2019
- 2021
- 2022
- 2023
- 2024

Source: The State of Queensland (2024); Yancoal Australia (2024)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE
Established Rehabilitation

Figure 2-11

2.13 REHABILITATION TRIALS AND STUDIES

2.13.1 Existing Rehabilitation Trials

Rehabilitation Trials undertaken to date include tubestock planting of native vegetation species and concave slope landform trials.

Native Vegetation

The A-Pit native vegetation trial was the first trial of the native vegetation PMLU at Yarrabee. The area was planted with tubestock, however, survival rates were low and tubestock failed to establish. Due to this, the A-Pit trial is not meeting the completion criteria for the native vegetation. There are a few potential reasons for the failures of this trial which are listed in section 2.12.2.

Subsequently, the native vegetation rehabilitation methodology and species selection were revised to include:

- Surface preparation targeted to occur at the end of the wet season (April/May).
- Erosion risks managed during landform development through the establishment of sufficient ground cover.
- Review of characteristics of the local REs and the Yarrabee Mine soil/waste rock to identify the REs most suited to the various soil and waste materials available for rehabilitation. The review identified that the available waste rock and soil materials limit plant selection to those adapted to alkaline, strongly sodic, and mostly saline soils with low to moderately low plant-available water capacity.
- Native vegetation rehabilitation should include initial establishment of local pioneer species to condition the soil for successive plant regeneration. Concentrated tree plantings should be incorporated to provide habitat areas, wildlife corridors and livestock shelter belts.

The A-Pit trial area will be reworked in line with the revised rehabilitation methodologies to achieve the required native vegetation completion criteria.

Concave Landforms

YEN-Pit East Rehabilitation was a trial of a concave slope as an erosion control measure. As outlined in Section 6.5, the concave slope was modelled by Landloch (Landloch, 2020 and Appendix K) and model results predicted a reduction of the average and maximum erosion rates. The landform was trialled to reduce erosion and was identified as a potentially useful rehabilitation technique for outer dumps that are close to ML boundaries. These areas have been included in the PRCP Schedule (Attachment 1). The YEN-Pit concave slope was last monitored in 2022 and has proved unsuccessful in establishing vegetation and preventing erosion. Table 2-14 outlines the findings of the 2022 and 2023 monitoring event. It was recommended that the landform is reworked to align with surrounding rehabilitation as these areas were rehabilitated using traditional landform design methods and are performing well.

Table 2-14: YEN-Pit East 2022 Rehabilitation Monitoring Results

Key Assessment Metric	YEN East Trial Site 1		YEN East Trial Site 2		YEN East Trial Site 3		YEN East Trial Site Average	
	2022	2023	2022	2023	2022	2023	2022	2023
Pasture grass cover (%)	2.0	16.0	43.2	34.2	NS	13.4	22.6	21.2
Legume cover (%)	0.0	36.2	0.8	69.2	NS	56.8	0.4	54.1
Litter cover (%)	22.0	14.8	15.4	35.0	NS	41.0	18.7	30.3
Weed species cover (%)	4.4	0.0	3.6	0.0	NS	0.0	4.0	0.0
Native species cover (%)	10.4	5.4	24.0	0.0	NS	2.4	17.2	2.6
Bare ground cover (%)	61.2	63.8	13.0	30.8	NS	43.2	37.1	45.9
Biomass (kg/ha)	400.0	1,050.0	4,750.0	2,850.0	NS	1,650.0	2,575.0	1,850.0
Erosion rating	0.0	0.0	1.0	1.0	NS	0.0	0.5	0.3
Topsoil remaining (%)	0.0	10.0	25.0	35.0	NS	20.0	12.5	21.7

Source: (Appendix D and Appendix E).

Note: kg/ha = kilograms per hectare; NS = not surveyed.

2.13.2 Future Rehabilitation Trials

Further rehabilitation trials and studies will be undertaken at Yarrabee Mine to increase knowledge and understanding of rehabilitation within the Yarrabee landscape, as well as to investigate potential opportunities to improve rehabilitation opportunities and outcomes. These trials will assist in refining rehabilitation methodologies and validating performance indicators and success criteria.

Table 2-15 provides the following details of potential future rehabilitation trials that may be undertaken to support rehabilitation success at Yarrabee Mine.

Table 2-15: Future Rehabilitation Trials

Rehabilitation Trial and Objective	Trial Design and Details	Trial Commencement, Location and Duration	Assessment of Success	Incorporation into Rehabilitation Strategies and Milestones
Species selection for optimum rehabilitation outcomes.	Trials will involve the seeding of different vegetation species across the PMLUs and varying slopes within the final landform to increase rehabilitation outcomes. The trial will involve: - Varying species selection and seed application rates and/or tubestock planting densities for each PMLU. - Identifying variables resulting in variation and deficiencies in seed germination and/or seedling and tubestock survival. - Improving seed and tubestock quality through including increasing germination and survival rates through breaking natural seed dormancy.	Trials will be undertaken throughout mine life and into the early stages of closure. Trials will be undertaken across multiples locations within the mine including: - Areas of slopes <12.5% with a Grazing or Native Vegetation PMLU. - Areas with slopes >12.5% with a Native Vegetation PMLU.	Success of the trial will be primarily based on species survivorship and species establishment.	Species that show increased establishment and survivorship would be preferentially planted to improve rehabilitation outcomes. This trial will also assist in refinement of the species list for all PMLUs.
Residual void water quality and achieving a post-mining land use for residual voids.	Trials shall involve undertaking long term water quality monitoring to identify long-term void water quality trends and potential beneficial use of void water as long-term habitat areas or for other uses. Trials may also involve habitat assessments where water quality monitoring identifies the void as potentially suitable for habitat.	Trials shall commence upon the completion of mining in each residual void. Trials will be undertaken over multiple years during operations to identify potential uses for water within the residual voids.	Success shall be measured by the ability of void water to sustain a use or ability to sustain a habitat.	Outcomes from this trial would be utilised to assign PMLUs to the residual voids and improve their long-term use.
Successful vegetation establishment and landform stability without the use of topsoil.	Trials will involve the revegetation of areas across the final landform to determine the ability of successful rehabilitation being achieved without the use of topsoil. The trial will involve: - Revegetation across varying slopes and PMLUs without the use of topsoil. - Optimum species selection and seed application rates and/or tubestock planting densities for each PMLU. - Use of nurse crops and/or primary successional colonising species to alter and improve soil conditions to facilitate establishment and survival of target species. Fertilising and ameliorating spoil materials in lieu of topsoil spreading.	Trials will begin upon the commencement of the establishment of the final landform. Trials will be undertaken over a period of years to ensure the landform is exposed to multiple seasons and weather patterns. Trials will be undertaken across multiples locations within the mine including: - areas of slopes <12.5% with a Grazing or Native Vegetation PMLU. - areas with slopes >12.5% with a Native Vegetation PMLU. Trials will also focus on areas of differing physical and chemical nature.	Trial success will primarily be measured by species establishment and survivorship. Stability of the landform upon successful vegetation establishment shall also be considered in determining trial success.	The outcome of this trial would be used to inform topsoiling requirements across the site. This trial would also assist in refinement of the species list for all PMLUs.

2.14 DESIGNING FOR CLOSURE

Transitional PRCPs are not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance as outlined in the PRCP Guideline. Nevertheless, the Yarrabee Mine rehabilitation strategy aims to achieve a safe, stable, non-polluting landform that supports a self-sustaining post-mining land use. This will enable the relinquishment of rehabilitated areas, and ultimately the surrender of Yarrabee Mine's mining tenements.

Where appropriate and as far as practical, final landforms have been designed to be sympathetic to and consistent with the topography of surrounding areas and general character of the region. The general landform features of the Bowen Basin and Central Queensland region include "rolling hill" low level grazing areas interspersed with corridors of native vegetation, broad catchment drainage and flood plain areas, steep and outcropping sedimentary terrain, and modified landscapes associated with other coal mines.

2.14.1 Rehabilitation/Improvement Planning

As per EA EPML00844613, the approved PMLUs for Yarrabee Mine are grazing, native vegetation, water storage and retained infrastructure. Eight residual voids are approved as NUMAs. The approved PMLUs and NUMAs are to be transitioned into this PRCP. Further detail on the approved PMLUs and NUMAs is provided in Section 4 and Section 5.

Condition F3 of EA EPML00844613 provides the overarching rehabilitation objective for the Yarrabee Mine:

Land disturbed by the authorised mining activities must be rehabilitated to a safe, stable and non-polluting landform, with a self-sustaining vegetation cover and in accordance with:

- a) *Figure 5: Final Land Use;*
- b) *Table F2: Post-mining Land Use Areas and Non-Use Management Areas;*
- c) *Landform design criteria, including end of mine design as per Condition F20; and*
- d) *Attachment 1: Rehabilitation Requirements.*

2.14.2 Mine Planning and Rehabilitation

Mine planning is a structured process that considers a range of key variables that may influence a potential mining operation and its viability. Aspects that are considered within the mining process include safety, resource recovery, geotechnical constraints, management of potential environmental impacts (e.g. noise, air quality, water, coal rejects), community issues, risks to the operation, mining methods and rates, equipment requirements and economics (i.e., capital and operating costs).

The disconnected nature of the coal resource at Yarrabee Mine (the result of complex geological faulting) has required the development of multiple mining areas, several of which are required to remain open and active at any one time. This makes it difficult to emplace waste rock back into the voids and creates a need for out-of-pit waste rock emplacements.

The mine planning process aims to maximise progressive rehabilitation by scheduling the commencement of rehabilitation as soon as feasible after land becomes available.

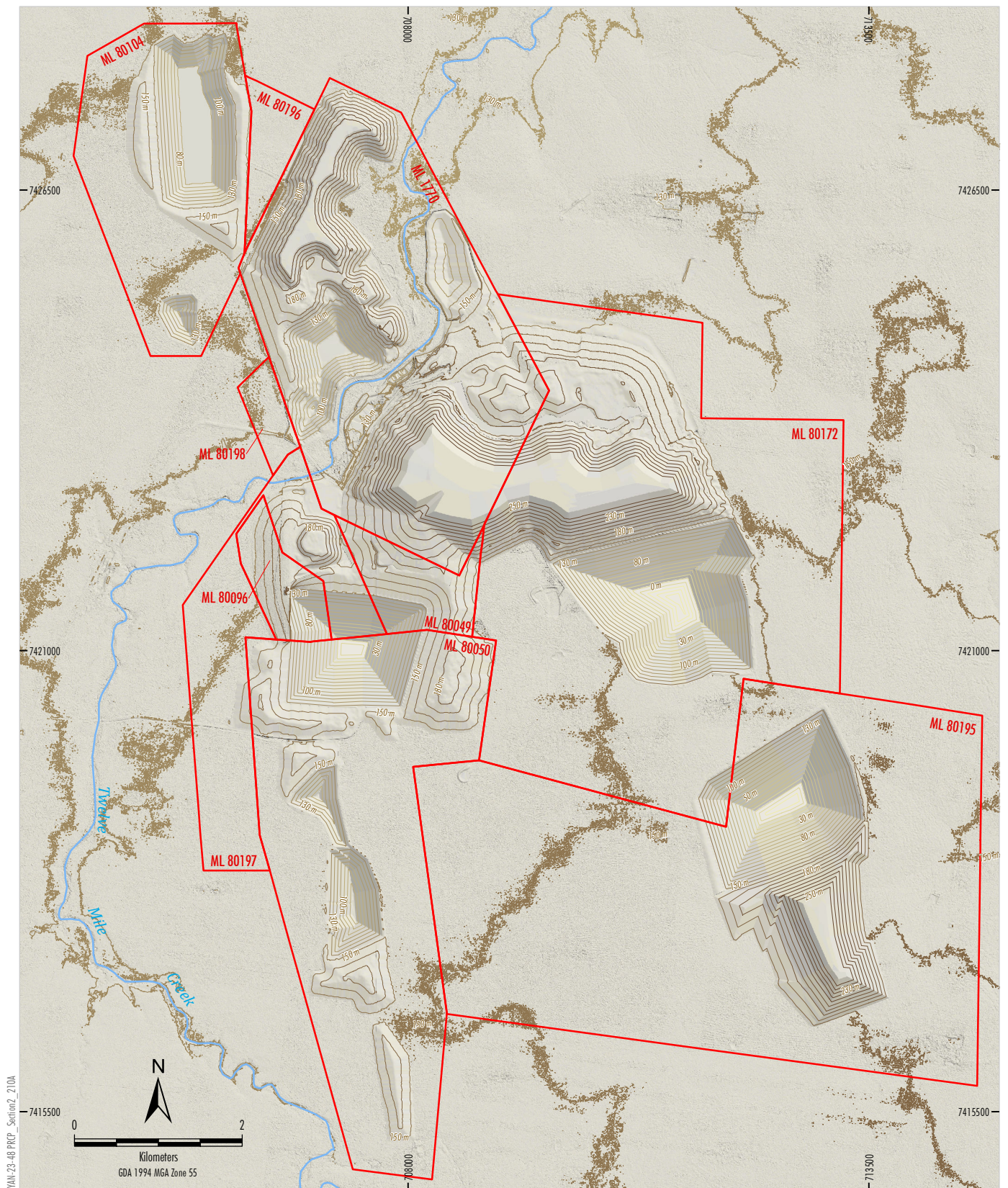
The final landform, including surface elevations (i.e., three-dimensional design), and the 0.1% Annual Exceedance Probability (AEP) flood extent is shown on Figure 2-12. Figure 2-12 demonstrates that all residual voids are protected from inundation during the 0.1% AEP event.

2.14.3 Rehabilitation Areas and Improvement Areas

Rehabilitation Areas (RAs) and Improvement Areas (IAs) have been developed based on the approved mine domains and PMLUs and are consistent with EA EPML00844613. The RAs and IAs are shown on Figure 2-13. The details of the relevant activities (i.e., predicted duration, extent, and ability to progressively rehabilitate during that activity) to be undertaken at each RA and IA is outlined in Table 2-16. Each RA will be rehabilitated to a PMLU, and each IA will be managed as a NUMA post-mining (see Sections 4 and 5).

Table 2-16: Rehabilitation Areas and Improvement Areas

RA	Relevant Activity	Land Use	Availability	Area (ha)
RA1	In-pit and Out-of-pit Waste Rock Emplacement (<12.5% Slopes)	Grazing	When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA1 will become available progressively.	944
RA2	In-pit and Out-of-Pit Waste Rock Emplacement (0 to <27% Slopes)	Native Vegetation	When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA2 will become available progressively.	1,264
RA3	Twelve Mile Creek Diversion	Native Vegetation (Riparian)	When landform development of Twelve Mile Creek Diversion is complete, and the landform stability will not be affected by adjacent mining activities.	53
RA4	Water Management Infrastructure (Water Storage)	Water Storage	When water management infrastructure is no longer needed for mining or rehabilitation activities, and the landform stability and/or water quality will not be impacted by adjacent mining activities, and/or the water management infrastructure has not been agreed for retention.	18
RA5	DE-Pit TSF	Native Vegetation	When landform development surrounding the TSF is complete.	2
RA6	DE-Pit TSF and DOM1 TSF	Grazing	When landform development surrounding the TSF is complete.	59
RA7	Infrastructure Areas (Retained Infrastructure)	Retained Infrastructure	When infrastructure is no longer needed for mining or to support rehabilitation activities.	12
RA8	Infrastructure Areas (Grazing)	Grazing	When infrastructure is no longer needed for mining or to support rehabilitation activities.	292
RA9	Infrastructure Areas (Native Vegetation)	Native Vegetation	When infrastructure is no longer needed for mining or to support rehabilitation activities.	50
RA10	Existing Rehabilitation	Native Vegetation	NA – Rehabilitation already commenced.	168
RA11	Existing Rehabilitation to be re-disturbed (Native Vegetation)	Native Vegetation	Rehabilitation to be re-disturbed due to an updated dumping schedule. When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA11 will become available progressively.	149
RA12	Existing Rehabilitation to be re-disturbed (Grazing)	Grazing	Rehabilitation to be re-disturbed due to an updated dumping schedule. When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA12 will become available progressively.	153
RA13	Undisturbed Land	Grazing	When an area is not to be used for any future exploration or mining activities. Areas previously used for exploration will become available progressively.	4230
IA1	Residual Voids	NUMA	When mining of the pit has ceased, or, if being backfilled or partially backfilled, when backfilling is complete.	882



LEGEND

Mining Lease Boundary

Elevation (m)

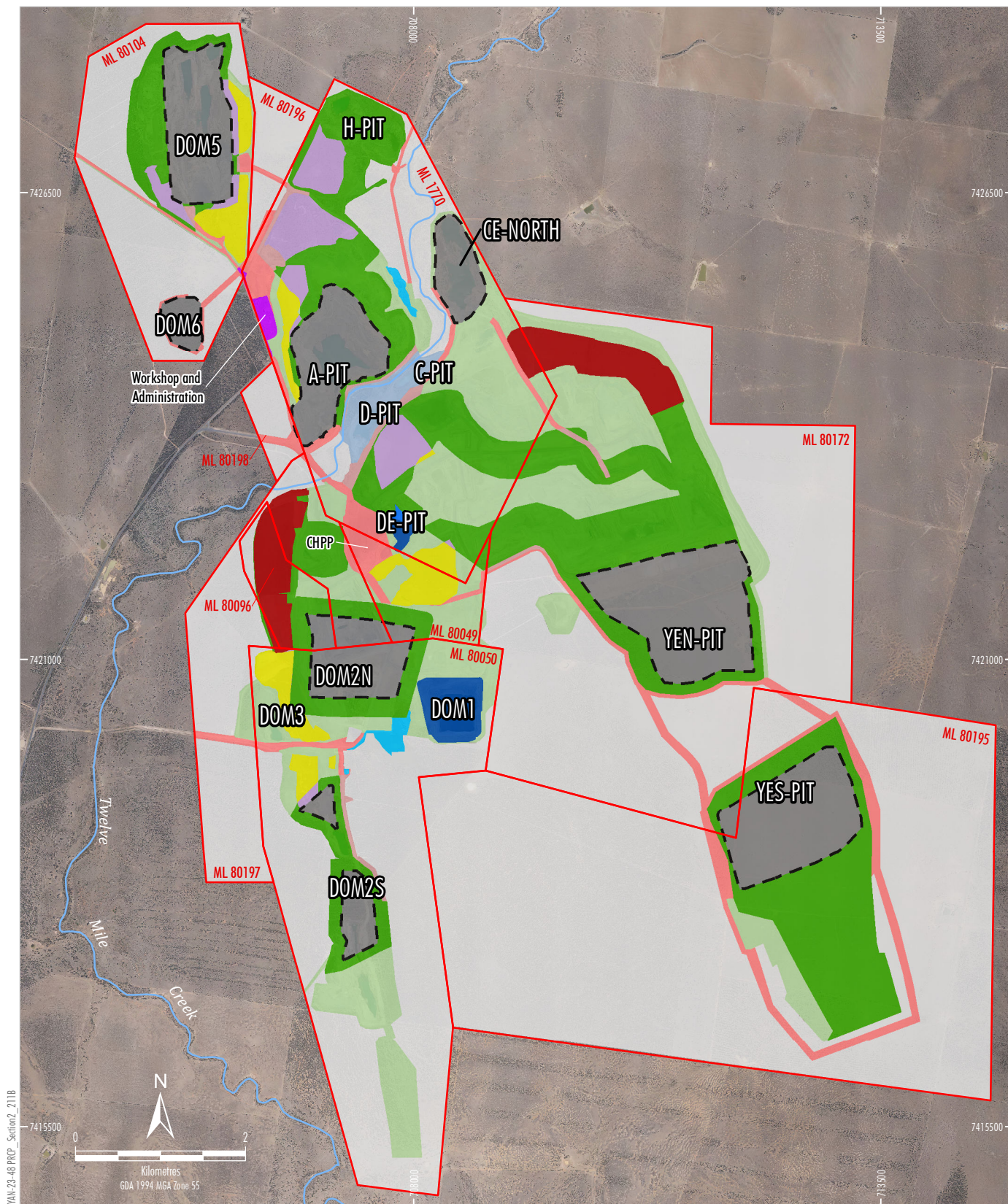
- 40 to -20
- 19 to 10
- 11 to 50
- 51 to 100
- 101 to 130
- 131 to 140
- 141 to 150
- 151 to 170
- 171 to 200
- 201 to 250

Source: The State of Queensland (2024); Yancoal Australia (2024)



YARRABEE COAL MINE
Final Landform

Figure 2-12



LEGEND

- | | |
|---|--|
| Mining Lease Boundary | RA7 - Infrastructure Areas (Retained Infrastructure) |
| Rehabilitation Area | RA8 - Infrastructure Areas (Grazing) |
| RA1 - In-pit and Out-of-pit Waste Rock Emplacement (<12.5%) | RA9 - Infrastructure Areas (Native Vegetation) |
| RA2 - In-pit and Out-of-pit Waste Rock Emplacement (0 to <27%) | RA10 - Existing Rehabilitation |
| RA3 - Twelve Mile Creek Diversion | RA11 - Existing Rehabilitation to be Re-disturbed (Native Vegetation) |
| RA4 - Water Management Infrastructure (Water Storage) | RA12 - Existing Rehabilitation to be Re-disturbed (Grazing) |
| RA5 - DE-Pit TSF | RA13 - Undisturbed Land |
| RA6 - DE-Pit TSF and DOM1 TSF | Improvement Area |
| | IA1 - Residual Voids |

Source: The State of Queensland (2024); Yancoal Australia (2024)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE Rehabilitation Areas and Improvement Areas

Figure 2-13

3 COMMUNITY CONSULTATION

3.1 COMMUNITY CONSULTATION PLANNING

A detailed Community Consultation Plan for Yarrabee Mine is described in Appendix F. Yancoal and YCC are committed to developing and maintaining successful partnerships and working relationships with the community and people impacted directly and indirectly by its operations. The Community Consultation Plan supports continual development, focuses on transparent engagement, and helps to identify, prioritise, and manage potential issues faced by the community.

The fundamental objective of the Community Consultation Plan is to ensure that community consultation is combined with Yancoal and YCC's decision making processes, including those relating to mine closure and rehabilitation. The plan provides proactive communication concepts and engagement principles to help ensure the community and stakeholders are consulted and engaged with in a meaningful way. The key objectives of the Community Consultation Plan include:

- To understand the views of the community and what they expect from Yancoal and YCC.
- To provide the community with an understanding of the mine closure and rehabilitation processes and procedures as well as associated risks and opportunities.
- To develop a fair and transparent consultation process, where community views can be voiced, understood, documented, and considered when planning for mine closure and rehabilitation.
- To ensure the community has the opportunity to participate in inclusive and equitable consultation practices.
- To ensure, where appropriate, the community is kept informed of decisions deriving from consultation.
- To ensure decision making is aligned with relevant legislative requirements.
- To provide Yancoal with an understanding of community concerns related to site operations, closure, and rehabilitation.

Future consultation to be undertaken regarding the PRCP and PRCP Schedule is outlined in Table 3-1.

Table 3-1: Community Consultation Plan

Stakeholder	Key Objectives	Proposed Methods and Activities	Frequency
Government Agencies			
DETSI	- Engage on PMLUs. - To ensure that any desired changes to PMLUs are considered. - Engage on rehabilitation processes. - Inform on progress of rehabilitation.	- Meetings. - Emails/Letters. - Site Tours.	As required
		Annual Returns.	Annually
		- PRCP Schedule. - Audits.	Every three years
Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development (DNRMMRRD)	To outline status of MLs once rehabilitation is complete.	- Emails/Letters. - Reports. - Site Tours.	Throughout operations and post-mining
Central Highlands Regional Council	- To provide updates on rehabilitation progress. - To ensure that any desired changes to PMLUs are considered.	- Emails/Letters. - Meetings. - Site Tours.	As required
Landholders			
Surrounding and Adjoining Landholders	- Engage on PMLUs. - To ensure that any desired changes to PMLUs are considered. - Engage on rehabilitation processes. - Inform on progress of rehabilitation.	- Emails/Letters. - Meetings. - Site Tours.	As required
Local Community Groups			
Blackwater Community Reference Group	- Engage on PMLUs. - Engage on rehabilitation processes. - Inform on progress of rehabilitation.	- Emails/Letters. - Newsletters. - Meetings. - Site Tours.	Annually or as required
Bluff Community Reference Group	- Engage on PMLUs. - Engage on rehabilitation processes. - Inform on progress of rehabilitation.	- Emails/Letters. - Newsletters. - Meetings. - Site Tours.	Annually or as required
Local Community	To provide updates on rehabilitation progress.	- Website. - Meetings. - Site Tours.	Annually or as required
Aboriginal Parties			
Gaangalu Nation People	- Engage on PMLUs. - To ensure that any desired changes to PMLUs are considered. - Engage on rehabilitation processes. - Inform on progress of rehabilitation.	- Emails/Letters. - Newsletter. - Meetings. - Site Tours.	As required

Source: (Appendix F)

3.2 COMMUNITY PROFILE

All groups and individuals within the community who may be impacted or have an interest in decisions being made relating to the closure and rehabilitation of Yarrabee Mine have and will continue to be invited to partake in consultation activities. Table 3-2 identifies key community groups considered in consultation activities.

Currently, YCC and Yancoal are the post-mining landholders for the Yarrabee Mine MLs. Therefore, no consultation with an external post-mining landholder is currently required.

3.3 COMMUNITY CONSULTATION UNDERTAKEN TO DATE

YCC is actively engaged with the local community, with principal engagement activities including:

- discussions with neighbouring properties regarding grazing on YCC-owned land;
- participation at local Community Reference Groups;
- consultation with the Gaangalu Nation People;
- partnering agreements providing funding;
- various site tours and engagement with regulatory agencies; and
- community sponsorship and donations programs.

A full register of all consultation completed to date regarding the closure of the Yarrabee Mine is described in the Consultation Register within the Community Consultation Plan (Appendix F). The Consultation Register will continue to be maintained, and includes:

- consultation date(s);
- identification of each community member;
- description of consultation type (workshop, quarterly meetings, etc.);
- information provided to the community;
- issues raised/discussed by the community;
- how issues have been considered;
- decisions/outcomes of engagement; and
- commitments made by the applicant.

Table 3-2: Key Community Groups

Community Members	Key Community Groups	Impact	Interest in the Land
Local Community Groups	- Blackwater Community Reference Group. - Bluff Community Reference Group. - Local Community and Groups. - Community members from Blackwater, Bluff, Comet, and Emerald.	Indirect impact	- Heritage interest. - Environmental interest. - Recreational interest. - Land use interest. - Health interest.
Aboriginal Party	Gaangalu Nation Endorsed Parties.	Direct impact	Cultural interest.
State Government Agencies	- DETSI. - DNRMMRRD.	Indirect impact	- Heritage interest. - Environmental interest. - Land use interest. - Health interest.
Local Government	Central Highlands Regional Council.	Indirect impact	- Heritage interest. - Environmental interest. - Land use interest. - Health interest.
Adjoining and Surrounding Properties/Landholders	Includes but not limited to: - Lucie. - Rea. - Bean Tree Park. - Palmal. - Woodleigh - Locarno. - Dunluce. - Yarrabee. - Tarcoola. - Jellinbah. - Scrubbee.	Direct impact	- Environmental interest. - Land use interest. - Health interest.
Employees and Contractors	Includes but not limited to: - Construction workers. - Managers. - Operators.	Direct impact	- Environmental interest. - Land use interest. - Health interest.
Neighbouring Mining Operations	- Jellinbah Mine. - Curragh Mine Complex.	Indirect impact	- Land use interest. - Environmental interest.
Service Providers and Local Business Owners	Includes but not limited to: - Hospitality venues. - Retail venues. - Medical facilities. - Educational facilities. - Utilities (i.e., water, electricity, telecommunications). - Transportation facilities.	Indirect impact	- Land use interest. - Heritage interest. - Health interest.
Emergency Services	- Queensland Police. - Ambulance. - Rural Fire Service.	Indirect impact	- Land use interest. - Health interest.

Source: (Appendix F)

4 POST-MINING LAND USE

4.1 PRE-APPROVED POST-MINING LAND USES

As per the transitional provisions of the EP Act, PMLUs can be transitioned from LODs into a PRCP. Under section 270 of the EP Act, the LODs for the Yarrabee Mine are EA EPML00844613 and the *Yarrabee Rehabilitation Management Plan* (YCC, 2021). The PMLUs, namely, grazing (low intensity cattle grazing), native vegetation, native vegetation (riparian) (Twelve Mile Creek Diversion) water storage and retained infrastructure have been transitioned from the LODs and are consistent with the rehabilitation requirements of the EA.

The approved PMLUs, associated slopes and approved areas are presented in Table 4-1 and shown in Figure 4-1. Table 4-2 details the PMLUs, relevant domains and rehabilitation areas, and a description of the PMLU. Rehabilitation requirements and completion criteria are outlined in Section 6.13.

Table 4-1: Transitioned Post-Mining Land Uses

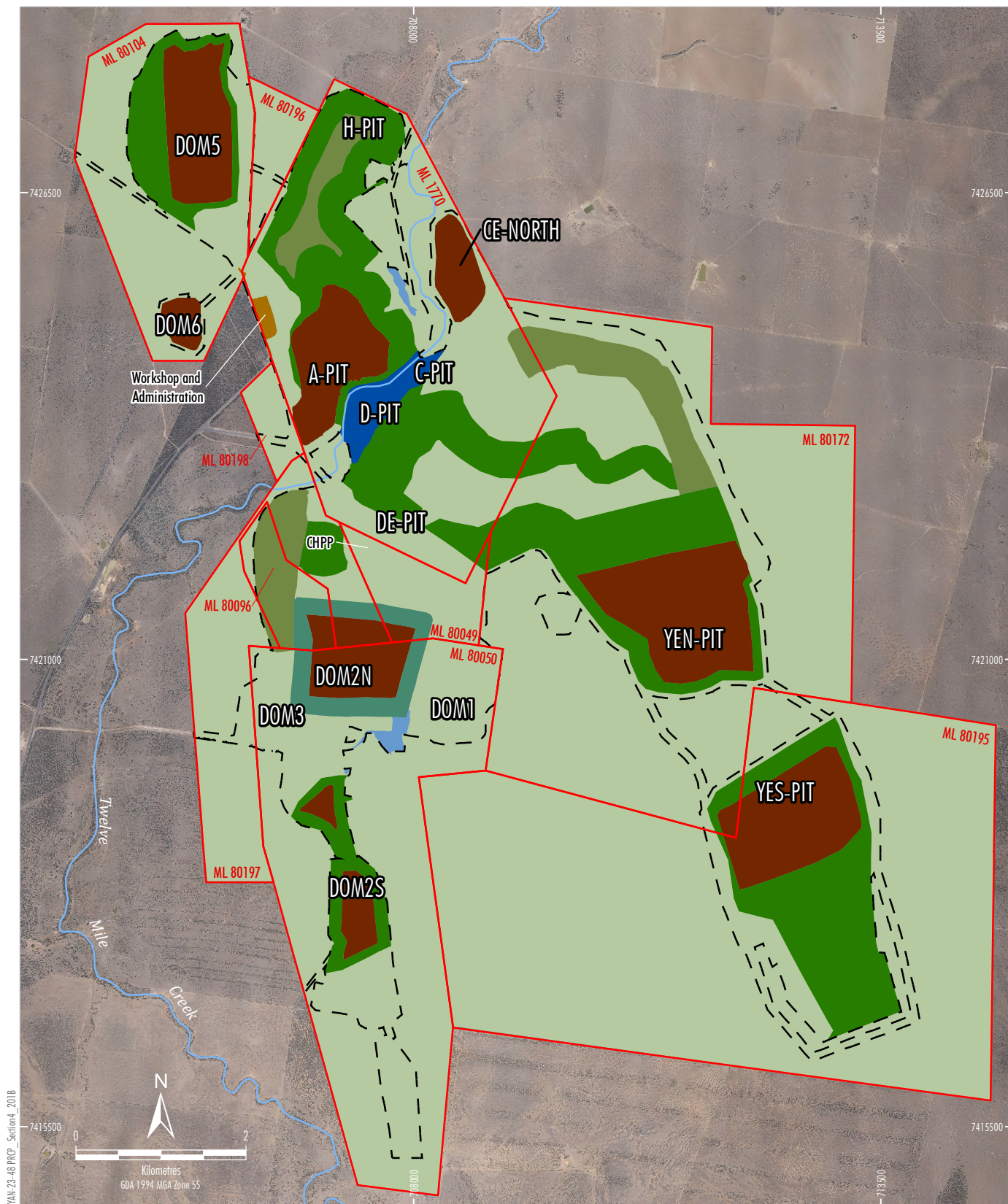
Post-mining Land Use	Slope	Area (ha)
Grazing	<12.5%	1448
Native Vegetation	<12.5%	282
Native Vegetation	<25%	1250
Native Vegetation	<27%	101
Native Vegetation (Riparian) (Twelve Mile Creek Diversion)	<25%	53
Water Storages	NA	18
Retained Infrastructure	NA	12
NUMA	As per EA Table F1	882
Total		4046

Source: (Appendix A).

Table 4-2: Post-Mining Land Uses, Relevant Domains and Rehabilitation Areas

PMLU	Relevant Domains	RA	Description
Grazing	- In-pit and Out-of-Pit Waste Rock Emplacements. - Water Storages. - Diversion Drains. - Levees. - Flood Protection Structures. - Sediment Dams. - Infrastructure Areas. - DE-Pit (TSF). - DOM1 (TSF).	RA1 RA6 RA8 RA12 RA13	Areas of slopes <12.5% rehabilitated with grazing species to enable grazing activities. Rehabilitation must establish a pasture capable of self-regeneration over successive seasons with minimal inputs outside that required for the management of pastures in surrounding, off-lease areas by landowners.
Native Vegetation	- In-pit and Out-of-Pit Waste Rock Emplacements. - Water Storages. - Diversion Drains. - Levees. - Flood Protection Structures. - Sediment Dams. - Infrastructure Areas. - DE-Pit (TSF).	RA2 RA5 RA9 RA10 RA11	Areas to be rehabilitated with endemic species to provide habitat for terrestrial species (Slopes 0 to <27%). Rehabilitation must establish and be capable of self-regeneration over successive seasons with minimal management.
Water Storages	- Retained Water Storages. - Retained Sediment Dams.	RA4	Water storages cleaned and retained to support grazing activities. The level of water storage and retention must be defined based on the environmental impacts of overflow to downstream waterways Water quality will be in line with the ANZECC and ARMCANZ Water Quality Guidelines – Livestock drinking water guidelines (2018).
Retained Infrastructure	- Workshops. - Administration Buildings. - Access Tracks/Roads. - Associated Services (e.g. Power).	RA7	Infrastructure retained post-mining to support grazing activities and enable vehicle access across site.
Native Vegetation (Riparian) (Twelve Mile Creek Diversion)	- Twelve Mile Creek Permanent Diversion. - C-Pit. - D-Pit.	RA3	Twelve Mile Creek Permanent Diversion constructed to design, to create a permanent stable feature which will serve to protect the A-Pit residual void from flood inundation up to and including 1:100 AEP flood event. Revegetated with native vegetation, including riparian vegetation to establish vegetation diversity. C-Pit and D-Pit will be backfilled and incorporated into the diversion design.

Note: ANZECC and ARMCANZ = Australia and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand; RA = Rehabilitation Area.



LEGEND

- Mining Lease Boundary
- Yarrabee Disturbance Footprint
- Post-mining Land Use
- Grazing (Low Intensity Cattle Grazing, Slope < 12.5%)
- Native Vegetation (Slope < 12.5%)
- Native Vegetation (Slope 12.5 - 25%)
- Native Vegetation (Slope 25 - 27%)
- Retained Infrastructure
- Water Storage
- Twelve Mile Creek Diversion (Including Riparian Vegetation)
- NUMA

Source: The State of Queensland (2024); Yancoal Australia (2025)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE
Post-Mining Land Uses and
Non-use Management Areas

Figure 4-1

Grazing

Grazing is a well-established land use on the Yarrabee Mine MLs as well as on neighbouring properties and across the Bowen Basin. Grazing is therefore a relevant and sustainable PMLU. Grazing will be implemented on areas slopes of <12.5% to ensure a stable landform that safe grazing can be undertaken upon. Grazing areas will be predominantly rehabilitated with pasture species suited to the reinstated soils and capable of sustaining grazing activities. Retained built infrastructure, such as hardstand areas, buildings, water storages, roads and tracks, will support grazing activities and facilitate vehicle access across the site. Revegetation species lists are provided in Section 6.12.3.

Native Vegetation

Native Vegetation will primarily be implemented on slopes >12.5% to <27%. Areas of native vegetation will be developed on some slopes <12.5% to improve landform connectivity across the post-mining landscape. Native vegetation areas will be rehabilitated with endemic species suitable for the post-mining landform (e.g., species suited to steep terrain on steeper slopes) and the growth media (i.e., soil and/or overburden). Revegetation species lists are provided in Section 6.12.3.

Water Storages

Permanent water features to provide habitat for terrestrial and aquatic species as well as providing wildlife corridors and stock sheltering areas will be developed as a PMLU within retained water storages. Water storages to be retained will be rehabilitated to provide water of a quality suitable for sustaining livestock and native fauna, as per the ANZECC and ARMCANZ Water Quality Guideline - Livestock drinking water guidelines (2018).

Retained Infrastructure

At closure, infrastructure including workshops, administration buildings, associated services (e.g., power) and access tracks/roads will be retained to support PMLUs, where agreed to with the post-mining landowner. Infrastructure to be retained will be agreed with the administering authority and any potential post-mining land user. Infrastructure retention agreements will be in place with the post-mining land user prior to closure. This will benefit the post-mining land users as they can continue utilising the existing infrastructure to support post-mining activities. If necessary, ongoing maintenance of retained infrastructure will be undertaken by the post mining landholder (Section 6.11). A landholder agreement for the retention of infrastructure post closure is provided in Attachment 2.

Native Vegetation (Riparian) (Twelve Mile Creek Diversion)

At closure, a permanent diversion of Twelve Mile Creek will be constructed to create a permanent stable feature which will serve to protect the A-Pit residual void from flood inundation up to and including 1:1,000 AEP flood event. The diversion will be revegetated with native vegetation including riparian vegetation. The diversion functional design is detailed in Section 6.9.1. As far as practical, the permanent creek diversion has been designed consistent with the geomorphic, hydrologic, and ecological features of undisturbed areas of Twelve Mile Creek and with reference to industry and government guidelines including (but not limited to) Department of Natural Resources, Mines and Energy (DNRME) (2019) and Australian Coal Association Research Program (ACARP) (2000a, 2000b and 2002).

4.2 RELEVANT LEGISLATION, PLANS AND STRATEGIES

In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRCP must state the extent to which each PMLU for land identified in the PRCP Schedule is consistent with:

- (a) *the outcome of consultation with the community in developing the plan; and*
- (b) *any strategies or plans for the land of a local government, the State or the Commonwealth.*

The following Legislation, Plans and Strategies have been considered during the development of the Yarrabee Mine's final landform.

Central Highlands Regional Planning Scheme 2016

The *Central Highlands Regional Council Planning Scheme 2016* (Central Highlands Regional Council [CHRC], 2024) outlines the strategic intent and outcomes for the Central Highlands region to guide development and land use, which is to be renowned for its diversity, liveability, and prosperity. The region has large and diverse agricultural and pastoral industries, which shape the character of the many communities within the region.

Yarrabee Mine falls within the rural zone, which allows rural activities including grazing of livestock. The PMLU of grazing augmented with areas of native vegetation and permanent water storages is in keeping with strategic intent and outcomes of the *Central Highlands Regional Planning Scheme 2016* as:

- The region's natural ecosystems will be supported through additional habitat and connectivity.
- The rehabilitated landform will be consistent with the region's intent to appropriately manage and utilise the natural landscape to maintain its character and identity, whilst sustainably managing agricultural assets.
- The return to grazing will support the region's agricultural industry and character. It will provide effective weed and pest management to ensure the protection of agricultural assets and natural resources, as well as prevent biosecurity hazards.
- The scenic amenity values of natural and rural landscapes will be maintained.

Central Queensland Regional Plan 2013

Another key strategy which guides the post-mining land uses at Yarrabee Mine is the *Central Queensland Regional Plan* (Queensland Government, 2013). The abundance of natural resources and productive agricultural land are becoming one of the largest industries in Central Queensland. Due to this, transitioning the land into grazing land to support the agricultural industry aligns with the *Central Queensland Regional Plan*.

Fitzroy Basin Water Plan 2011

Due to Twelve Mile Creek running through Yarrabee Mine, the *Water Plan (Fitzroy Basin) 2011* is legislation which must be considered during closure planning for the mine site. The purpose of this plan is to:

- i. to define the availability of water in the plan area;
- ii. to provide a framework for sustainably managing water and the taking of water;
- iii. to identify priorities and mechanisms for dealing with future water requirements;
- iv. to provide a framework for establishing water allocations;
- v. to provide a framework for reversing, where practical, degradation in natural ecosystems;
- vi. to regulate the taking of overland flow water;
- vii. to regulate the taking of groundwater.

The Queensland Plan 2014

In addition to the above, *The Queensland Plan: Queenslanders' 30-year vision* (The Queensland Plan) (Queensland Government, 2014) outlines the key strategies to guide future development in Queensland, with a focus on education, community, regions, and the economy. The Queensland Plan identifies key success criteria to ensure the mining and agricultural industry are integrated, equitable, profitable, and environmentally responsible. This plan supports the continuation of the mining and agricultural industries in an environmentally sustainable manner. The proposed PMLUs for Yarrabee Mine have been developed to transition the land to the dominant surrounding land uses to positively impact on the surrounding environment.

4.3 COMMUNITY CONSULTATION

The PMLUs described above are consistent with EA EPML00844613 and consultation undertaken with DETSI and other stakeholders (e.g. surrounding landholders) during the original EA application process and subsequent EA amendments. As discussed in Section 3, consultation has also been undertaken with surrounding landholders and the community.

The proposed PMLUs will benefit the community as grazing is the dominant land-use of the region. In 2020, four meetings were held with the landholder of a nearby property, Scrubbee, to discuss the proposed final landform and land uses. In addition to these meetings, in March 2020 YCC presented to the landholders of Scrubbee, Tarcoola, Yarrabee Station, and Jellinbah Station to discuss the proposed PMLUs.

In July 2024, a letter was supplied to all surrounding landholders, the Gaangalu Nation People and the Blackwater and Bluff Communities outlining the PRCP process for Yarrabee Mine and the final landform. Additionally in July 2024, YCC presented to the Blackwater Community Reference Group describing the PRCP in detail including the associated post-mining land uses.

5 NON-USE MANAGEMENT AREAS

5.1 PRE-APPROVED NON-USE MANAGEMENT AREAS

Section 126(D) of the EP Act states that land can be identified as a NUMA if:

- a) *carrying out rehabilitation of the land would cause a greater risk of environmental harm than not carrying out the rehabilitation; or*
- b) *both of the following apply —*
 - i. *the risk of environmental harm as a result of not carrying out rehabilitation of the land is confined to the area of the relevant resource tenure;*
 - ii. *the applicant considers, having regard to each public interest consideration, that it is in the public interest for the land not to be rehabilitated to a stable condition.*

As per the transitional provisions of the EP Act, NUMAs can be transitioned from LODs into a PRCP. Under section 270 of the EP Act, the LODs for Yarrabee Mine are EA EPML00844613 and the *Yarrabee Rehabilitation Management Plan* (YCC, 2021). The NUMAs are described in the LODs and have been transitioned into this PRCP and the PRCP Schedule.

Within this PRCP, the term ‘residual void’ refers to the reshaped mining void that remains within the final landform post closure. The term ‘NUMA’ refers to the area approved in *Table F1* of EA EPML00844613 that will not be assigned a PMLU post closure. NUMA footprints remain consistent and align with EA EPML00844613.

Table F1 of EA EPML00844613 details the approved design (depth, slope, area, and volume) of the NUMAs within the Yarrabee Mine final landform. The NUMAs and residual voids detailed in EA EPML00844613 must comply with *Condition F5: Residual void outcomes* including the design requirements in *Table F1*, as well as the locations presented in *Figure 3* and *Figure 4* of EA EPML00844613. The NUMAs detailed in *Table F1*, are all reflected as in *Figure 3* and *Figure 4* of EA EPML00844613.

The NUMAs transitioned into this PRCP are consistent with the design parameters in *Table F1* of EA EPML00844613, which specifies maximum slope, depth, area, and volume for each residual void. The locations of the residual voids are outlined in *Figure 4-1* and the extent of the NUMA within the voids is consistent with *Table F1*, *Figure 3* and *Figure 4* of the EA EPML00844613. The remaining walls of the residual voids will be either a native vegetation or grazing PMLU depending on slopes.

Table 5-1 outlines the void design parameters in *Table F1* of EA EPML00844613.

Table 5-1: Non-Use Management Area Design

NUMA Identification	NUMA high wall competent rock maximum slope (degrees)	NUMA high wall incompetent rock maximum slope (degrees)	NUMA low wall competent rock maximum slope (degrees)	NUMA low wall incompetent rock maximum slope (degrees)	NUMA Maximum Depth (m)	NUMA Maximum Area (ha)	NUMA Maximum Volume (Mm ³) ³
A-Pit	70	45	37	37	113	126	40
CE-North	70	45	37	37	40	53	8
DOM2N	70	45	37	37	100	103	41
DOM2S	70	45	37	37	59	45	7
DOM5 ²	70	45	37	37	50	133	41
DOM6	70	45	37	37	54	25	10
YEN-Pit	70	45	37	37	129	223	121
YES-Pit	70	45	37	37	129	174	87
Total						882	355

1 Geotechnical review of residual void design for highwalls and low walls in Table F1, can be undertaken in final landform design plan in Condition F20 to ensure the final slope profiles achieve a safe and stable landform.

2 The extent of DOM5 residual void includes the consolidated extent of DOM5N, DOM5S and DOM4 mine voids.

3 Mm³ = cubic megametre.

5.2 RELEVANT LEGISLATION, PLANS AND STRATEGIES

In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRCP must state the extent to which each NUMA identified in the PRCP Schedule is consistent with:

- (a) *the outcome of consultation with the community in developing the plan; and*
- (b) *any strategies or plans for the land of a local government, the State or the Commonwealth.*

The approved NUMAs will be managed in a way as to minimise impacts upon the strategic intent and outcomes for the Central Highlands region, as outlined in the *Central Highlands Regional Council Planning Scheme 2016* (CHRC, 2024), *Central Queensland Regional Plan* (Queensland Government, 2013), *Water Plan (Fitzroy Basin) 2011*, and *The Queensland Plan* (Queensland Government, 2014). In particular:

- The region's natural ecosystems will be supported through additional habitat and connectivity surrounding the NUMAs.
- The improved landform will not adversely impact groundwater resources.
- The scenic amenity values of natural and rural landscapes will be maintained.

These plans are described further in Section 4.3.

5.3 COMMUNITY CONSULTATION

Consultation has previously been undertaken with government agencies, underlying landholders, surrounding landholders and other stakeholders regarding the NUMAs. The consultation described in Section 4.2 relates to the PMLUs of Yarrabee Mine including the proposed NUMAs and therefore satisfies the community consultation requirements for the NUMAs.

6 REHABILITATION AND MANAGEMENT METHODOLOGY

In accordance with section 126C(1)(e) and (i) of the EP Act, Section 6 states:

- e) *for each proposed PMLU for land, the proposed methods, or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP Schedule; and*
- ...
- i) *for each proposed NUMA, the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP Schedule for the area; and*
- ...

6.1 LANDFORM DESIGN

6.1.1 Key Landform Features

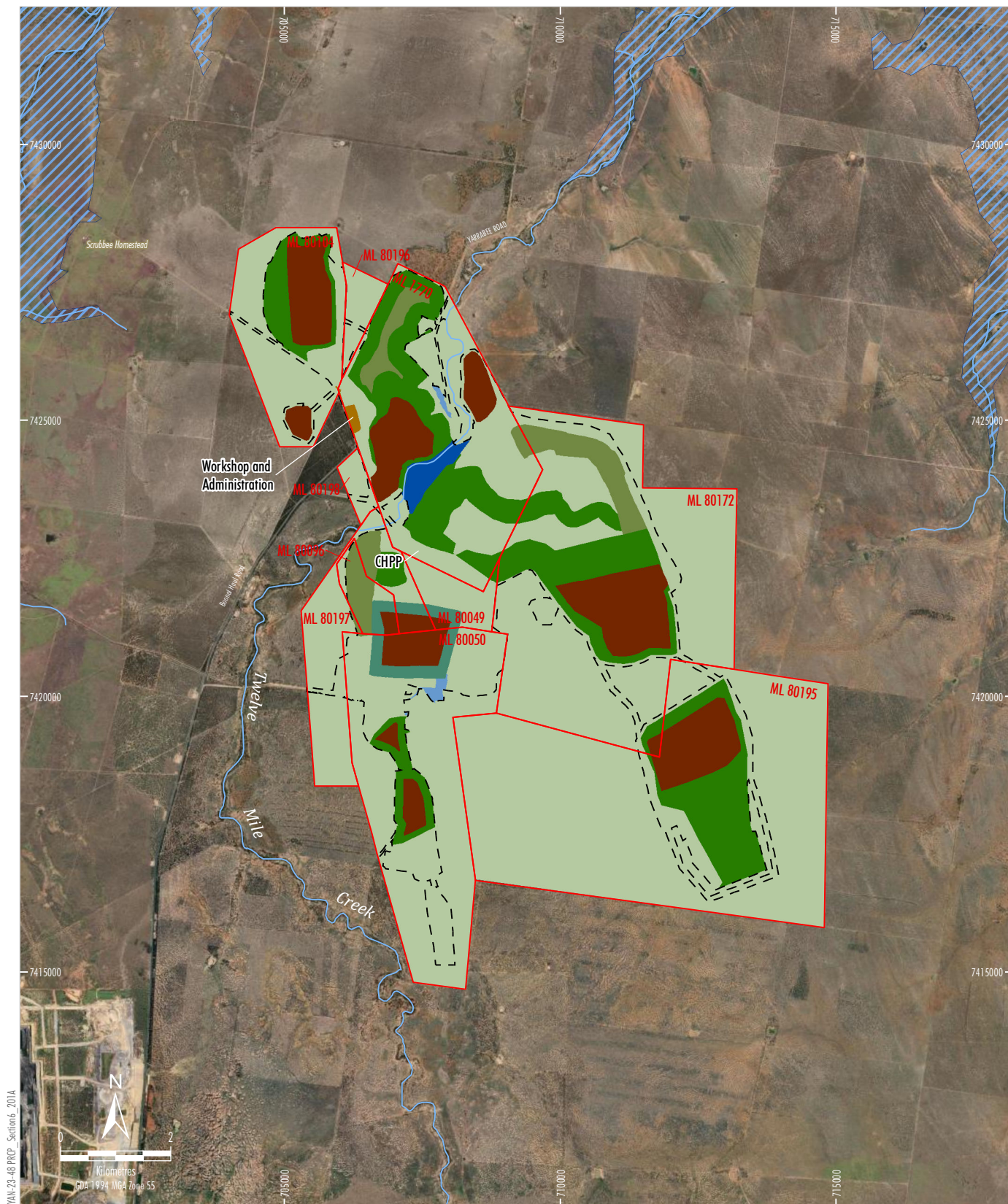
The key features of the Yarrabee Mine final landform are:

1. rehabilitated in-pit and out-of-pit waste rock emplacements;
2. a rehabilitated out-of-pit TSF;
3. a rehabilitated in-pit TSF;
4. backfilled and rehabilitated pits;
5. eight pre-approved NUMAs;
6. rehabilitated infrastructure areas;
7. retained infrastructure, where agreed with post-mining the landholder, including access tracks and buildings;
8. retained water management features, where agreed with the post-mining landowner, including drainage and diversion channels and water storages supporting the post-mining land uses; and
9. a permanent diversion of Twelve Mile Creek.

The final landform, including surface elevation contours (i.e., three-dimensional designs) is presented in Figure 2-12.

The final landform has been designed to be sympathetic to and consistent with the topography of surrounding land and landform characteristics of the region. As described in Section 2.1, the general landform features of the Bowen Basin and Central Queensland include “rolling hill” low level grazing areas, broad catchment drainage and flood plain areas, steep and outcropping sedimentary terrain, such as the Blackdown Tablelands to the south, and modified landscapes associated with other coal mines. Figure 6-1 presents the final site design including:

- Maximum disturbance footprint;
- ML 1770, ML 80049, ML 80050, ML 80096, ML 80104, ML 80172, ML 80195, ML 80196, ML 80197, and ML 80198;
- PMLU and NUMA distribution; and
- Flood plain extent.



LEGEND

- Mining Lease Boundary
- Yarrabee Disturbance Footprint
- Queensland Floodplain Assessment Overlay (DoR, 2023)
- Post-mining Land Use
- Grazing (Low Intensity Cattle Grazing, Slope < 12.5%)
- Native Vegetation (Slope < 12.5%)
- Native Vegetation (Slope 12.5 - 25%)
- Native Vegetation (Slope 25 - 27%)
- Retained Infrastructure
- Water Storage
- Twelve Mile Creek Diversion (Including Riparian Vegetation)
- NUMA

Source: The State of Queensland (2024); Yancoal Australia (2025)
 Orthophoto: Esri, Maxar, Earthstar Geographics, and the GIS User
 Community (2024)



YARRABEE COAL MINE Final Landform Design

Figure 6-1

A range of landform options have been modelled to determine optimum slope gradients to maximise runoff erosion stability (Appendix K, Appendix L and Appendix M). In considering landform stability, the following strategy was applied:

1. a laboratory study measured the erodibility of coarse waste rock both singly and in two different mixtures with topsoil;
2. Water Erosion Prediction Program (WEPP) simulations were carried out using the erodibility data considering a range of landform/material treatments (or combinations), including rocky wastes, topsoil, gypsum, contour ripping and vegetation covers; and
3. completion of SIBERIA modelling on the final landform with a vegetation groundcover level of 50% and a soil-waste mixing ratio of between 1:1 and 1:2 (both mixing ratios yield similar results). Using input parameters derived for this surface material and groundcover level, the model was run for 300 years, with outputs provided for every 50 year period.

Further discussion of the erosion assessment is provided in Section 6.6. Detailed descriptions of the key landform features and the relevant rehabilitation methodology are provided in Section 6.1.2 to Section 6.1.4.

6.1.2 Waste Rock Emplacements

Out-of-pit waste rock emplacements will be progressively constructed and rehabilitated as soon as practical following dumping to the final dimensions and height. Where the progression of mining allows, open cut pits will be progressively backfilled with excavated overburden. The commencement of progressive rehabilitation as spoil dumps achieve final dimension and height will minimise the area of disturbance at any one time. The final landform has been designed to suit:

1. the characteristics of the spoil material;
2. the geographic position and location of the area relative to other naturally occurring landscape features; and
3. the approved PMLU.

Surface preparation and revegetation of the waste rock emplacements will be undertaken in accordance with the methods detailed in Section 6.12.

The waste rock emplacements will be rehabilitated to comprise slopes with gradients between 0 and <27%. This will increase catchment area and the volume and length of run-off but will reduce run-off velocity, reducing the erosion risk and sediment run-off downstream. Where spatial constraints do not allow for reduced slopes, the landform will be constructed with slopes no more than 27%.

These steeper slope areas (>12.5%) will have a smaller catchment area and volume and length of surface water run-off than areas rehabilitated to grazing, however will need to cope with increased surface water run-off velocity.

Steeper slope areas (>12.5%) will be rehabilitated to a native vegetation PMLU. As far as practical, the reconstructed steeper landform slopes will be shaped to have non-linear profiles and a high degree of surface roughness. Graded banks and contour channels/benches may be used where required to break up long slopes, as well as slow down and redirect run-off.

Water management controls such as sediment dams, and drainage swales and diversion channels will be incorporated where required to manage and support post-mining surface water flows, and divert run-off away from erodible surfaces, particularly during landform construction and seed emergence stages of rehabilitation. These structures will form part of the final landform and will be vegetated with stoloniferous grasses or other suitable ground cover for long-term protection.

6.1.3 Residual Voids

The Yarrabee Mine final landform includes eight residual voids which encapsulate approved NUMAs and PMLUs. Low wall, highwall and end wall slopes of the residual voids have been designed to achieve a minimum factor of safety (FoS) of 2.

The catchment area reporting to each residual void will be minimised as far as practical, and bunding and/or fencing will prevent access to the NUMA by humans and livestock. The flood modelling demonstrates that the residual voids are protected from inundation up to and including a 0.1% AEP event (Appendix I). The results of flood modelling and the residual void water balance are outlined in Sections 6.3 and 6.7.4 respectively. Detail of void minimisation, dimension and slopes are provided in Sections 6.7.1 and 6.7.2.

Residual void batters will be rehabilitated with native vegetation that is appropriate to the final character and slope of the void walls. Slopes will be treated where required to provide erosion stability per the design parameters in Table 6-1. The voids not pre-approved as NUMAs will be progressively backfilled (as waste rock emplacements) and rehabilitated to support a PMLU of grazing or native vegetation as outlined in Section 6.1.2. These areas will be rehabilitated as per the surface preparation and revegetation methods described in Section 6.12.

Table 6-1: Residual Void Slope Treatment for Erosion Stability

Slope (%)	Benign Permian Spoil Cover (m)	Durable Rock Mulch (m)	Average Topsoil Depth (mm)
<10	>0.5	0 to 0.4	200
10 to 15	>1.0	0 to 0.4	200
15 to 25	>1.0	>1.0	200
25 to 33*	>1.0	>1.0	-

Note: * The steeper 25 to 33% slope treatment is applicable to shorter slopes only.

6.1.4 Water Management Infrastructure

The water management infrastructure at Yarrabee Mine comprises water storage dams, sediment dams, in-pit water storage, A-Pit and YEN-Pit flood levees, diversion drains, and the Twelve Mile Creek Diversion. Their rehabilitation strategies are described below.

Diversion Drains

Where not required in the post-mining landscape, diversion drains will be decommissioned, and the resultant landform designed and shaped to be sympathetic with the surrounding landscape and/or to support the approved PMLU. Drains will be backfilled and contoured consistent with the surrounding landscape, then rehabilitated per the surface preparation and revegetation methods described in Section 6.12.

Diversion drains retained to manage water in the post-mining landscape will be designed with similar morphology to regional ephemeral drainage lines. They will be rehabilitated per the surface preparation and revegetation methods described in Section 6.12.

Dams

Dams not required to support post-mining activities (e.g. grazing) will be decommissioned and rehabilitated. This will involve dewatering via pumping and evaporation, pushing dam walls inwards to cover sediments, backfilling with overburden, shaping and contouring will create a free draining landform with slopes of <10%. These areas will then be rehabilitated as per the surface preparation and revegetation methods described in Section 6.12.

Some dams may be retained, upon agreement with the post-mining land holder, to support the post-mining activities, including to provide permanent sediment and erosion control, and stock watering. Dams to be retained will be de-silted, inspected and, where required, remediated (including rehabilitation of the dam walls and immediate surrounds) to ensure the ongoing structural integrity of the dam for the intended end use. Revegetation of permanent sediment dams and ponds will include native vegetation species to provide bank stability and fauna habitat.

In-pit Water Storages

At cessation of mining, eight residual voids will remain as NUMAs, comprising water bodies and areas of the low walls, highwalls, and end walls that are not to be rehabilitated to a PMLU. The residual voids, including the hydrological performance, are discussed in Section 6.7.

Flood Levees

Two levees provide flood protection during operations, the A-Pit Levee and the YEN-Pit Levee. The A-Pit Levee is located along the highwall of A-Pit and provides protection for A-Pit from Twelve Mile Creek floodwaters up to and including a 0.1% AEP flood event. The YEN-Pit Levee has been constructed across the major drainage inflow catchment for the local area, providing flood protection to YEN-Pit up to and including a 0.1% AEP flood event from the upstream catchment. Both levees are regulated structures. The YEN-Pit Levee will be mined through as YEN-Pit progresses south to north.

Once no longer required to function as a regulated structure, the A-Pit Levee will be reshaped and rehabilitated to create a permanent stable landform feature which will serve to protect the A-Pit residual void from flood inundation up to and including a 0.1% AEP flood event. The design of the resultant landform includes batter slopes of 10% (or less), a top width of 25 m, an increased overall height of at least 1 m above the height of the existing levee and a setback from the crest of the A-Pit highwall of approximately 25 m. The area will be rehabilitated per the surface preparation and revegetation methods described in Section 6.12.

Twelve Mile Creek Diversion

The existing temporary diverted section of Twelve Mile Creek will be realigned within its associated flood plain to create the permanent Twelve Mile Creek Diversion. This will require backfilling and rehabilitating C-Pit and D-Pit, the construction and rehabilitation of a stable raised permanent landform adjacent to and along the length of the A-Pit highwall, the possible expansion of the creek floodplain to the east of C-Pit and the construction and rehabilitation of a new permanent creek channel.

As far as practical, the permanent creek diversion will be designed, constructed, and rehabilitated consistent with the geomorphic, hydrologic, and ecological features of undisturbed areas of Twelve Mile Creek with reference to industry and government guidelines including (but not limited to) DNRME (2019) and ACARP (2000a, 2000b and 2002). The final design will be informed by detailed engineering design as well as hydrological modelling of the Twelve Mile Creek catchment upstream of the diversion, including the influence of the reconstructed and rehabilitated final landform on this flow regime. Further detail of the Twelve Mile Creek Diversion design is provided in Section 6.9.1.

6.1.5 Quality Assurance and Quality Control Requirements

Quality assurance measures and Environmental Quality Inspection Forms (EQIF) are used to ensure that works are completed to the specifications identified in this plan. At all stages of the rehabilitation program, EQIFs need to be completed and signed off by relevant personnel prior to commencing the next stage of works.

Included in the EQIF process are 'Hold Points'. Hold points represent key steps in the rehabilitation process where signoff must be obtained from nominated entities; this may include the Contractor Representatives, Project Managers, Environment Team, Appropriately Qualified Person(s) (AQPs), and Field Supervisors.

EQIF hold points requiring signoff are as follows:

1. Landform design and drainage construction approval (prior to commencing RM3 and RM4).
2. Surface preparation and seed selection (prior to commencing RM6).
3. Ripping, seeding, and fertilising (following RM6).

6.1.6 Methodology to Verify the Success of the Final Landform Design

Successful rehabilitation of the final landform will be assessed through the rehabilitation milestone criteria and monitored following the monitoring program outlined in Section 8.

Where possible, progressive rehabilitation certification will be undertaken to verify that rehabilitation is successful prior to surrender of the EA. Under section 318Z of the EP Act, the administering authority may certify a particular area within a relevant tenure for a resource project has been rehabilitated under all relevant requirements of the EP Act, EA EPML00844613, the PRCP Schedule, and any relevant guidelines or documents made under the EP Act.

Sections 6.2 to 6.12 describe the information necessary to underpin the development of the rehabilitation and management methodologies applicable to the Yarrabee Mine.

6.1.7 Limitations and Assumptions of the Final Landform Design

The final landform design has the following limitations and assumptions:

- Erosion modelling was undertaken on slopes between 10% and 33.3%, multiple growth mediums and vegetative covers.
- Landform Evolution modelling was undertaken on a landform treated with soils and waste treated with gypsum.
- Soil availability and quality are based on soil test sites located within the undisturbed footprint of the MLs.
- Groundwater modelling was undertaken over a period of 552 years.
- Climate data was utilised from BoM and Scientific Information for Landowners (SILO) data.
- Waste characterisation is based on representative samples collected across the MLs.
- Void hydrology was modelled using GoldSim software for a 200-year period.
- Flood assessments were undertaken using a Watershed Boundary Network Model Hydrological model and a TUFLOW Hydraulic Model.

6.2 HYDROGEOLOGY

SLR Consulting Pty Ltd (SLR) undertook a groundwater assessment (Appendix G and Appendix H) to determine the long-term post closure hydrogeological regime associated with the Yarrabee Mine final landform.

The assessment included two principal components: description of the hydrogeological setting and development of a conceptual hydrogeological model; and numerical groundwater modelling to simulate the effect of mining and the post-mining landform on the local hydrogeological regime. The objective of the assessment was to:

- present an understanding of the hydrogeological setting and processes in the vicinity of the mine;
- understand the local groundwater values and identify potential groundwater receptors;
- simulate the post-mining groundwater level recovery using the proposed final landform for to understand whether the final voids act as groundwater sinks or sources; and
- understand the long-term effect of the proposed post-mining landform on local groundwater levels i.e. the impact of residual drawdown on potential groundwater receptors.

6.2.1 Groundwater Monitoring

A groundwater monitoring network was installed at Yarrabee Mine in early to mid-2024 based on an investigation program developed by Hydrogeologist.com (2022). The network is comprised of a total of 23 monitoring bores including:

- Three bores installed to the base of the Late Tertiary – Quaternary deposits along Twelve Mile Creek.
- 19 bores installed within the RCM at 10 locations, with six of these locations having two to three bores screened at different elevations.
- One bore installed in the Rewan Formation.

In addition to data from the Yarrabee Mine monitoring network, some monitoring data was obtained from bores at Jellinbah Mine, specifically from around the Mackenzie North operation located at the northern end of Jellinbah Mine. The Jellinbah monitoring bore data provided additional data for calibration of the numerical groundwater model.

6.2.2 Hydrostratigraphy

As discussed in Section 2.5, there are three main geological units within the Yarrabee Mine area that have the most potential to store and transmit groundwater:

- Quaternary alluvium – primarily that associated with the Mackenzie River, and potentially the Late Tertiary – Quaternary alluvium and Tertiary where it thickens west and north-west of Yarrabee Mine and includes permeable horizons.
- Coal seams within the Permian coal measures – typically the most permeable horizons within the coal measures strata.
- Regolith – the upper weathered rock horizon where the water table fluctuates. Regolith is present across all the consolidated formations where they naturally outcrop/subcrop.

The Rewan and Burngrove formations and Gylanda Subgroup are mainly considered aquitards, as are thick sequences of the Permian coal measure interburden where they are comprised of siltstones and mudstones. The available groundwater level data is discussed in Section 6.2.2.1 to 6.2.2.4 and is limited to recent groundwater levels for the RCM at Yarrabee Mine and available time series data for the Mackenzie River Alluvium at Jellinbah Mine.

6.2.2.1 Alluvium

The Late Tertiary – Quaternary Alluvium present across much of Yarrabee Mine is thin (median thickness of 5 m) and is therefore significantly elevated above the saturated water table. Three monitoring bores are present within the alluvial deposits along Twelve Mile Creek. The bores were installed to depths of 3.6 m, 10 m and 12 m and have remained dry since installation. Twelve Mile Creek is ephemeral but may provide localised recharge to shallow permeable unconsolidated deposits during periods of flow.

The available groundwater level time series data for the Mackenzie River Alluvium at North Jellinbah Mine is presented in Figure 6-2, together with the Cumulative Rainfall Departure (CRD), which was utilized to assess trends in groundwater levels against longer term rainfall trends. This data was collected from bores installed in the Basal Sands (lower layer of the Mackenzie River Alluvium), at the northern end of Jellinbah Mine. A correlation in the data with the CRD is clearly shown i.e. the sharp increase shown in 2010 in response to high rainfall followed by a decline as a result of a period of average rainfall and then lower than average rainfall.

Groundwater flow through the Mackenzie River Alluvium at North Jellinbah Mine occurs to the north-east, aligned with the flow direction of the Mackenzie River and the topography of its floodplain.

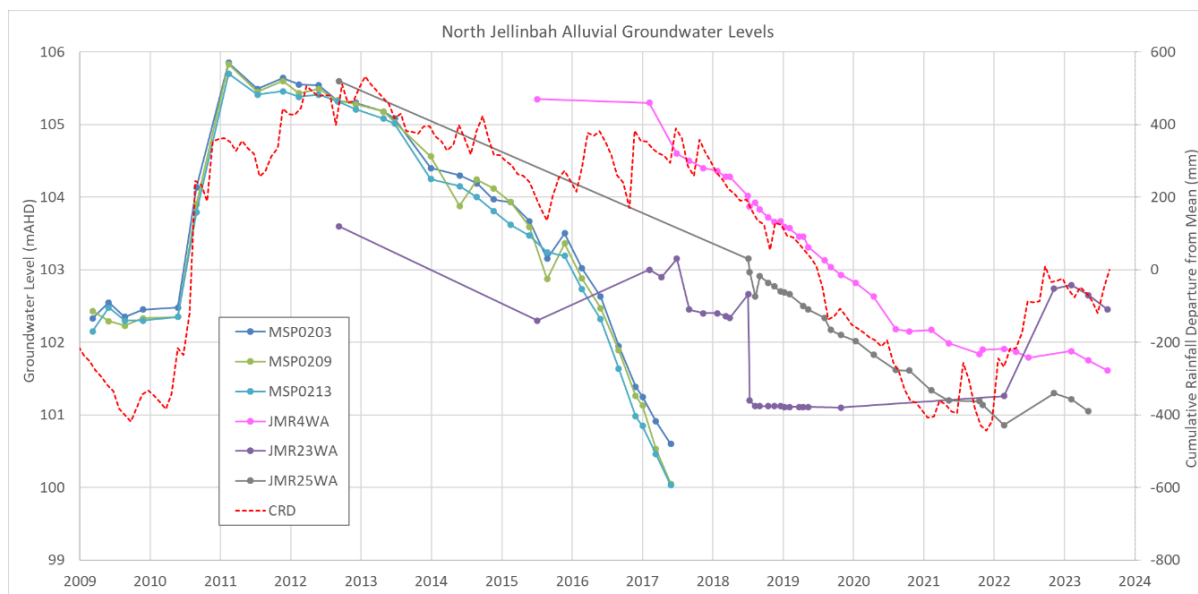


Figure 6-2: Alluvial Groundwater Levels (Basal Sands) at Jellinbah Mine (Appendix G)

6.2.2.2 Tertiary Sediments

Late Tertiary – Quaternary alluvium and the Tertiary Duaringa Formation are mapped across much of Yarrabee Mine. Tertiary deposits identified in exploration bores have a median thickness of 5 m and are elevated above the saturated water table. The Tertiary deposits thicken towards the Mackenzie River, with a limited number of exploration bores to the west and north-west of Yarrabee Mine having identified Tertiary sediments exceeding 50 m deep with layers of sand and gravel. However, topsoil mapping indicates “depositional plains of Tertiary clays” over large areas suggesting low recharge rate to the deeper Tertiary.

6.2.2.3 Permian Coal Measures

Collection of groundwater level data for the RCM at Yarrabee Mine commenced in mid-2024 (Figure 6-3 and Figure 6-4). Due to the limited monitoring period, there is currently no significant time series or obvious trends in the data, with levels remaining consistent.

Groundwater levels in the RCM across the site broadly fall from south to north towards the Mackenzie River floodplain. The highest groundwater levels are observed at the southern end of the site around 127 to 121 mAHd. Levels generally fall to the north with levels in the central area of the site between 115 to 105 mAHd. Levels at the northern end of the site are around 101 mAHd.

At the northern end of the site MB04 has shown a consistent level of around 101.5 mAHd since installation. Whilst MB06, located in the central area of the site, does record the lowest RCM groundwater level (approximately 83 mAHd), this is considered to be impacted by mining in YEN-Pit adjacent to the north-east which is supported by the approximately 1m decline in the level in this bore over the year of monitoring despite the rising trend in the CRD.

Several of the Yarrabee Mine monitoring locations consist of multiple monitoring bores screened at different depths. At MB12 in the south of the site groundwater levels in the shallower Pisces seam and the deeper Pollux seam are consistent.

Bores MB09a and MB09b are screened in the Rewan and Lower Pollux respectively at a similar depth, and 400 m apart on opposite sides of the major thrust fault bounding the west of the site. The groundwater level in the Rewan bore west of the fault is approximately 8 m higher than the Lower Pollux bore on the east of the fault although this bore is adjacent to a small pit which may be depressing the measured groundwater level

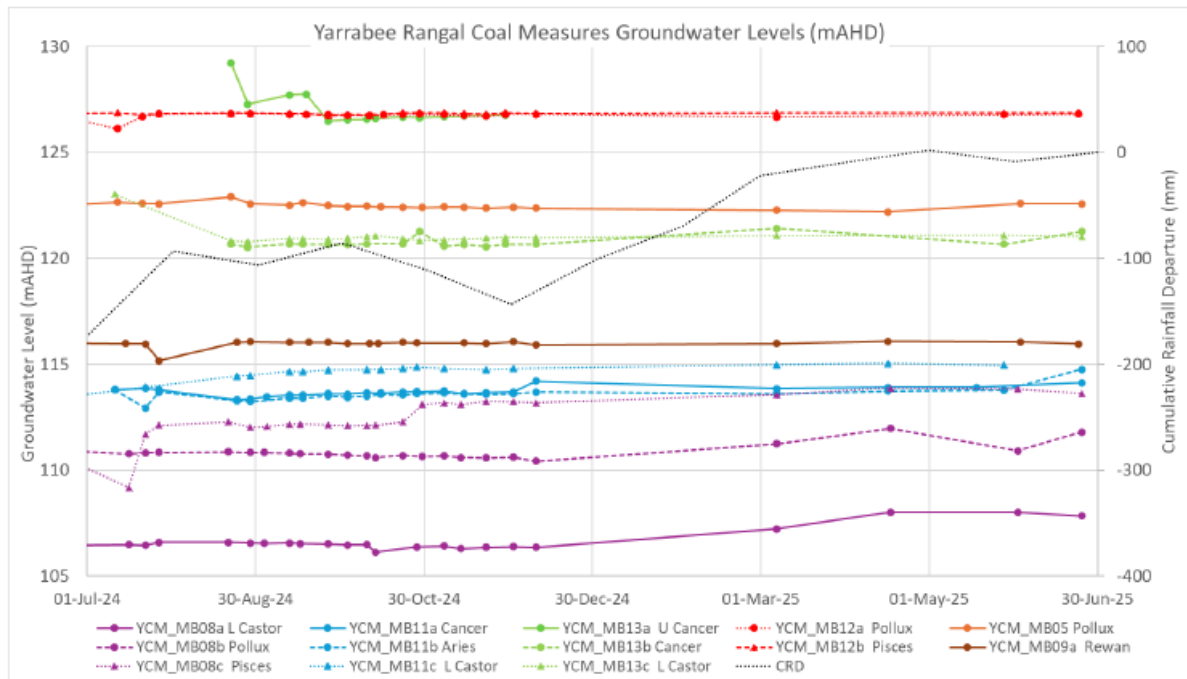


Figure 6-3: Rangal Coal Measures Groundwater Levels (1) (Appendix G)

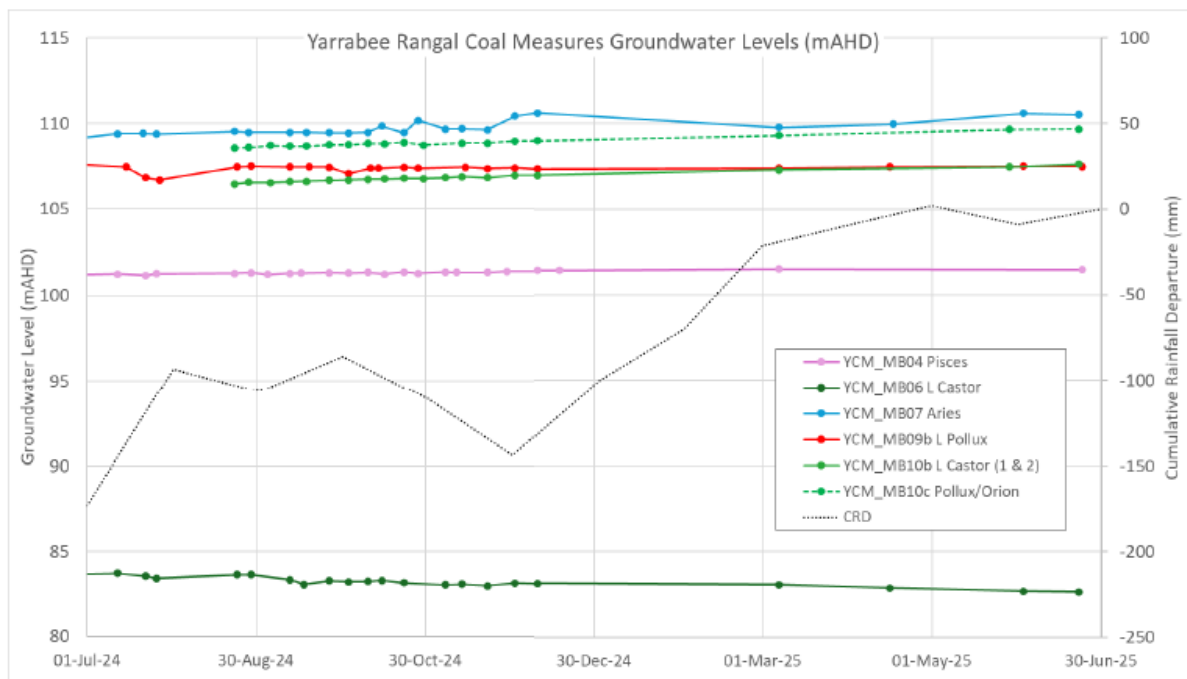


Figure 6-4: Rangal Coal Measures Groundwater Levels (2) (Appendix G)

6.2.2.4 *Regolith/Weathered Zone*

An upper zone of weathered rock/regolith is present across the subcropping solid geology. The base of weathering has an average depth of 23 mbgl and is defined as a surface in the site geological model. The regolith may exhibit higher permeability than the underlying unweathered strata because of changes from “rock” to “sediment”, as well as the enhancement of fractures and other discontinuities through weathering. The base of weathering is often deemed an approximate long-term average or lower level for the water table. When groundwater levels exceed the base of weathering, groundwater may be more mobile due to the higher permeability of this layer. The weathered zone may therefore provide a preferential flow path for groundwater.

6.2.3 **Hydraulic Properties**

6.2.3.1 *Conductivity Estimates*

Formation permeability tests were undertaken as part of the 2024 monitoring bore installation program. Testing included packer tests during drilling and slug tests.

The scale of permeability tests (i.e. the volume of the formation being tested by the test method), typically results in smaller scale tests. The larger the volume of tested aquifer, the more heterogeneities such as joints and fractures it will incorporate. Therefore, pumping tests can yield significantly higher permeability estimates than laboratory testing on a small sample of in-tact aquifer matrix. Subsequently, pumping test results are deemed to yield more reliable bulk permeability values for a formation and are more appropriate for regional scale hydrogeological conceptualisation than core sample tests or slug tests.

This test scale effect is clearly illustrated in Figure 6-5 which presents data from permeability test undertaken on the RCM from various Bowen Basin mines. Estimates obtained from laboratory core sample tests yield values five orders of magnitude lower than the estimates derived from pumping tests. Permeability estimates derived from slug tests and packer tests mostly lie between core tests and pumping tests. The permeability estimates presented in Figure 6-5 fall within the range of estimates derived from other packer and slug tests in the RCM from other Bowen Basin mines. Permeability estimates towards the upper end of the range are more appropriate for regional scale modelling.

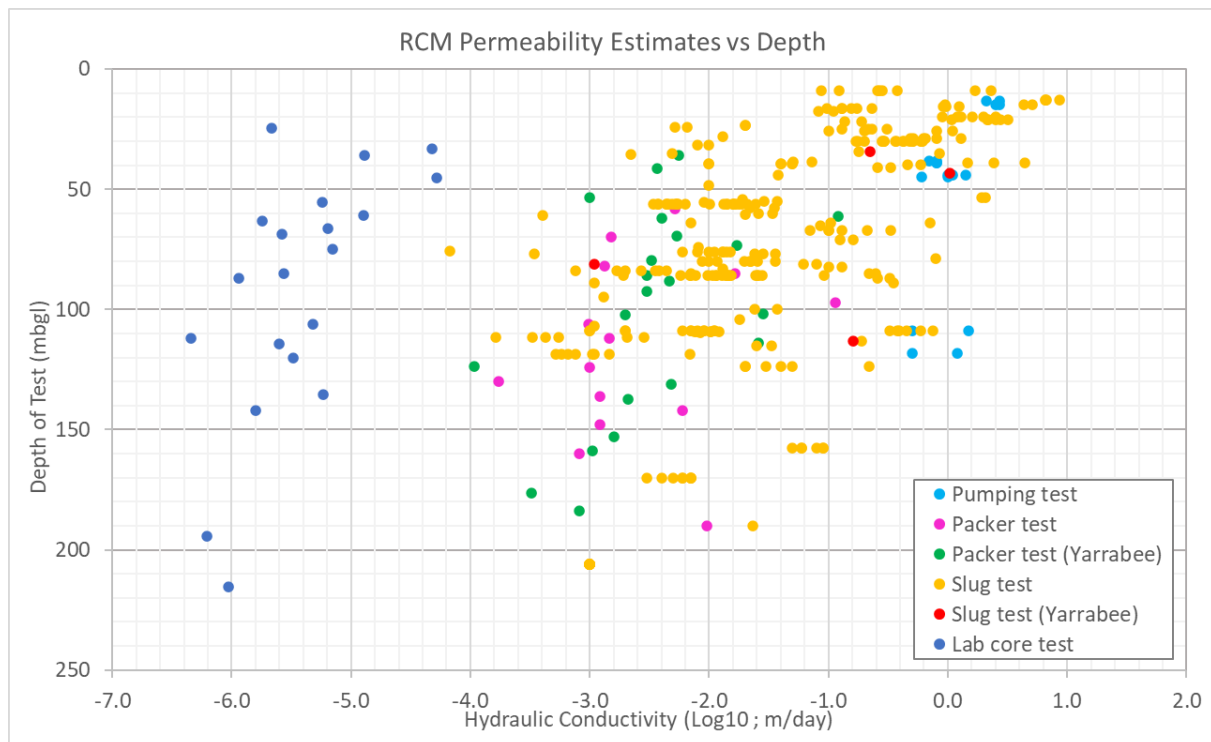


Figure 6-5: RCM Permeability Test Data vs Depth (Appendix G)

6.2.3.2 Effect of Faulting

Yarrabee Mine is situated within the Jellinbah Thrust Belt and is heavily faulted with numerous thrust faults mapped across the mine. Faulting can lead to higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane (Jourde et al., 2002). However, this can also depend on whether faults are currently active (Paul et al., 2009). Faulting within the Bowen Basin has been inactive for over 140 million years (Clark et al., 2011), indicating that the fault zones are less likely to act as conduits to flow; this relates to filling of the fracture spaces over time through hydrothermal alteration and mineralisation (Uysal et al., 2000).

Site specific testing of the faults to derive hydraulic properties of the fault zones and determine whether the faults act as conduits or barrier to groundwater flow was not undertaken. However, the faults are anticipated to act as barriers rather than conduits as they compartmentalise the coal seams by juxtaposing them against lower permeability interburden (Appendix G and Appendix H).

Coffey (2014) has developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin. This conceptualisation provides a way of inferring hydraulic conductivities of the fault core and the fault damage zone from regional hydraulic conductivity, with the fault core typically one to three orders of magnitude lower conductivity than the regional host rock, and the damage zone approximately an order of magnitude higher.

6.2.4 Recharge

The Chloride Mass Balance (CMB) estimates of recharge based on Yarrabee Mine groundwater samples are presented in Table 6-2 and are very low due to the very high salinity of groundwater, even in shallow bores. The estimate ranges from 0.021 to 0.121 mm/yr, which are small percentages of annual rainfall.

The very low recharge estimates and the high groundwater salinities align with the moderately low mobility of groundwater at Yarrabee Mine through the compartmentalisation of groundwater within the coal seams as a result of the highly faulted nature of the RCM. Additionally, the presence of shallow Tertiary clays across parts of Yarrabee Mine may also limit recharge.

CMB recharge estimates are also available for Jellinbah Mine. Whilst the salinity of groundwater from the Jellinbah bores was significantly lower than at Yarrabee Mine, CMB derived recharge estimates are still low:

- Alluvium – mean recharge value of 9.9 mm/year (1.7% of rainfall).
 - Ranging from 5.5 mm/year (0.97% of rainfall) to 30.3 mm/year (5.3% of annual rainfall).
- Permian interburden – mean recharge value of 0.7 mm/year (0.12% of rainfall).
 - Ranging from 0.4 mm/year (0.07% of rainfall) to 2.1 mm/year (0.37% of rainfall).
- Pollux coal seam – mean recharge value of 0.7 mm/year (0.12% of rainfall).
 - Ranging from 0.4 mm/year (0.12% of rainfall) to 2.2 mm/year (0.39% of rainfall).

Table 6-2: Recharge Estimates from Chloride Mass Balance

Bore ID	Formation screened	Groundwater Chloride Concentration mg/L	Estimated Recharge Rate (mm/yr, percentage of rainfall)					
			Low		Medium		High	
			mm/yr	%	mm/yr	%	mm/yr	%
YCM_MB04	Pisces	7550	0.075	0.013	0.136	0.024	0.415	0.073
YCM_MB05	Pollux	26200	0.022	0.004	0.039	0.007	0.120	0.021
YCM_MB06	Castor Lower	23700	0.024	0.004	0.043	0.008	0.132	0.023
YCM_MB07	Aries	23100	0.025	0.004	0.044	0.008	0.136	0.024
YCM_MB08a	Castor Lower	4450	0.128	0.022	0.231	0.040	0.704	0.124
YCM_MB08b	Pollux	4430	0.129	0.023	0.232	0.041	0.708	0.124
YCM_MB08c	Pisces	4660	0.122	0.021	0.220	0.039	0.673	0.118
YCM_MB09a	Rewan	26600	0.021	0.004	0.039	0.007	0.118	0.021
YCM_MB09b	Pollux Lower	24500	0.023	0.004	0.042	0.007	0.128	0.022
YCM_MB10b	Castor Lower (1 and 2)	20300	0.028	0.005	0.051	0.009	0.154	0.027
YCM_MB10c	Pollux/Orion	18600	0.031	0.005	0.055	0.010	0.169	0.030
YCM_MB12a	Pollux	22900	0.025	0.004	0.045	0.008	0.137	0.024
YCM_MB12b	Pisces	23600	0.024	0.004	0.043	0.008	0.133	0.023
YCM_MB13a	Cancer Upper	25200	0.023	0.004	0.041	0.007	0.124	0.022
YCM_MB13b	Cancer	24600	0.023	0.004	0.042	0.007	0.127	0.022
YCM_MB13c	Castor Lower	17400	0.033	0.006	0.059	0.010	0.180	0.032
YCM_MB11a	Cancer	25800	0.022	0.004	0.040	0.007	0.122	0.021
YCM_MB11b	Aries	26500	0.022	0.004	0.039	0.007	0.118	0.021
YCM_MB11c	Castor Lower	18800	0.030	0.005	0.055	0.010	0.167	0.029

Source: (Appendix G).

6.2.5 Deep Drainage Estimates

The Australian Water Resources Assessment Landscape model (AWRA-L model) simulates the historical and projected landscape water balance for Australia and provides estimates of surface runoff, soil moisture, evapotranspiration, and deep drainage (water reaching the water table). The AWRA-L model incorporates climatic variables including radiation, temperature, actual vapor pressure, wind, and precipitation (Frost and Shokri, 2021), in addition to hydrological processes including:

- rainfall (interception losses and net rainfall);
- overland flow (due to saturation of groundwater store exceedance);
- infiltration and Hortonian overland flow;
- drainage and interflow within and from soil layers;
- evaporation from surface soil store;
- transpiration from shallow and deep soil stores; and
- groundwater evaporation, transpiration and baseflow.

Historical monthly deep drainage estimates obtained from the AWRA-L simulated dataset for the Yarrabee Mine area are presented in Figure 6-6 against the SILO derived actual monthly rainfall.

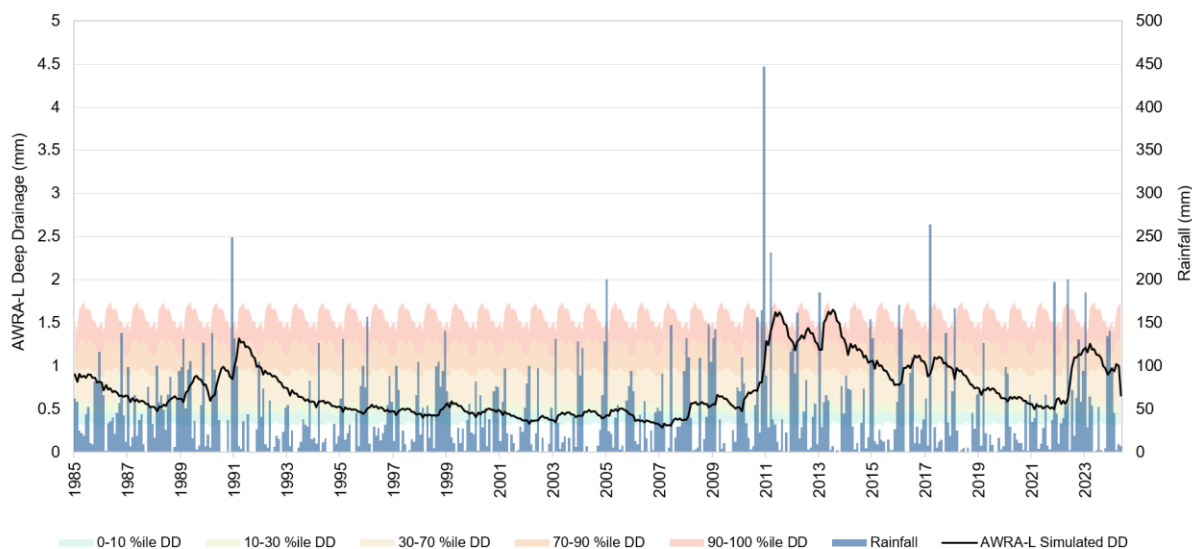


Figure 6-6: AWRA-L Simulated Deep Drainage (DD) vs Actual Rainfall (Appendix G)

The deep drainage estimates are much higher than the CMB recharge estimates. However, the deep drainage data provides a base value for temporal variability (including major recharge events such as 2010/2011) to which factors can be applied in the numerical model to reduce the total volume of recharge applied, to better align with the very low recharge rates implied by the CMB estimates. Spatial variability in recharge may also occur depending on surface geology, particularly across the riparian zones which may be subject to inundation or occasional surface water flows (e.g. Twelve Mile Creek).

6.2.6 Groundwater Quality

Groundwater resources in the Yarrabee Mine area are scheduled under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity), as Mackenzie Groundwaters within the Mackenzie River sub-catchment (DEHP, 2011) of the Fitzroy Basin water plan (WQ1310). The legislated environmental values for these Groundwaters are:

- Biological integrity of aquatic ecosystems – these occur where groundwaters interact with surface waters i.e. baseflow supports streams and wetlands to some extent (seasonally or permanently).
- Human use environmental values:
 - Irrigation – where groundwater is utilised for crop growth and pastures for commercial purposes.
 - Farm water supply/use – where groundwater is used to provide domestic supply and support of domestic produce growing.
 - Stock watering – where groundwater is used for stock watering.
 - Drinking water supply – where groundwater is used for potable water supply.
 - Cultural and spiritual values – to protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.
 - Industrial use – no specific water quality guidelines are in place for the protection of industrial use. It is usually protected by other values, such as the aquatic ecosystem environmental value.

The following water quality guidelines were utilised to assess groundwater quality in the vicinity of Yarrabee Mine against the designated environmental values:

- Australian Drinking Water Guidelines (NHMRC, NRMCC 2018).
- Livestock drinking water guidelines (ANZECC, 2000).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) - guideline values for the protection of freshwater habitats – 95% species protection value (where available).
- Recreational Water Quality and Aesthetics (ANZECC, 2000).
- Irrigation (ANZECC, 2000) – long term trigger value.

6.2.6.1 Salinity and pH

Salinity is assessed based on TDS concentrations, or by EC and can be a key constraint to water management and groundwater use. Table 2-2 outlines TDS concentrations for the RCM and Rewan groundwater across Yarrabee Mine against livestock drinking water standards. Salinity is mostly very high with the twentieth percentile TDS value for the RCM samples exceeding all but the upper guideline range for the most salinity tolerant stock (sheep). Average TDS concentrations in the RCM are well beyond the tolerable ranges for livestock. The salinity of Yarrabee Mine groundwater essentially renders it unsuitable for most uses except for its potential use in dust suppression.

Groundwater pH across Yarrabee Mine is generally neutral to very slightly alkaline with a median value of 7.42.

6.2.7 Numerical Groundwater Model

To simulate the effect of mining at Yarrabee, and mine closure on the groundwater regime, a regional scale numerical model was developed of the mine and the surrounding area. The key objectives of the numerical groundwater model were to:

- simulate the regional groundwater regime including the full extent of mining at Yarrabee Mine;
- simulate the post-mining groundwater level recovery;
- estimate the post-mining groundwater flux to the residual voids and potential for seepage from the voids to groundwater; and
- predict the long-term effect of the final landform on the local groundwater regime, i.e. predict residual groundwater level drawdown around the residual voids.

Full details of the model development, parameterisation, boundary conditions (BC), stresses, calibration, model confidence classification and predictive simulations are presented in the Technical Modelling Report (Appendix H). A summary of key elements of the numerical model and outcomes of the modelling are detailed in Section 6.2.7.1.

6.2.7.1 *Inputs from Conceptual Model*

Table 6-3 presents initial hydraulic parameter ranges for the model layers that were represented within the model, including the model layering for the Jellinbah Mine area which was adopted directly from the AGE 2013 model in the absence of any other geological data being available for the Jellinbah Mine for this assessment.

Table 6-3: Suggested Initial Hydraulic Parameter Ranges for Numerical Model

Lithology	Kh (m/day)	Kv (m/day)	Specific Yield (%)	Specific Storage (m-1)
Mackenzie River Alluvium	0.1 - 5	0.01 - 5	0.1 - 0.01	0.001 - 0.0001
Mackenzie Basal Sands	2 - 10	0.1 - 10	0.1 - 0.01	0.001 - 0.0001
Alluvium (TQa)	0.01 - 1	0.001 - 0.1	0.05 - 0.001	0.001 - 0.0001
Tertiary	0.1 - 5	0.01 - 1	0.05 - 0.001	0.001 - 0.0001
Regolith (weathered RCM/Rewan/Gyranda)	0.1 - 0.001	0.05 - 0.0001	0.01 - 0.001	0.001 - 0.0001
Coal seams	1 - 0.0005	0.1 - 0.0001	0.01 - 0.001	5.0E-4 - 5.0E-6
RCM at Yarrabee	0.001 - 1.0E-5	0.001 - 1.0E-6	0.02 - 0.001	5.0E-4 - 5.0E-6
Fault zones	0.001 - 1.0E-5	0.001 - 1.0E-6	0.02 - 0.001	5.0E-4 - 5.0E-6
Rewan Formation	1.0E-3 - 1.0E-5	5.0E-4 - 5.0E-7	0.01 - 0.001	1.0E-5 - 1.0E-6
Gyranda Subgroup	1.0E-3 - 1.0E-5	5.0E-4 - 5.0E-7	0.01 - 0.001	1.0E-5 - 1.0E-6
Additional Model Layers Adopted from AGE Model (2013), for the Jellinbah Mine Area				
Overburden (weathered)	0.01 - 0.001	0.005 - 0.0001	1.0x10 ⁻³	5.0E-3 - 5.0E-5
Overburden (unweathered)	0.001 - 0.0001	0.0001 - 1.0E-5	8.0x10 ⁻³	5.0E-4 - 1.0E-5
Interburden	0.0001 - 1.0E-5	1.0E-5 - 1.0E-6	8.0x10 ⁻³	5.0E-4 - 5.0E-6
Castor/Aries Seams	2.0E-2 - 2.0E-4	2.0E-3 - 2.0E-5	7.0x10 ⁻³	5.0E-4 - 5.0E-6
Pollux Upper Seam	5.0E-1 - 1.0E-3	1.0E-2 - 1.0E-4	7.0x10 ⁻³	5.0E-4 - 5.0E-6
Pollux Lower Seam	5.0E-1 - 1.0E-3	1.0E-2 - 1.0E-4	5.0x10 ⁻³	5.0E-4 - 5.0E-6
Basal Sediments	1.0E-4 - 1.0E-6	1.0E-5 - 1.0E-7	1.0x10 ⁻³	5.0E-5 - 1.0E-6

Source: (Appendix G).

6.2.7.2 Numerical Model Key Elements

Numerical modelling was undertaken using MODFLOW-USG, a version of the MODFLOW code developed by the United States Geological Survey. MODFLOW-USG is widely regarded as the industry standard. The model extent was designed to be substantial enough to incorporate Yarrabee Mine with boundaries set at appropriate geological features or distances from the mine such that they would not influence mining related drawdowns. The model extent was as follows:

- Southern boundary – 8.5 km from the southernmost mining at Yarrabee.
- Western boundary – along the Jellinbah fault, 10.5 km from the westernmost mining at Yarrabee Mine such that the Jellinbah Mine is included within the model domain, to allow the assessment of potential cumulative impacts. On the west side of the fault is a substantial area of thickness of the Rewan Formation and on the eastern side, the Burngrove Formation, which are both regarded largely as regional aquitards.
- Eastern boundary – 5 km from Yarrabee Mine within the substantial thickness of the Gyranda Subgroup up faulted immediately east of Yarrabee Mine and considered to be a regional aquitard.
- Northern boundary – 15 km from Yarrabee Mine and approximately 5.5 km north of Jellinbah Mine on the northern side of the Mackenzie River floodplain.

To enable stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes was utilised to allow refinement around areas of interest, with coarser resolution utilised elsewhere within the model to reduce the total cell count.

The model was vertically discretised into 15 layers, as detailed in Table 6-4. The top of layer 1 (topography) was developed from available Yarrabee Mine LiDAR and publicly available digital topography data, which was utilised for the extent beyond the Yarrabee Mine LiDAR. Model layers were based on the Yarrabee Mine geological model where available and extended beyond the site using available information on geological structures (major thrust faults and throws), and geological mapping. For the western portion of the model, which incorporates Jellinbah Mine, layering developed by AGE (2013) for numerical modelling of the northern extension to Jellinbah Mine (Mackenzie North) was utilised.

Due to the thickness of the unconsolidated material in certain areas of the model, in places up to three layers were used to represent these units in places. The alluvium/Tertiary were represented by layers 1, 2 and 3 where appropriate, to reflect the variable thicknesses observed and increase vertical resolution within the model domain where necessary. The layers were parameterised as required to represent the unconsolidated material present in different areas of the model. For example, layer 1 represents the thin layer of Late Tertiary – Quaternary alluvium over the southern model area, and the Quaternary Mackenzie River alluvium across the Mackenzie floodplain. Layers 2 and 3 were parameterised to represent the basal sands across parts of the Mackenzie River floodplain but were also parameterised to represent the Tertiary deposits to the west and north-west of the mine.

Layers 7 to 12 represent the RCM. Due to heavy thrust faulting across Yarrabee Mine and the resulting complex distribution of the target coal seams across the mine, individual seams were not represented in the layering of the model. A composite surface for the Lower Pollux (the primary target and base of mining across all Yarrabee Mine voids), was developed from the multiple individual surfaces representing the seam within the site geological model. The developed Lower Pollux surface was replicated for the base of the RCM and for shallower layers to provide adequate vertical resolution to represent the changes in hydraulic properties representing mining activity. Beneath the RCM, layers 13 to 15 represent the Permian aged Gyranda Subgroup.

Table 6-4: Numerical Model Layers

Model Layer	Age	Lithology	Average Thickness (m)
1	Quaternary/ Tertiary	Alluvium	8.4
2		Alluvium, Basal Sands, Regolith	9.3
3		Alluvium, Basal Sands, Tertiary, Regolith	6.4
4	Triassic	Regolith	15.3
5		Rewan	84.5
6		Rewan	75.4
7	Permian	Upper RCM	35.4
8		Mid RCM	24.1
9		Lower RCM (base of Lower Pollux, and mining)	19.6
10		Permian Underburden	41.5
11		Permian Underburden (Yarrabee Mine area only)	57.3
12		Permian Underburden	78.4
13		Upper Gyranda	150.0
14		Lower Gyranda	150.0
15		Basement Unit	210.0

Source: (Appendix G).

A General Head Boundary (GHB) condition was primarily utilised to represent the regional flow into and out of the model area. Groundwater enters the model where the GHB water level is set higher than the modelled water level in the adjacent cell and leaves the model when the water level is lower in the GHB. Groundwater elevations at the GHB boundaries were set initially based on topography and estimated depth to groundwater.

The Mackenzie River and Twelve Mile Creek were represented by river cells. The river cells for the Mackenzie River were designated properties to result in leakage not exceeding 12 megalitres per day (ML/d) based on the pro-rated loss in flow recorded between the upstream and downstream gauging stations. Twelve Mile Creek is ephemeral, and it is understood to flow approximately 16% of the time. It is represented within the model by river cells with a stage height of 0 m to reflect the average long-term condition.

Temporal variability in recharge was taken from the AWRA-L model, which models the historical and projected landscape water balance for Australia and outputs estimates of surface runoff, soil moisture, evapotranspiration, and deep drainage. This temporal variability provided a base value to which factors were applied to represent the low recharge rates the chloride mass balance indicated. Spatial variability in recharge was simulated by utilising multiple recharge zones based on surface geology and riparian zones.

Mining was simulated across the mining pit shells, using drain cells applied to all cells to the base of layer 9 (base of Lower Pollux). Historic mine progression was interpolated from available historic mine scheduling data and aerial imagery. Forward mine progression was also utilised in the predictive model. At Jellinbah Mine, drain cells representing historical and future mining were applied using the progression reported by AGE (2013). Full details of the model build, parameterisation, calibration statistics, water balance, predictive setup and a discussion of the model classification and confidence are presented in the Technical Groundwater Modelling Report (Appendix H).

6.2.7.3 Calibrated Groundwater Levels

Pre-Mining

Figure 6-7 presents the simulated steady-state water table elevation, representative of pre-mining conditions. The water table broadly reflects topography, falling in a north to north-west direction towards the Mackenzie River floodplain. Across the floodplain groundwater levels fall from approximately 105 mAHD to approximately 101 mAHD at the downstream end of the floodplain within the model domain (the north-east model boundary).

Simulated pre-mining groundwater levels in the deeper alluvium/basal sands/Tertiary (layers 2 and 3) are presented in Figure 6-8. These layers represent the quaternary alluvium and basal sands across the Mackenzie River floodplain whilst to the west and north-west of Yarrabee Mine, they represent older alluvium and Tertiary deposits. The absence of simulated water levels over parts of the model domain demonstrates where the water level is below the base of the layer or where these deposits are absent.

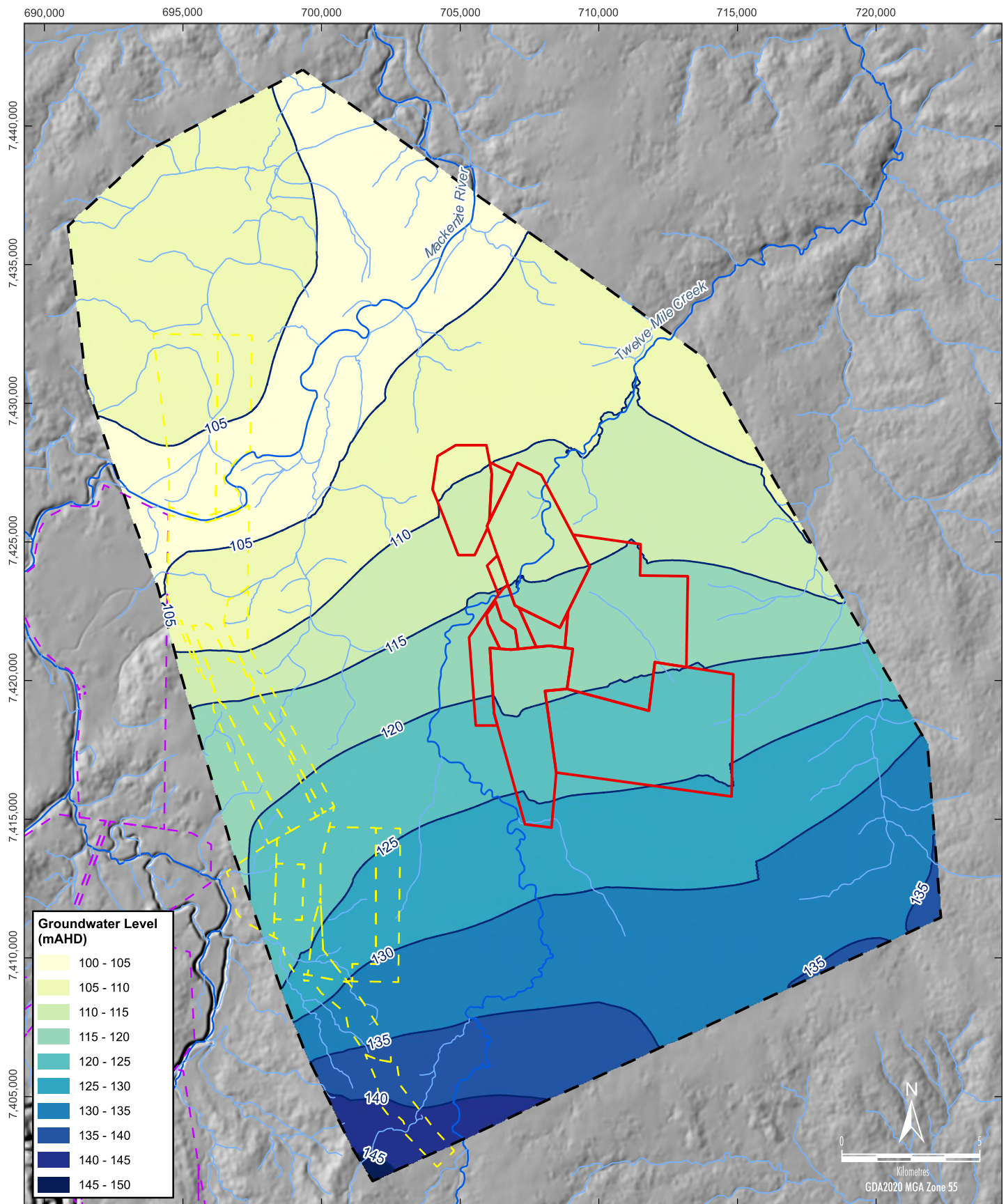
Simulated pre-mining groundwater levels for the alluvium and basal sands along the Mackenzie River and its tributaries present more extensive saturation, as well as the area west and north-west of Yarrabee Mine where thicker Tertiary deposits are present. Simulated pre-mining groundwater levels in the RCM (layer 9) are presented in Figure 6-9, where present, the Permian Coal Measures are saturated with groundwater levels falling towards the Mackenzie River floodplain.

End of Calibration

Figure 6-10 to Figure 6-12 present the predicted groundwater levels at the end of the calibration period, simulated by the best calibrated realisation. The simulated water table elevation for the end of the calibration period (October 2024) clearly presents the drawdown resulting from operations at both Yarrabee Mine and Jellinbah Mine (Figure 6-10).

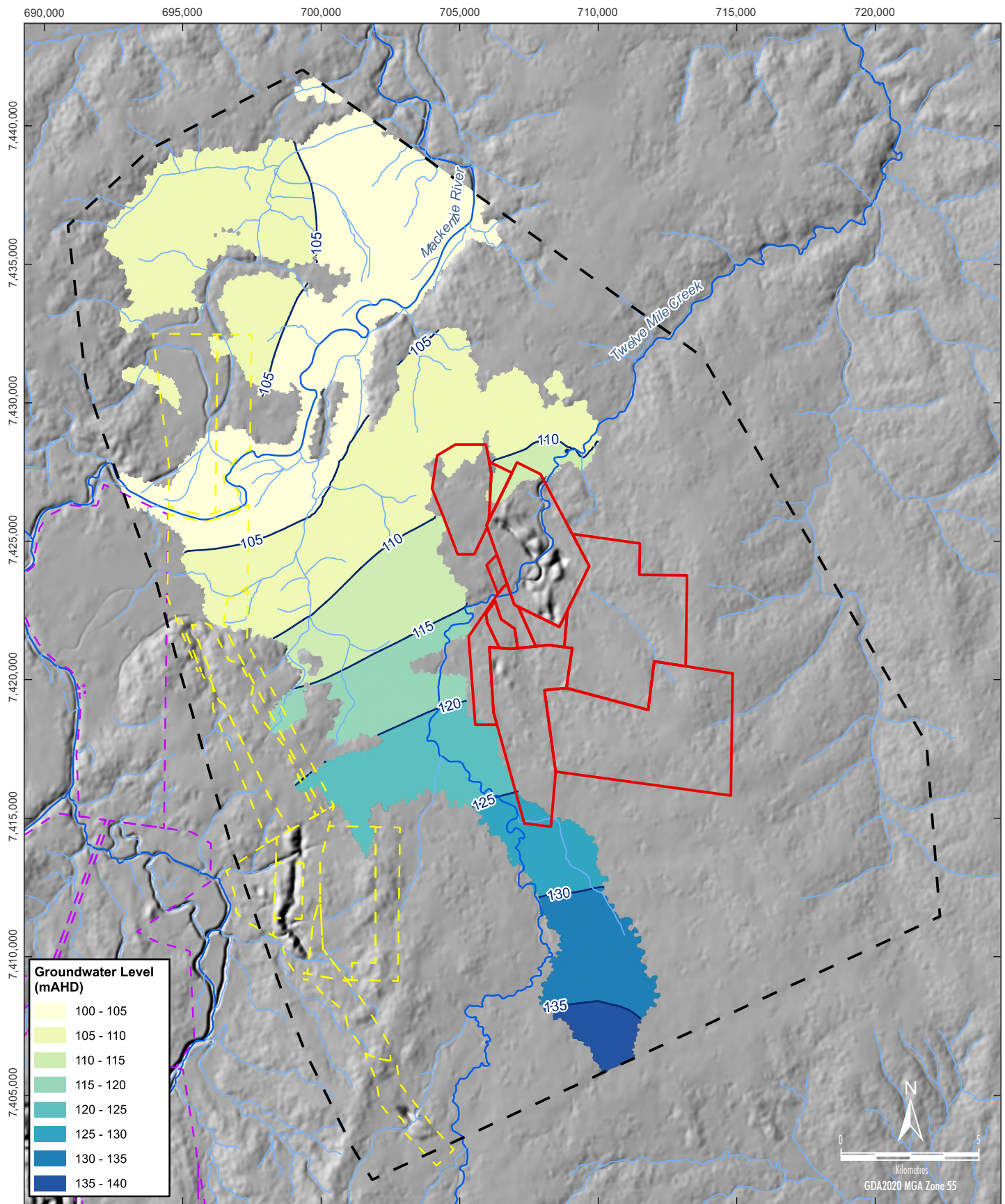
The simulated groundwater levels at the end of calibration in the deeper alluvium/Tertiary (layers 2 and 3) is outlined in Figure 6-11. Across the Mackenzie River floodplain layers 2 and 3 represent the quaternary alluvium and basal sands. To the west and north-west of Yarrabee Mine layers 2 and 3 represent older alluvium and thicker Tertiary deposits between Yarrabee Mine and Jellinbah Mine. Saturation across the Mackenzie River floodplain and around Yarrabee Mine is very similar to the pre-mining levels. The absence of simulated water levels over parts of the model domain demonstrates where the water level is below the base of the layer or where these deposits are absent.

Figure 6-12 presents the groundwater levels for the end of calibration period in the RCM (layer 9). Significant drawdown is simulated, reflecting the extent of historic and current existing mining activity.



YANCOAL
YARRABEE COAL MINE
Simulated Water Table
Pre-mining

Figure 6-7



Source: Appendix G - SLR Hydrogeology Assessment



YARRABEE COAL MINE

Simulated Water Level
in the Alluvium (L2) and Basal Sands (L3)
Pre-Mining

Figure 6-8

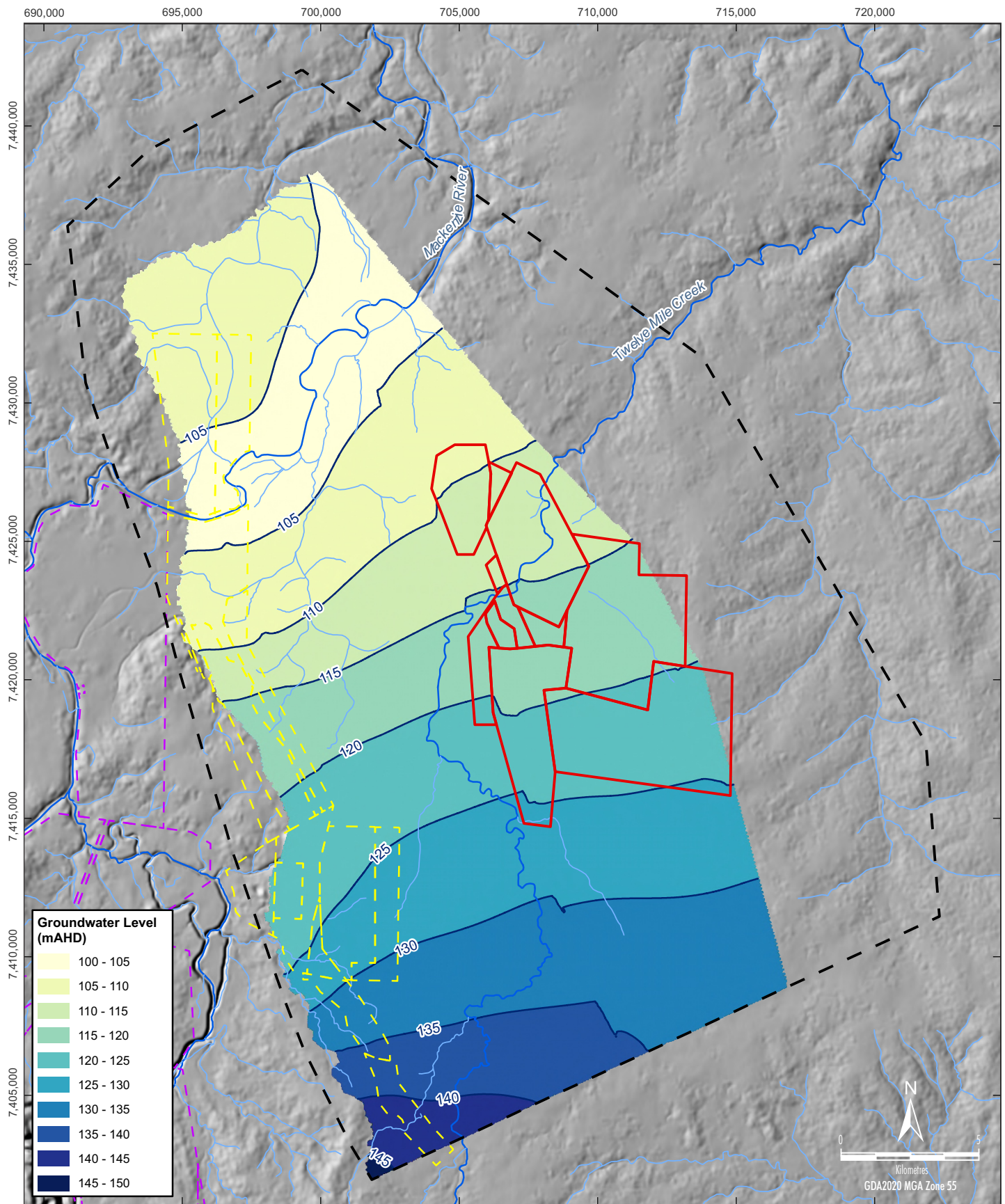


Figure 6-9

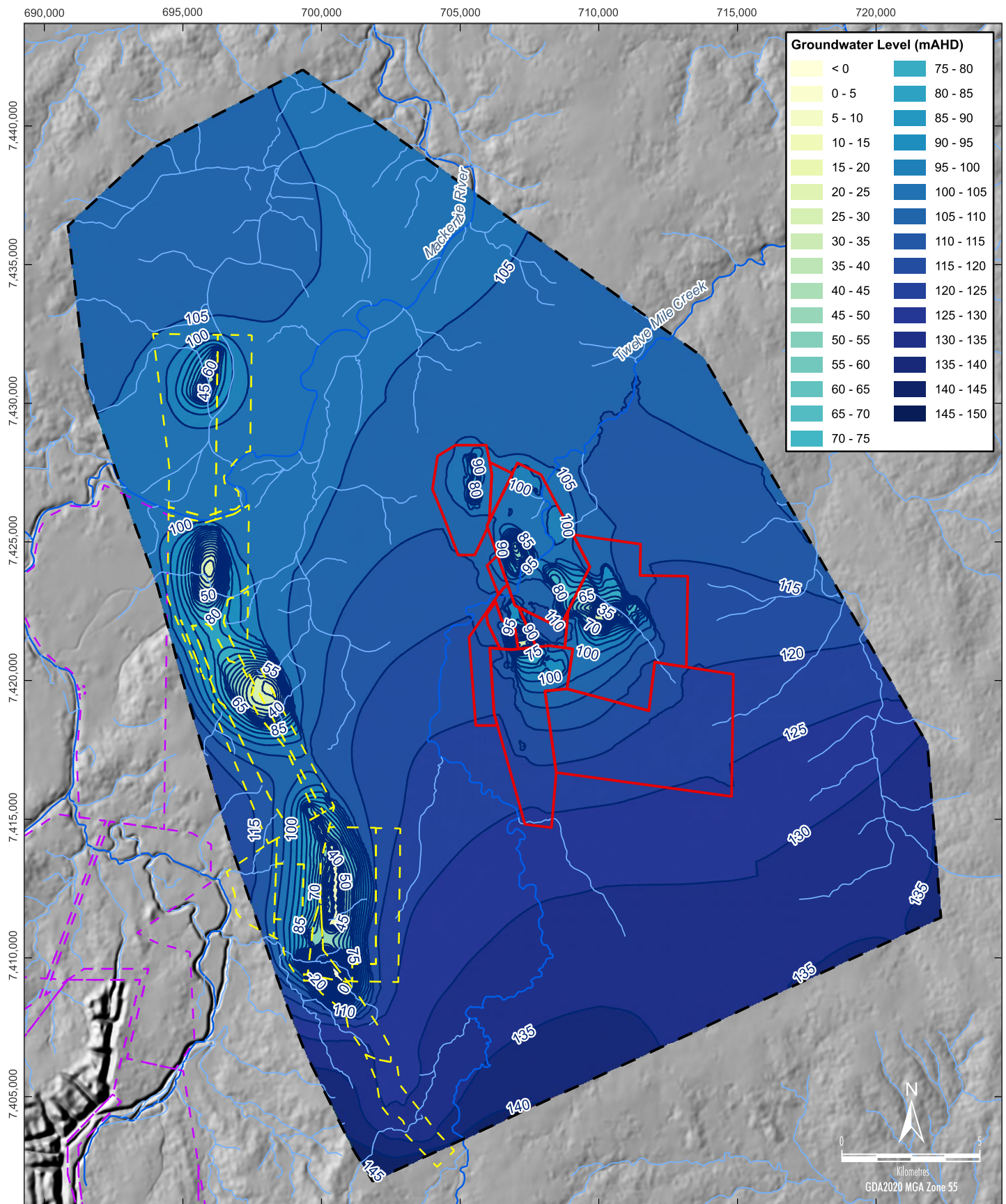
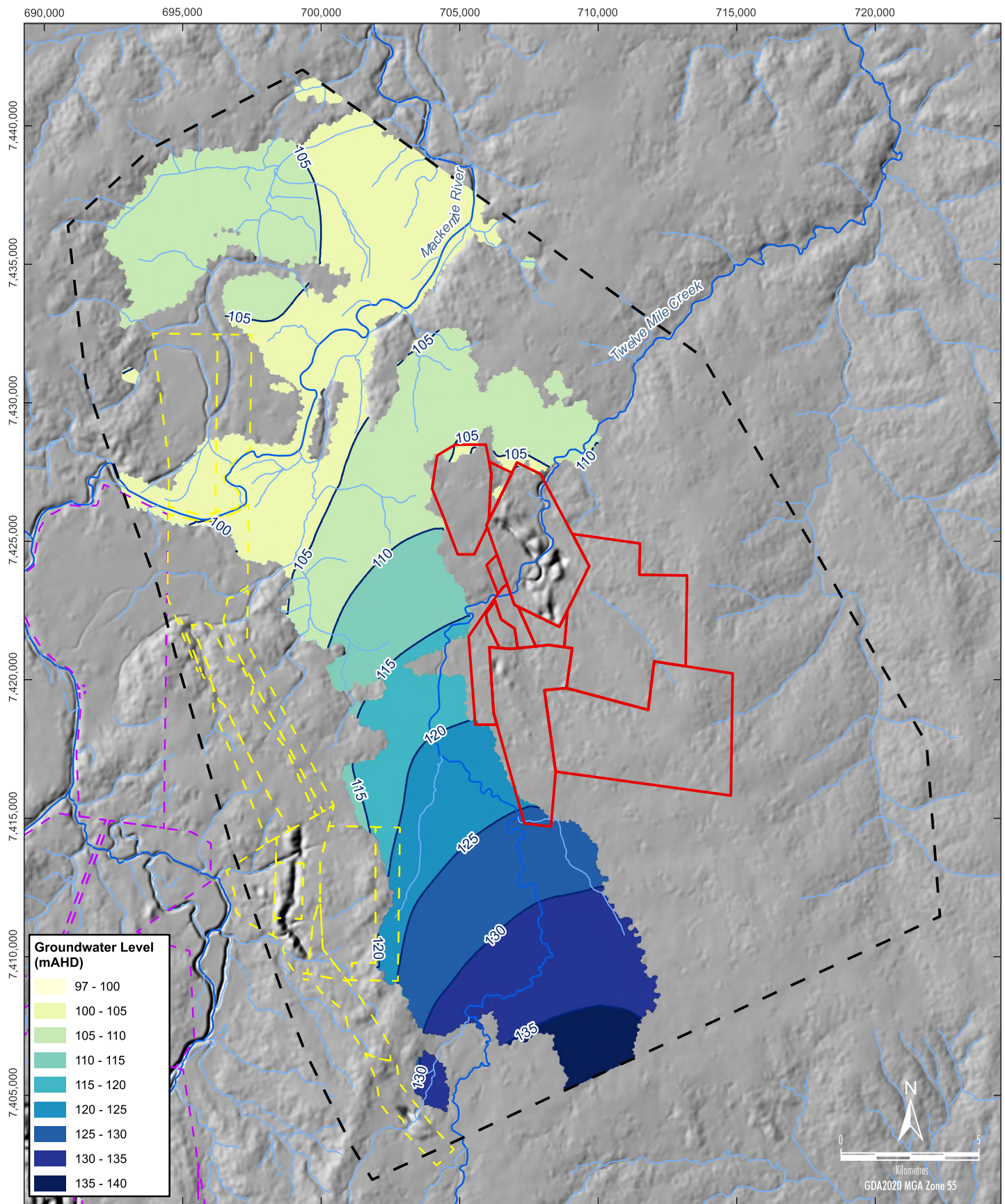


Figure 6-10



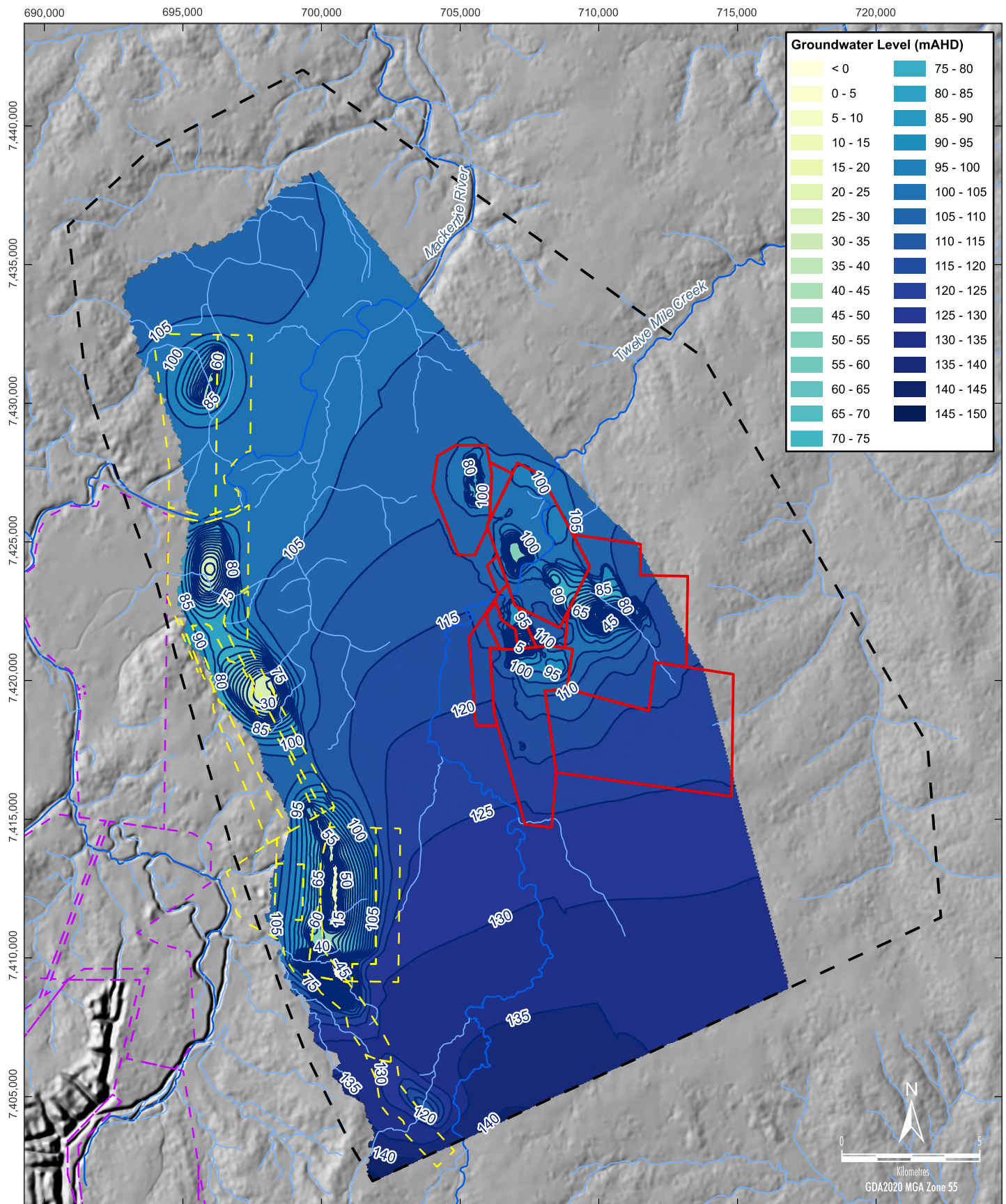
Source: Appendix G - SLR Hydrogeology Assessment



YARRABEE COAL MINE

Simulated Water Level
in the Alluvium (L2) and Basal Sands (L3)
End of Calibration

Figure 6-11



LEGEND

- Major Watercourse
- Minor Watercourse
- Groundwater Level Contour (mAHd)
- Yarrabee Mining Lease
- Curragh Mine Area
- Jelinbah Mine Area
- Model Domain

Source: Appendix G - SLR Hydrogeology Assessment



YARRABEE COAL MINE

Simulated Water Level in the RCM (L9)
End of Calibration

Figure 6-12

6.2.7.4 Model Set Up

Future mining at both Yarrabee Mine and Jellinbah Mine was simulated to predict groundwater conditions at the end of mining. Following this, simulation of the post-mining groundwater recovery period was undertaken. The pits at Jellinbah Mine were simulated as being backfilled with spoil, as information regarding the post-mining landform was not available.

Climate related BC such as recharge and evapotranspiration, were set at long term averages for the duration of the predictive simulation.

The transient post-mining recovery period commences at the end of mining in approximately 2052 and continues until 2600, covering a period of 548 years. The transient recovery period consists of annual stress periods until January 2060 and subsequently every five years to every 100 years for the remainder of the transient post-mining period. This was followed by a single steady-state stress period of 1000 years, to simulate the equilibrium condition at the end of the post-mining period and allow particle tracking to run for an extended period.

The Yarrabee Mine final landform was replicated in the model, including areas of spoil within mined out pits and residual voids.

At the end of mining, all drain cells which represent pit dewatering in areas of active mining were removed from the model. To simulate free water movement within the residual void, the properties of the residual void cells were assigned high horizontal and vertical hydraulic conductivities (1,000 m/d) and a specific yield of 1.0. Areas of spoil were represented using horizontal conductivity of 0.3 m/day and vertical hydraulic conductivity of 0.1 m/day. Specific yield of 0.05 m/day and specific storage of 1×10^{-5} were applied to the spoil, within the bounds described by MER (2009).

It is suggested that recharge rates ranging from 1% to 5.5% of long-term rainfall prevail in rehabilitated soil profiles (spoil) exhibiting stability (MER, 2009). To represent this higher recharge over spoil, an enhanced recharge factor of 3.5 was applied, resulting in a recharge rate of approximately 5.5% of long-term rainfall.

Two transient predictive recovery scenarios have been developed, to enable the assessment of cumulative impacts:

- PRCP scenario – historical and planned mining at Yarrabee Mine and Jellinbah Mine and the post-mining landform at Yarrabee Mine.
- Null scenario – no mining within the region anytime (past, current or future).

6.2.8 Residual Void Water Balance

Recovering groundwater levels, rainfall, runoff, and drainage of rainfall infiltration through the spoil may result in and the formation of water bodies within the residual voids. Whilst the numerical groundwater model can simulate the groundwater inflow component, direct rainfall, runoff, and evaporative loss from the void water body, are more accurately accounted for within the residual void hydrology assessment completed by Engeny (Appendix P). The components of the residual void water balance in the post-mining model are presented in Figure 6-13.

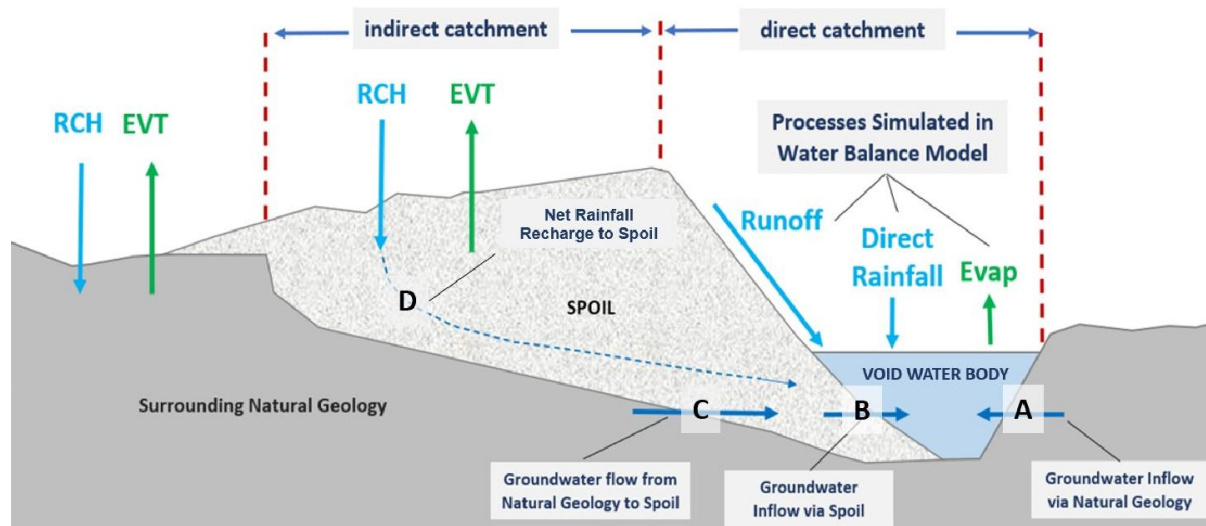


Figure 6-13: Components of the Void Water Balance (Appendix G)

The groundwater model was used to predict the components of groundwater flux to the residual voids:

- groundwater inflow from the natural geology directly to the residual void (A);
- groundwater inflow to the residual void from the spoil backfill (B, comprising components C and D);
- groundwater inflow from the natural geology to the spoil backfill (C); and
- groundwater inflow originating from areas of spoil backfill that receive rainfall recharge that then flows through the spoil into the residual void (indirect catchment) (D).

The surface water balance model developed by Engeny (Appendix P) estimated the void water body levels, utilising direct rainfall and rainfall runoff from the surrounding landform catchment against the evaporation loss from the void water body, as well as nominal estimates for groundwater inflow. Initial predictions of post-mining equilibrium groundwater levels were derived from the groundwater model, independent of the surface water balance modelling, to assess the connectivity between the water body levels predicted by Engeny (Appendix P) and the post-mining groundwater system predicted by the groundwater model. This process is detailed in the Technical Modelling Report (Appendix H).

Typically, final void equilibrium water body levels would be arrived at through an iterative process utilising both the groundwater and the surface water models. This process has not been undertaken and subsequently, it is considered that the two independent estimates provide a minimum and maximum range of final equilibrium water body levels. With Engeny (Appendix P) providing an estimate of the minimum and this groundwater assessment providing the maximum.

A summary of the equilibrium water body levels is presented in Table 6-5, which demonstrates that the void water body levels are typically below the pre-mining groundwater levels and well below the void spill elevations. However, CE-North is an exception to this, as the minimum elevation for the void is above the saturated water table and no water body is predicted by the groundwater model to form. Recovery curves for water levels within the final voids are presented in Appendix H. Equilibrium water body levels predicted by Engeny (Appendix P) are lower than the groundwater model predictions. This indicates that final equilibrium water body levels that would be generated as a result of combining the two models would be lower than those predicted by the groundwater model.

Table 6-5: Approximate Equilibrium Conditions for Residual Voids at Yarrabee Mine

Residual Void	Spill Elevation (mAHD)	Minimum Elevation of Void (mAHD)	Fill Time to Equilibrium Level (years) ¹	Equilibrium Void Water Level (mAHD) ²	Approximate Pre-mining Groundwater Level (mAHD)	Freeboard (m) ⁴	Median EC after 100 years (µS/cm) ⁵
DOM5	134.4	64.6	129.0	79.5	109 - 113.5	54.9	>300,000
DOM6	133.6	83.9	23.0	100.6	112.5	33.0	220,300
A-Pit	129.8	61.2	235.0	86.2	112 - 114.5	43.6	293,100
CE-North ³	129.2	110.4	3.0	113.5	112.5 - 113	15.7	1,700
DOM2N	139.7	-22.9	367.0	68.4	116 - 118	71.3	182,200
DOM2S	141.6	68.8	144.0	99.4	119 - 123	42.2	>300,000
YEN-Pit	138.8	-50.8	367.0	48.1	115 - 119	90.7	178,400
YES-Pit	146.3	-30.3	368.0	52.0	120.5 - 124.5	94.3	186,000

Source: (Appendix G).

1 Fill time derived by Engeny surface water balance model (Engeny, 2025).

2 Median void water body levels at post-mining equilibrium predicted using the Engeny surface water balance model and void groundwater fluxes from the SLR groundwater model.

3 The base of the CE-North void is above the post-mining saturated water table. The formation of a water body in this void and its level is predicted entirely by the Engeny surface water model i.e. there is no groundwater inflow component. This water body is represented in the groundwater model as an applied recharge rate representing leakage of the void water body through the base of the void.

4 Freeboard is the remaining depth of void between the predicted median equilibrium water body level and the void spill level.

5 EC estimates derived using the Engeny surface water balance model (Engeny,2025).

6.2.9 Residual Void Groundwater Flux

The predicted total inflow to the residual void is the sum of the components discussed above. The total inflow to the residual void includes both groundwater from surrounding natural geology, and through-flow of rainfall recharge to the spoil (the sum of A and B). The inflow to the voids of groundwater from the surrounding geology is the sum of A and B subtract D.

The predicted post-mining equilibrium flux to each residual void is presented in Table 6-6, including the contributions to inflow from each component as described above and presented in Figure 6-13. Negative numbers represent outflow and positive numbers represent inflow.

Total fluxes presented for DOM6, DOM2S and CE-North indicate a predicted net loss of water from the void to the surrounding groundwater system at post-mining equilibrium. At CE-North, the predicted outflow of 53.6 m³/d represents leakage of the void water body through the base of the void which is above the saturated water table. At DOM6 and DOM2S the predicted net outflows of 231 m³/d and 218 m³/d respectively indicate water entering the surrounding groundwater system from the spoil and void water body. The elevation of these two voids and the predicted final water body level is significantly higher than other neighbouring voids resulting in a hydraulic gradient from these voids towards the stronger sinks of the neighbouring voids.

At DOM5, A-Pit, DOM2N, YEN-Pit and YES-Pit, the net flux at equilibrium is positive indicating that the final voids act as sinks with respect to groundwater. The net inflow to the A-Pit void at equilibrium is small due to a predicted outflow of water from the spoil to natural geology.

Table 6-6: Yarrabee Mine Final Void Water Body Levels and Groundwater Flux at Equilibrium

Void Inflow Component	Predicted Equilibrium Void Inflows (m ³ /d)							
	DOM5	DOM6	A-Pit	CE-North	DOM2N	DOM2S	YEN-Pit	YES-Pit
A – Groundwater inflow directly to void from natural geology	230	-31.8	8.9	0	395	-66.9	191	90
B – Total spoil drainage to void	430	-199	92.1	-53.6	467	-151	967	719
C – Groundwater inflow to spoil from natural geology	398	-206	-61.9	-106	270	-244	257	519
D – Net rainfall to spoil draining to void	32.6	0	92.1	0	197	0	710	201
Total flux to void (A+B)	660	-231	101	-53.6	862	218	1,158	809
Total groundwater flux to void, excluding spoil recharge infiltration (A+B-D)	627	-231	8.9	-53.6	665	-218	448	608

Source (Appendix G).

Note: Whereby the components listed above represent those illustrated in Figure 6-13:

A – groundwater inflow directly to the void from adjacent natural geology.

B – total drainage to the void from spoil in the backfilled pitshell.

C – groundwater inflow that has entered the spoil from adjacent natural geology.

D – net rainfall recharge to the spoil draining into the void.

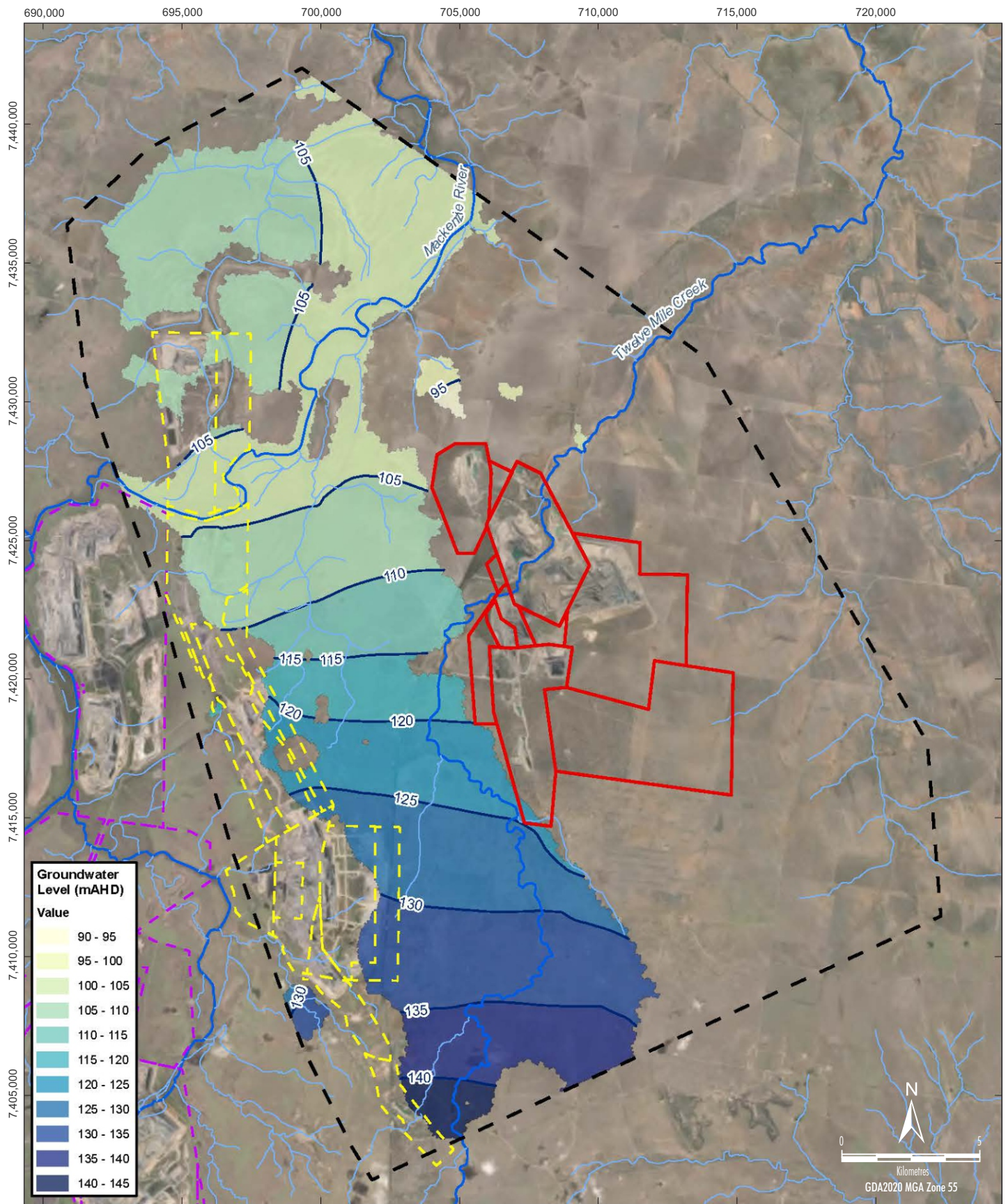
6.2.10 Post-Mining Groundwater Equilibrium

The predicted post-mining equilibrium groundwater table is presented in Figure 6-14. The groundwater levels for the water table are a composite of levels for the shallowest saturated layer across the model domain and therefore reflect water levels in multiple layers across the model. Figure 6-15 presents the predicted equilibrium groundwater levels for the deeper alluvium and basal sands, and Figure 6-16 presents the Lower RCM predicted equilibrium groundwater levels.

Figure 6-14 indicates a clear residual hydraulic gradient towards the residual voids in line with the equilibrium groundwater fluxes, which primarily indicate the residual voids as a whole act as groundwater sinks. The predicted groundwater levels indicate a permanent influence from mining with the residual voids acting as sinks to the groundwater system. The water table in proximity to the residual voids is forecast to remain depressed in the long term as a result of ongoing groundwater discharge to the final voids, governed by void water body elevations which are maintained at low levels by low inflows and continual evaporative losses.

Figure 6-15 indicates that groundwater levels in the alluvium and basal sands across the Mackenzie River floodplain will essentially be the same as pre-mining mining levels. The older alluvium/Tertiary deposits to the west of Yarrabee Mine (adjacent to Jellinbah Mine) show greater saturation in comparison to the end of calibration period and pre-mining conditions. This is due to the simulated backfilling of the pits at Jellinbah Mine for recovery modelling (as the Jellinbah Mine final landform was not available for inclusion in the model), and the higher recharge rates applied to spoil. This results in full recovery of groundwater levels around Jellinbah Mine and increased recharge locally, which increases saturation in the Tertiary deposits to the east.

Figure 6-16 indicate that groundwater levels within the Permian are anticipated to remain depressed in the long term, driven by the low final void water body levels maintained by low inflows and high evaporation rates.



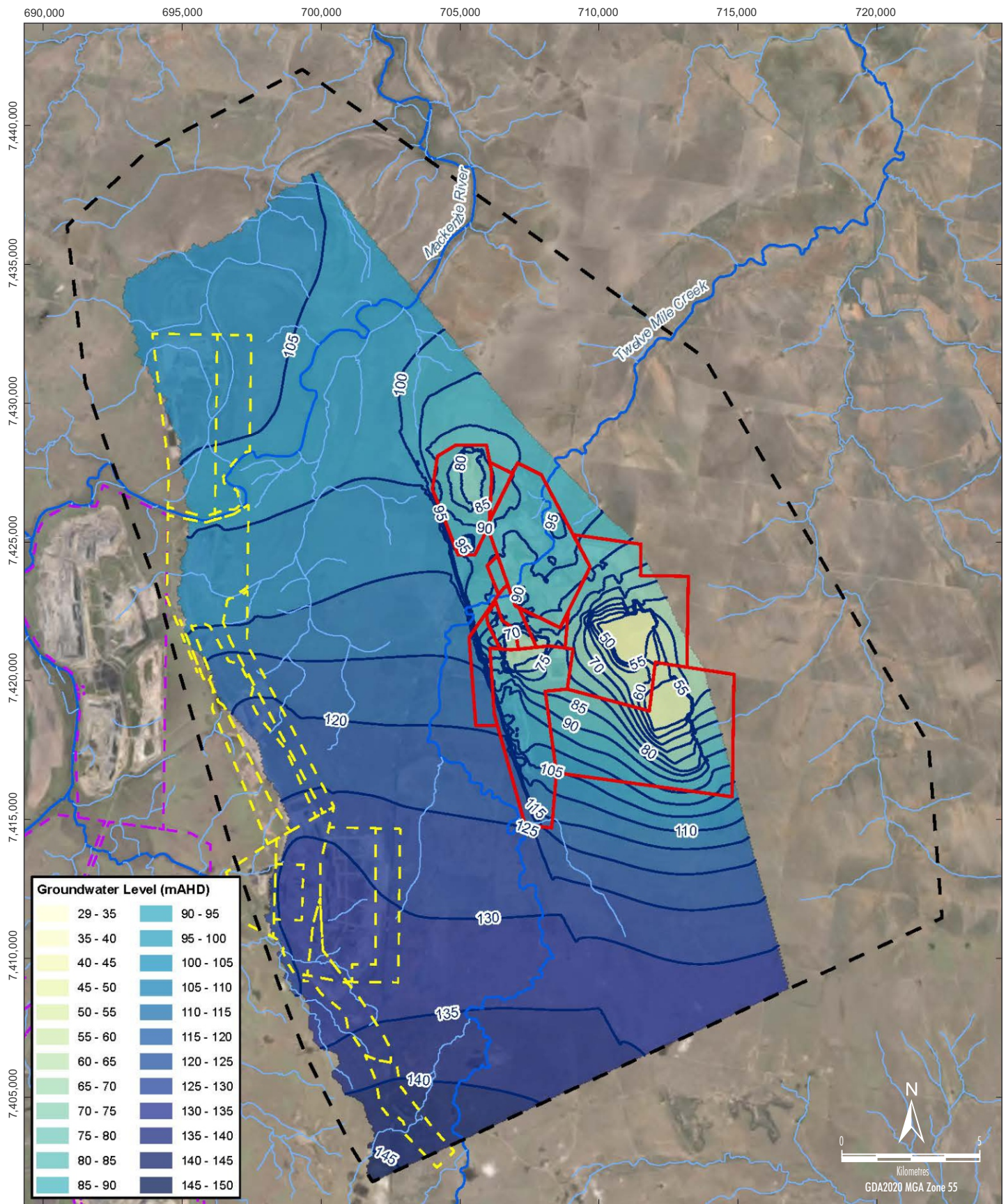
Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd



YARRABEE COAL MINE

Predicted Water Level
in the Alluvium (L2) and Basal Sands (L3)
Post-Mining Equilibrium

Figure 6-14



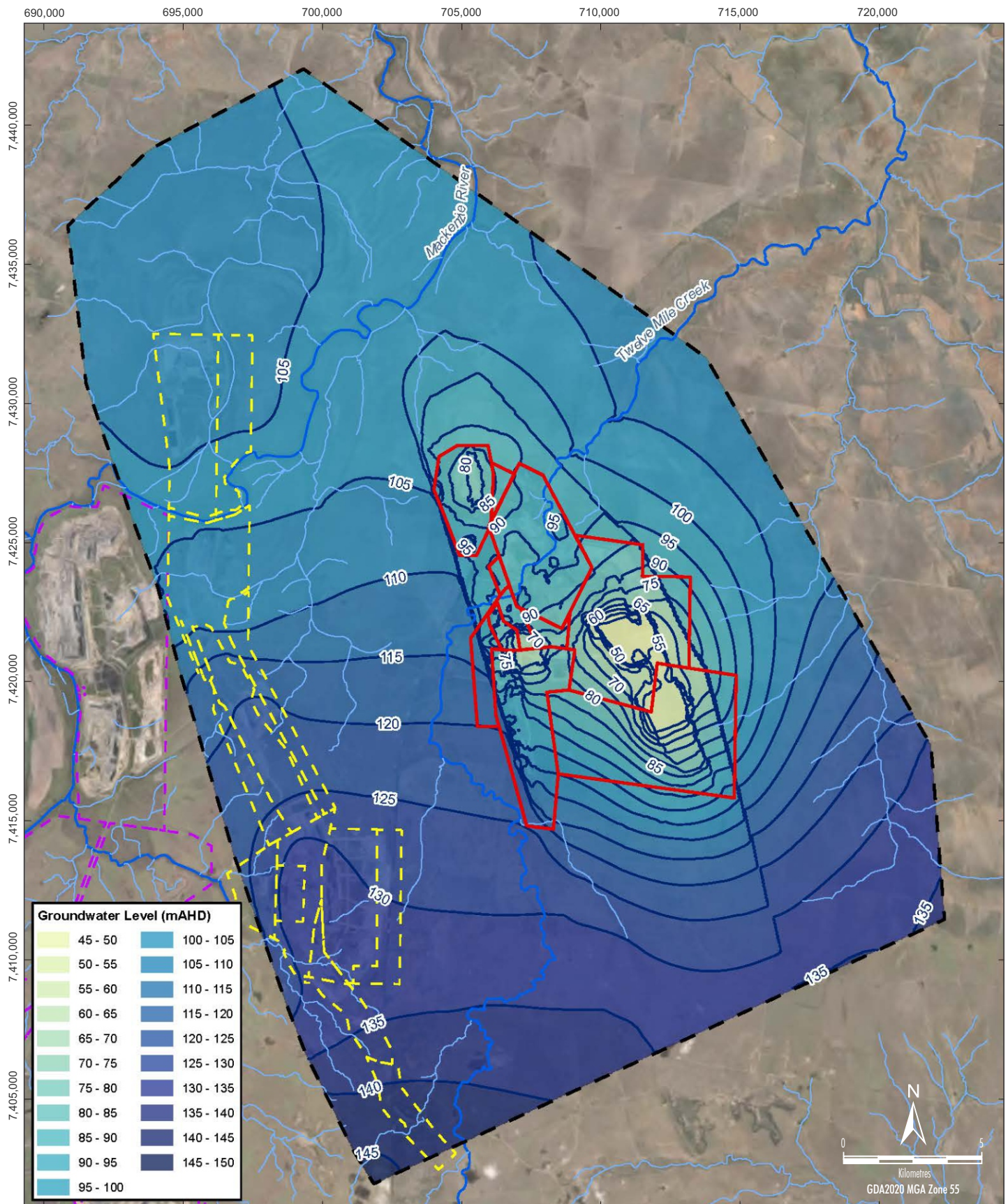
Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd



YARRABEE COAL MINE

Predicted Water Level in the RCM (L9)
Post-Mining Equilibrium

Figure 6-15



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YARRABEE COAL MINE
Predicted Water Table
Post-Mining Equilibrium

Figure 6-16

6.2.11 Post-Mining Equilibrium Residual Drawdown

Residual drawdown is the permanent groundwater level drawdown after groundwater levels recover to long term equilibrium conditions when compared to a scenario without mining.

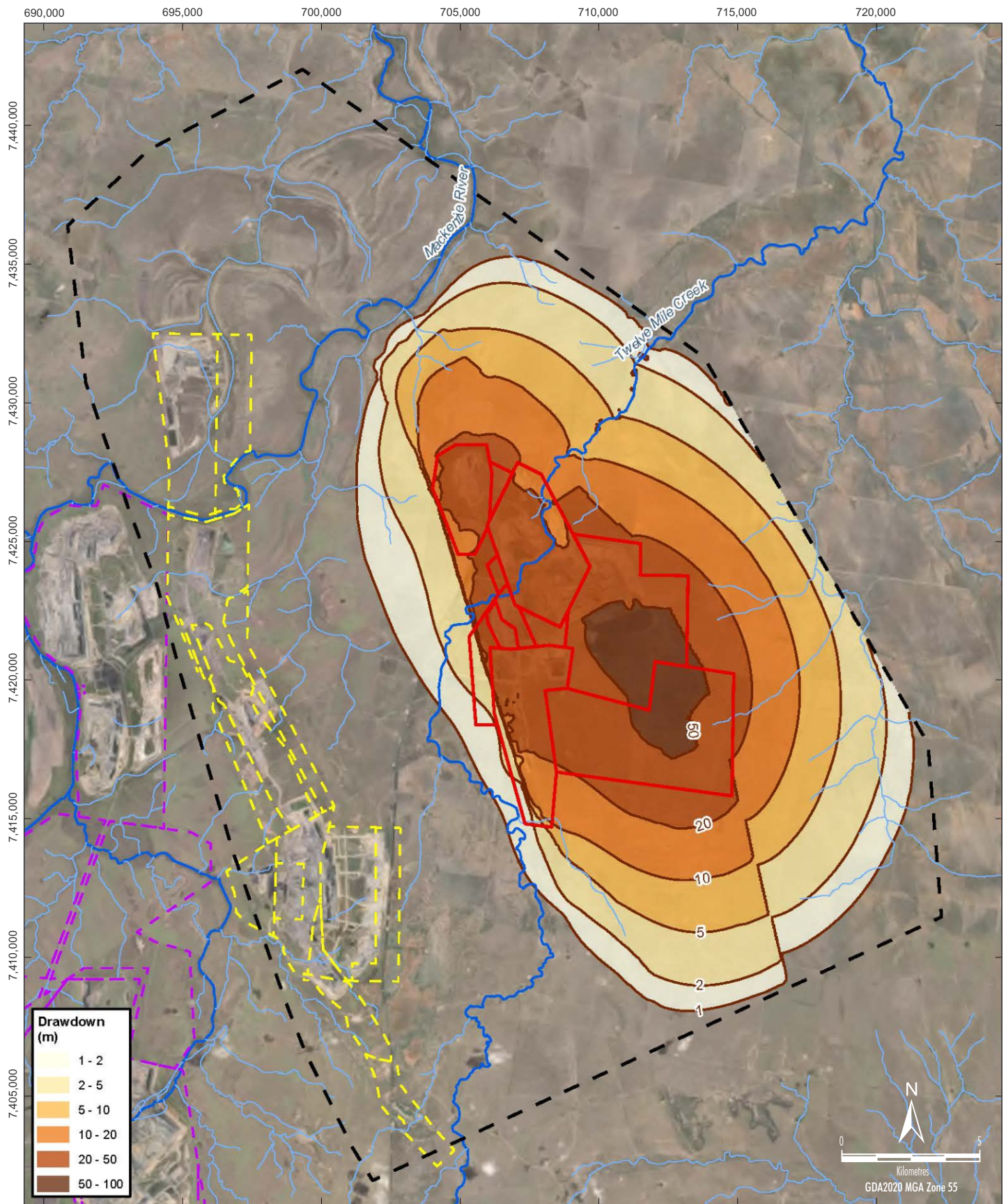
The predicted residual groundwater table drawdown (>1 m) at post-mining equilibrium is presented in Figure 6-17. The predicted water table drawdown is around 20 to 50 m within the immediate vicinity of the residual voids. The following has been determined regarding drawdown surround Yarrabee Mine:

- To the west, beyond the major thrust fault that bounds the RCM, very limited residual drawdown is predicted.
- To the north, drawdown extends approximately 5 km to just south of the Mackenzie River floodplain.
- To the east, the residual drawdown is predicted to extend 5 km.
- To the south, drawdown is predicted to extend approximately 8 km.

It is noted that the predicted residual drawdown extends out to the eastern and southern model boundaries.

As presented in Figure 6-18, residual drawdown is expected in the deeper alluvium and basal sands. No residual drawdown is predicted across the Mackenzie River floodplain, however some residual drawdown predicted in the deeper Late Tertiary alluvium immediately west and up to 4 km north of Yarrabee Mine.

Residual drawdown in the lower RCM (layer 9 of the model) extends 8 km south, towards the model boundary, and 5 km north, just short of the Mackenzie River floodplain. Residual drawdowns in the order of 50 to 20 m are predicted around the residual voids, reducing towards the full extent of residual drawdown. To the west of Yarrabee Mine residual drawdown in the lower RCM is limited (>1 m) and predicted extend no more than 3 km.



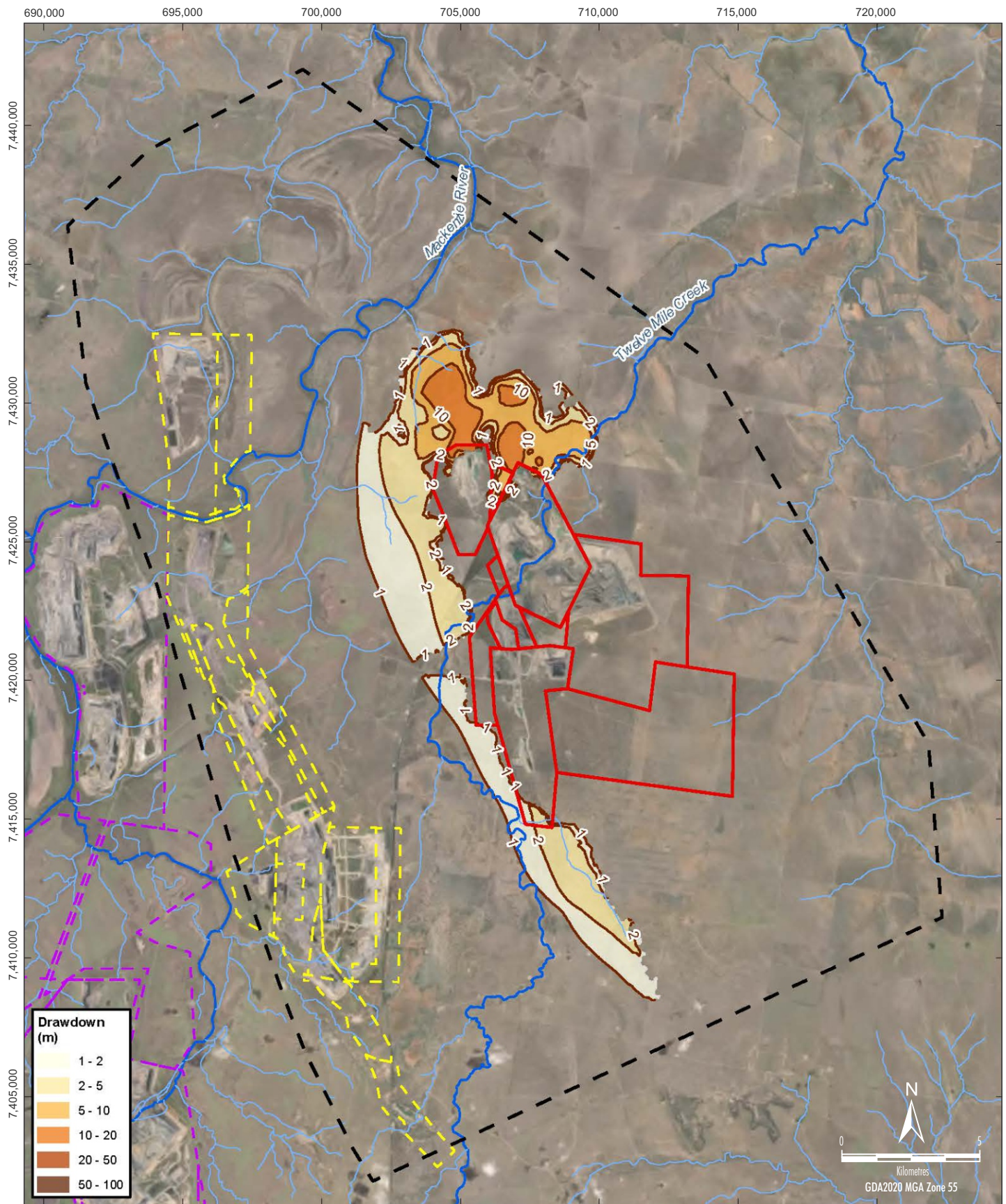
Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd



YARRABEE COAL MINE

Water Table Residual Drawdown at
Post-Mining Equilibrium

Figure 6-17



LEGEND

- Major Watercourse
- Minor Watercourse
- Groundwater Level Contour (mAHD)
- Yarrabee Mining Lease
- Curragh Mine Area
- Jelinbah Mine Area
- Model Domain

Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd



YARRABEE COAL MINE
Alluvium (L2) and Basal Sands (L3)
Residual Drawdown at Post-Mining Equilibrium

Figure 6-18

6.2.12 Post-Mining Flow Path Equilibrium

Particle tracking was undertaken to illustrate the post-mining movement of groundwater around the final voids using mod-PATH3DU (MP3DU) (S.S. Papadopoulos & Associates, Inc., 2018). Particle tracking can be considered as the advection component contributing to solute transport and thus can assist with identifying potential flow paths of contaminants.

Particles were placed around the final voids and throughout the in-pit and out of pit spoil emplacements represented in the recovery groundwater model. MP3DU automatically transfers the particles to the shallowest saturated layer at the commencement of the simulation. It then simulates the movement of the particles through the groundwater flow field, utilising the transient head outputs from the groundwater flow model. Around much of the model the shallowest saturated layer is Permian, as the upper model layers of the model are largely unsaturated at the end of mining and start of recovery.

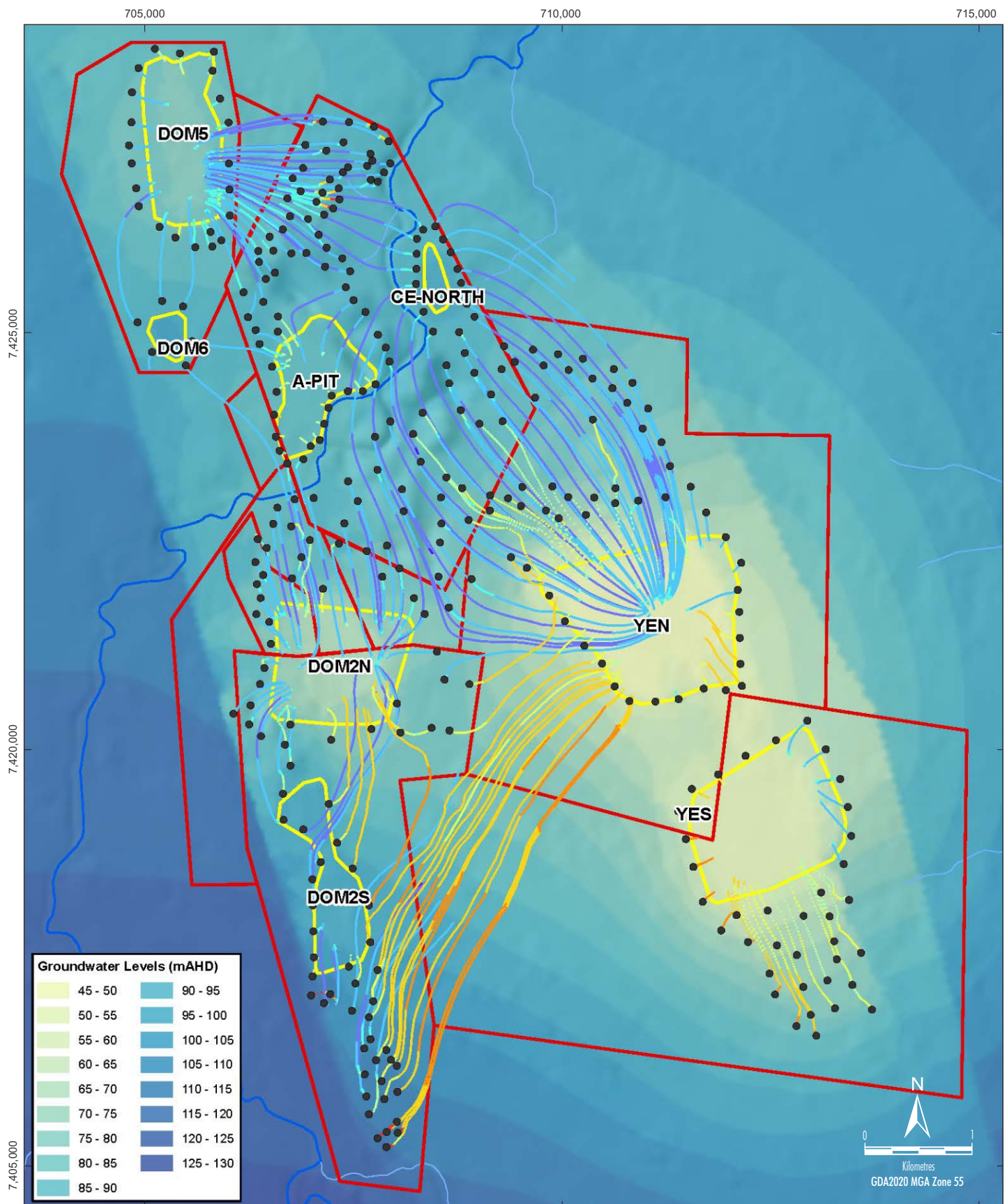
Two particle tracking simulations were run for Yarrabee Mine, one with particles released at the start of recovery and one with particles released at the end of recovery when groundwater levels have equilibrated.

Figure 6-19 shows particle tracks for particles released at the end of groundwater recovery i.e. at post-mining equilibrium. The flow paths indicate that groundwater around the mine is captured by the voids and that the particles then typically terminate within the voids through evaporative loss of water.

The DOM2S, DOM6 and CE-North voids all have a net outflow of water and as expected particle tracking shows the loss of water from these voids and an outward migration of particle tracks. However, this groundwater is then captured by other voids with low water body levels which act as stronger groundwater sinks. Water lost from DOM2S is captured by the YEN-Pit and DOM2N. The small DOM6 void loses water to the DOM5 void to the north and the A-Pit void to the east, and the outflow from the CE-North water body (which sits above the saturated water table) migrates south to YEN-Pit and north-west towards the DOM5 void. The DOM2 and YEN-Pit voids towards the centre of the site have two of the lowest void water body levels and act as strong groundwater sinks with DOM5 acting as a local groundwater sink at the northern end of the site.

The particle tracking shows that as a whole the site acts as a groundwater sink at the end of groundwater level recovery with no off-site migration of groundwater. Where there is outward migration of water from final void water bodies this groundwater is captured by neighbouring voids. The end of recovery water table in the immediate vicinity of the mine is depressed and well below the invert level of Twelve Mile Creek where it crosses the mine. Consequently, particles migrating west from CE-North are predicted to pass under the creek rather than “daylight” in the creek. Particles released over the large areas of out of pit spoil are all captured by the nearest voids.

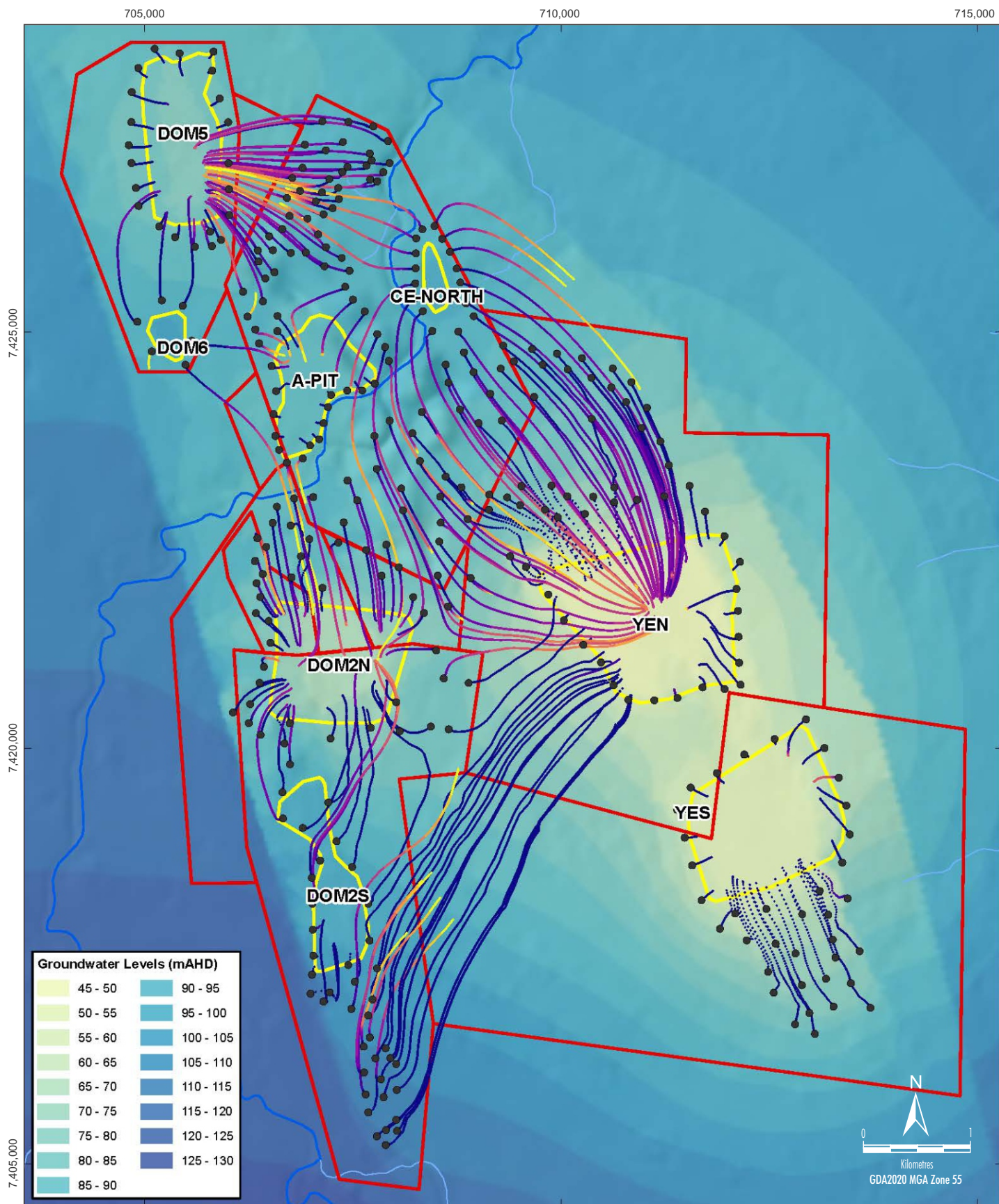
Figure 6-20 shows the travel time of the particles released at the end of recovery. The maximum run time for the particles set within the model is approximately 1,000 years although most particles terminate well before this once, they enter void water bodies. Particles from CE-North reach the maximum or near maximum travel time of 1,000 years without terminating, as do some particles released at the south of DOM2S as they travel north-west to the YEN-Pit void.



Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd

YANCOAL
YARRABEE COAL MINE
Movement of Particles Released at the
End of Recovery (Post-Mining Equilibrium)

Figure 6-19



Source: Appendix G. Groundwater Assessment — SLR Consulting Pty Ltd

YANCOAL
YARRABEE COAL MINE
Travel Time of Particles Released at the
End of Recovery (Post-Mining Equilibrium)

Figure 6-20

6.2.13 Post-Mining Hydrogeological Regime

Numerical modelling of post-mining groundwater recovery at Yarrabee Mine following development of the final landform indicates that:

- Water bodies will form in the residual voids with equilibrium levels stabilising substantially below the pre-mining groundwater elevations. The exception is CE-North which sits above the saturated water table and forms an ephemeral water body depending on rainfall runoff intensity.
- Post-mining residual water table drawdown, exceeding 1 m, will extend to the north, east and south away from the voids, and a limited distance to the west. Residual drawdown will not reach the Mackenzie River floodplain.
- Ongoing drawdown around the voids is driven by low final void water body levels relative to pre-mining groundwater levels, generating ongoing steep hydraulic gradients towards the voids. Evaporative loss will maintain the low water body levels.
- While DOM6, DOM2S and CE-North act as local sources, the remaining voids act as strong groundwater sinks capturing seepage from all spoil emplacements or water seeping from other voids.
- End of post-mining recovery particle tracking indicates that that no migration of water will occur from the residual voids or groundwater from areas around the final voids beyond the immediate vicinity of the mining affected areas.
- Twelve Mile Creek is ephemeral and elevated above the saturated water table. Post closure particle tracking indicates it is unlikely to be a receptor for mining affected groundwater.

The findings of the Numerical modelling did not result in any alterations to the Yarrabee Mine final landform or the proposed rehabilitation techniques detailed throughout this report. A summary of the key predictions from the numerical modelling and information on the final landform is presented in Table 6-7.

Table 6-7: Summary of Key Groundwater Modelling Predictions for Yarrabee Mine Final Voids

Void Inflow Component	DOM5	DOM6	A-Pit	CE-North	DOM2N	DOM2S	YEN-Pit	YES-Pit
Final Void Minimum Elevation (mAHD)	64.6	83.9	61.2	110.4	-22.9	68.8	-50.8	-30.0
Void Crest/Spill Elevation (mAHD)	109 - 113.5	112.5	112 - 114.5	112.5 - 113	116 - 118	119 - 123	115 - 119	120.5 - 124.5
Equilibrium Void Water Level (mAHD) ¹	134.4	133.6	129.8	129.2	139.7	141.6	138.8	146.3
Freeboard (m) ³	79.5	100.6	86.2	113.5 ²	68.4	99.4	48.1	52.0
Total groundwater flux to void, excluding spoil recharge infiltration (m ³ /d)	54.9	33.0	43.6	15.7	71.3	42.2	90.7	94.3

Source: (Appendix G).

1 Median void water body levels at post-mining equilibrium predicted using the Engeny surface water balance model and void groundwater fluxes from the SLR groundwater model.

2 The base of the CE-North void is above the post-mining saturated water table. The formation of a water body in this void and its level is predicted entirely by the Engeny surface water model. This water body is represented in the groundwater model as leakage to the water table through an applied recharge rate.

3 Freeboard is the remaining depth of void between the predicted median equilibrium water body level and the void spill level.

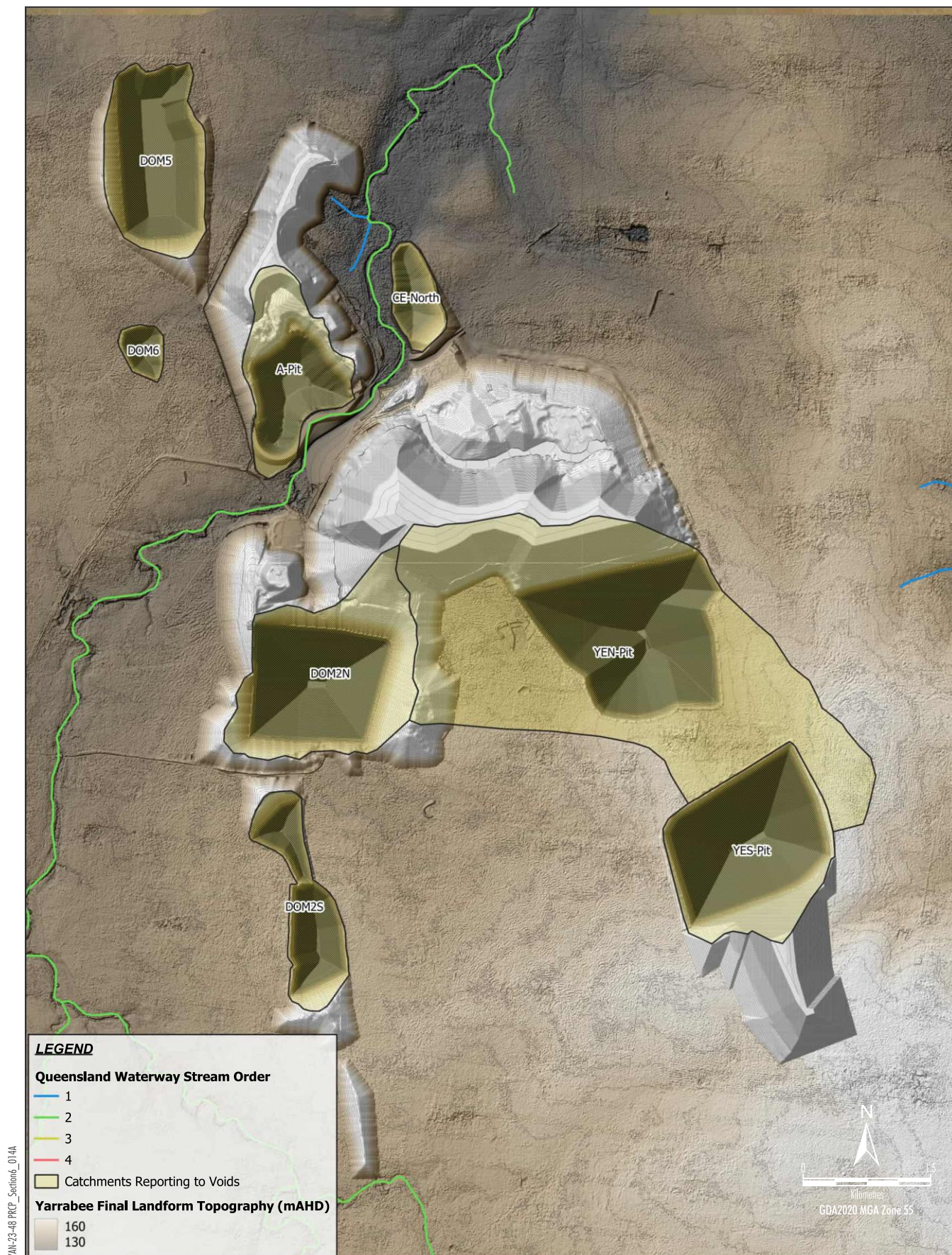
6.3 FINAL LANDFORM FLOOD ASSESSMENT

Engeny undertook a Final Landform Flood Assessment (Appendix I) to inform the development of the Yarrabee Mine final landform. The assessment was undertaken to identify the flood susceptibility of the final landform and ensure that the final landform can withstand a 0.1% AEP flood event. To do so, Engeny developed and calibrated a hydrological model for the Yarrabee Mine final landform and undertook a review of the final landform flood velocities, levels, and risk profiles.

6.3.1 Yarrabee Mine Catchment

As described in Section 2.4, Yarrabee Mine is located in the Mackenzie River catchment which flows into the Fitzroy River ultimately flowing into the ocean at Keppel Bay. Local drainage flows into Twelve Mile Creek which ultimately flows to the Mackenzie River approximately 32 km downstream from Yarrabee Mine. The catchment for Twelve Mile Creek includes several smaller, lower-order streams and creeks.

Catchment areas that drain to the residual voids are illustrated in Figure 6-21. Catchments that drain to residual voids were excluded from the PRCP Flood Assessment. The stream order of waterways within and surrounding Yarrabee Mine are presented in Figure 6-21. The highest stream order waterway within Yarrabee Mine is Twelve Mile Creek, which is a Stream Order 2.



Source: Appendix I - Engenry Final Landform Flood Assessment

Figure 6-21

6.3.2 Hydrological Model

Engeny previously developed a hydrological model for Twelve Mile Creek at Yarrabee Mine (Engeny, 2017). This assessment was updated with the current assessment of Twelve Mile Creek using contemporary modelling software and adopted the runoff routing hydrological modelling software WBNM. The site was assessed for the 50%, 10%, 2%, 1%, 0.1% AEP, and the Probable Maximum Flood (PMF).

6.3.2.1 Hydrologic Model Build

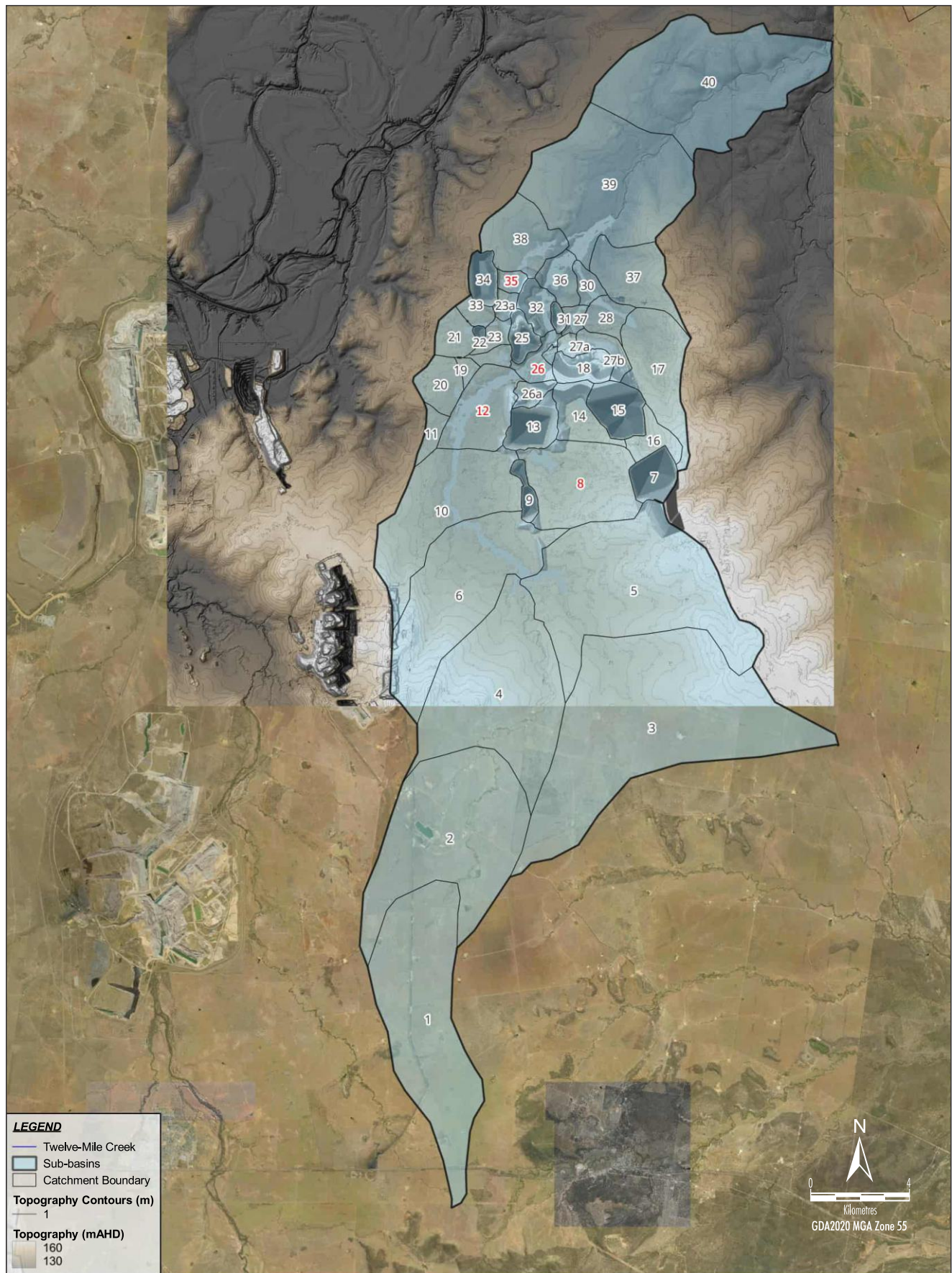
The final landform sub-catchments were generated using the XP-RAFTS catchments from the previous assessment and were updated to reflect the final landform. The site was divided into 44 sub-catchments for Twelve Mile Creek catchment to reflect the topographical impacts of introducing the final landform into the hydraulic model. The sub-catchment layout for the Yarrabee Mine flooding assessment hydrology model is outlined in Figure 6-22.

50%, 10%, 2%, 1% and 0.1% AEP Intensity Frequency Duration (IFD) depths were sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available from the BoM, at Latitude -23.25, Longitude 149.00. Durations assessed ranged from one hour to the 48-hour event, as detailed in Table 6-8.

Table 6-8: Intensity Frequency Duration Depths

Duration (hours)	Rainfall Intensity (mm/hr)				
	50% AEP	10% AEP	2% AEP	1% AEP	0.1% AEP
1.0	36.1	58.1	80.7	91.3	129.0
1.5	26.6	43.1	62.2	71.8	98.6
2.0	21.5	35.6	53.2	62.4	80.9
3.0	15.7	25.9	39.9	47.5	61.0
4.5	11.5	19.2	29.5	35.0	45.9
6.0	9.2	17.8	22.2	25.8	37.5
9.0	6.8	11.3	16.4	18.9	28.5
12.0	5.5	9.3	13.3	17.0	23.3
18.0	4.1	6.9	10.1	12.8	17.8
24.0	3.3	5.7	8.3	10.3	14.6
30.0	2.8	4.9	7.1	8.8	12.8
36.0	2.5	4.3	6.3	7.5	11.3
48.0	2.0	3.5	5.2	6.1	9.24

Source: (Appendix I).



Source: Appendix I - Engeny Final Landform Flood Assessment

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YARRABEE COAL MINE
Hydrologic Model Layout

Figure 6-22

The Probable Maximum Precipitation (PMP) was determined using the *Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (BoM, 2003). PMP rainfall was estimated using the Generalised Short Duration Method (GSDM) for events up to six-hour in duration.

The Revised Generalised Tropical Storm Method (GTSMR) was utilised to estimate PMP rainfall for event durations greater than or equal to 24 hours. Rainfall depth estimates for PMP event durations between the six-hour and 24-hour were interpolated. The derived GSDM and GTSMR PMF rainfall depths assessed in this hydraulic model are presented in Table 6-9.

Table 6-9: Derived Generalised Short Duration Method and Revised Generalised Tropical Storm Method Rainfall Depths

Duration (hours)	Rainfall Depth (mm)	Intensity (mm/hr)
1.0	250	250
1.5	330	220
2.0	380	190
2.5	430	172
3.0	470	157
4.0	530	133
5.0	570	114
6.0	610	102
9.0	680	76
12.0	740	62
18.0	870	48
24.0	1000	42

Source: (Appendix I).

Ten temporal patterns ensembles were simulated for each design storm AEP and storm duration as recommended by *Australian Rainfall and Runoff: A Guide to Flood Estimation* (Commonwealth of Australia [Geoscience Australia], 2019) (ARR 2019). Temporal patterns for 50%, 10%, 2%, 1% and 0.1% AEP design storms were adopted from the ensemble Areal and East Coast North point temporal patterns. As the total catchment exceeds 100 km², durations equal to or longer than 12 hours were assessed using the areal temporal patterns. For PMF events, the full historical ensemble of ten temporal patterns (plus the Average Variability Method pattern) was simulated.

The areal reduction factor (ARF) is a multiplier applied to the design rainfall to account for increased spatial variability over larger catchments. ARF is calculated using region specific parameters and the total catchment area upstream of the study area (Yarrabee Mine). Calculation of storm ARF within the Yarrabee catchments were based on the methodology for catchments between 10 km² and 1,000 km² in accordance with ARR 2019 recommendations, using ARF parameters for the East Coast North zone and a catchment area of approximately 412.56 km². Design values of 33.0 mm for initial loss and 0.8 mm/hr for continuing loss were utilised for the 50%, 10%, 2%, 1%, 0.1% events and 1.0 mm and 0.0 mm/hr for the extreme events (PMF).

Validation of the peak flows produced by the hydrologic model against industry standard methods were completed prior to simulation of the hydraulic model. To validate peak flow estimates multiple validation methods were determined to be appropriate:

- Peak flows derived from the previous Twelve Mile Creek assessment undertaken using XP-Rafts for the hydrological aspect of the study.
- Queensland Urban Drainage Manual (QUDM) derived rational method. Utilised for estimating peak discharge of runoff from a catchment above a specific point, calculated using peak discharge, rainfall intensity for the selected period, runoff coefficient, and catchment area.
- Quantile Regression Technique (Palmen and Weeks, 2011) – Department of Main Roads Quantile Regression Technique is a validation method of peak flow estimations for rural catchments up to 1,000 km.
- Regional Flood Frequency Estimation Model (RFFE) (ARR 2019) – Provides peak flow estimation based on catchment area and a catchment shaping factor, determined by using the catchment centroid and outlet coordinates.

Flood Frequency Analysis was undertaken using data from the Blackwater Creek at Curragh Gauge (130108A). Gauge 130108A is located upstream of Yarrabee Mine at Curragh mine and has been in operation since 1972, with flows recorded up to 2008. A summary of the yearly maximum peak flows recorded is provided in Figure 6-23.

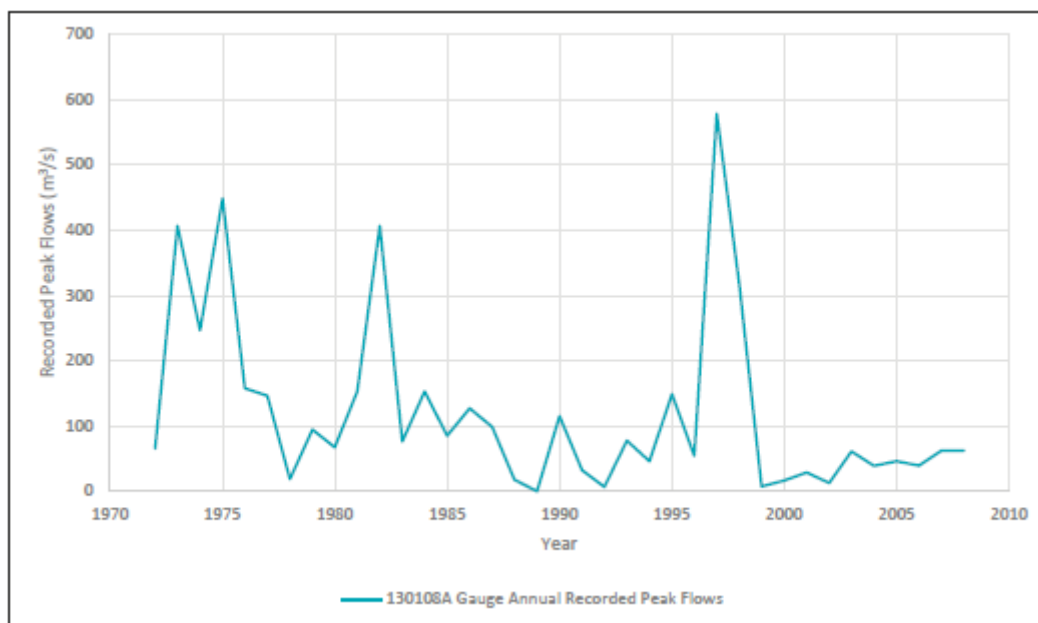


Figure 6-23: 130108A Gauge Annual Recorded Peak Flows (Appendix I)

The RFFE predicted peak flows and confidence limits are outlined in Table 6-10. Whilst the RFFE method can provide an indication of the expected flows for a given catchment, it is not considered to be applicable for catchments greater than 1,000 km². The Yarrabee Mine catchment areas is 412.7 km² and therefore is considered to be within the range of acceptable area.

Table 6-10: Regional Flood Frequency Estimation

AEP (%)	Discharge (m ³ /s)	Lower Confidence Limit (5%) (m ³ /s)	Upper Confidence Limit (95%) (m ³ /s)
1	809.0	203.0	3230.0
2	620.0	176.0	2190.0
10	299.0	110.0	823.0
50	96.4	36.7	255.0

Source: (Appendix I).

6.3.2.2 Hydrologic Model Validation Results

A validation of WBNM peak flow estimates was undertaken against the previous XP-RAFTS modelling (Engeny, 2017), Scaled Flood Frequency, QRT and RFFE estimates. The outcome of the validation process at the downstream end of the Twelve Mile Creek Diversion (sub-catchment 26) is outlined in Table 6-11.

Table 6-11: Hydrology Model Validation Peak Flows – Catchment 26

AEP (%)	WBNM Peak Flow (m ³ /s)	Quantile Regression Technique (m ³ /s)	RFFE Peak Flow Estimate (m ³ /s)	Scaled FFA Peak Flow Estimate (m ³ /s)	XP-RAFTS – Previous Model (m ³ /s) (Engeny, 2017)
0.1	1307.0	-	-	862.0	1196.0
1	781.0	903.0	809.0	430.0	679.0
2	623.0	715.0	620.0	328.0	-
10	374.0	328.0	299.0	149.0	-
50	138.0	75.5	96.4	38.0	-

Source: (Appendix I).

The model validation indicated the WBNM modelled peak flows were quite conservative relative to the scaled FFA and slightly higher than the previous XP-RAFTS modelling. However, the WBNM flows compared well to QRT and RFFE (i.e. within 15%). The RFFE used a large number of coastal catchments which may have influenced the estimates.

The WBNM model results were considered to be on the higher side because the Twelve Mile Creek catchment is very flat and long with large floodplain storage, and the hydrology response may not be represented by the default WBNM parameters. However, as the peak flows compared well against RFFE, QRT and previous XP-RAFTS and were conservative relative to scaled FFA, the model parameters were not refined.

6.3.3 Hydraulic Model

Flood Modelling for Yarrabee Mine was undertaken using the 1 Dimensional/2 Dimensional (2D) software TUFLOW to quantify behaviour and characteristics of Twelve Mile Creek. The PRCP flooding assessment was completed to meet the flooding requirements of Section 3.6.1 General Rehabilitation Practices within the PRCP Guideline (ESR/2019/4964, Version 3.01) which is required where flooding is a consideration for the site.

6.3.3.1 Hydraulic Model Build

The hydraulic model extent was delineated to capture the Yarrabee Mine ML boundaries, and all relevant flow paths upstream, downstream and throughout the final landform. A cell size of 5 m was selected to allow for detailed representation of the natural watercourses and onsite drainage features. To ensure accurate representation of waterways, this was paired with TUFLOWS Sub-Grid-Sampling (SGS) methodology, which samples each model cell at a finer resolution (1 m) and builds a surface area/volume curve for them. This ensured that regardless of the uniform elevation each cell is assigned, that TUFLOW accurately understands the storage potential of each cell.

The Digital Elevation Model for Yarrabee Mine and the contributing upstream catchment were developed based on:

- The Yarrabee Mine PRCP final landform, provided at 1 m resolution.
- 1 m LiDAR topographic survey of Yarrabee Mine captured in 2023.

Boundary Conditions

BC are required in the model to define terrain hydrology inflows and outflows. The inflow BC used Source-Area (SA) and BC type boundaries, allocating flow to the defined model grid cells based on the modelled hydrograph from the WBNM hydrologic model (flow vs time) input. BC inflow lines were used to apply total inflow hydrographs for Twelve Mile Creek and its tributaries at the upstream model boundaries, for areas that were not included in the hydraulic modelling. SA polygons were used to apply local inflow hydrographs for individual sub-catchments along Twelve Mile Creek and associated confluences with joining tributaries within the model extent.

The outflow BC for the Yarrabee Mine model were represented as a normal depth based on low flow channel grades at the downstream extent of the model, outflow boundaries for voids and breakout locations during the PMF.

The downstream boundary is located a sufficient distance downstream of Yarrabee Mine to not influence the flood behaviour onsite. The downstream boundary was applied to the TUFLOW model to allow flow to exit the model area. Outflow boundaries for pits were also applied to allow inflow into the voids (if any) to exit the model to prevent inconsistencies in model duration with flows into voids recorded with plot output lines along the perimeters of the voids.

An additional outflow boundary condition was applied to an area of the western side of the code extent to allow breakout during the PMF event to ensure the results were representative of realistic results.

Hydraulic Roughness

The Manning's roughness coefficients used in the model were based on visual observation of aerial photography of the site. The Manning's Roughness coefficients used in this model are outlined in Table 6-12. Some mine infrastructure will be retained in the final landform and was present within the flooding assessment.

Table 6-12: Adopted Hydraulic Roughness Values

Land Use Category	Manning's Roughness (n)
Waterbody/Pits	0.020
Mine Areas	0.035
Light Riparian Vegetation	0.040
Medium Riparian Vegetation	0.060
Dense Vegetation	0.070

Source: (Appendix I).

Pit Ingress Protection, Drains and Diversions

A review of the Final Landform, and flood modelling results indicated additional updates to drainage and void flood protection infrastructure were required to avoid runoff collecting within the residual voids and to redirect surface water flows around the residual voids in the final landform. The redirection of runoff towards waterways was achieved within the hydraulic model by assuming the implementation of flood protection landforms and drainage channels/diversions.

The Twelve Mile Creek Diversion structure with associated flood protection landform for A-Pit was incorporated into the final landform flooding assessment. Additional minor modifications to the landform surface included:

- Removal of agreed haul-roads that will be rehabilitated at closure.
- Removal of haul road safety bunds that would be removed during large overtopping floods.
- Drainage structure between DOM2S and DOM2N.
- Updates to drainage between DOM5 and Twelve Mile Creek.
- Drain on southern side of CE-North.

6.3.3.2 Hydraulic Model Simulations

The 50%, 10%, 2%, 1% and 0.1% AEP design flood events and PMF were simulated using design event hydrographs from the WBNM hydrology model for the final landform. The flood model results were used to assess the performance of the final landform, including:

- Residual void flood protection/immunity.
- The long-term stability of creek diversions and drainage features.
- Stability of other landform domains (e.g. reshaped spoil dumps, roads, and infrastructure areas).
- Identification of any unacceptable flooding outcomes.

6.3.4 Flood Assessment

Flood risks were assessed based on flood model results for the 50%, 10%, 2%, 1% and 0.1% AEP design flood events and the PMF. 0.1% AEP flood mapping results are shown in Figure 6-24 and Figure 6-25. All other flood mapping results for depth and velocity are shown in Appendix A of Appendix I.

The AEP and PMF events were assessed to determine the flood ingress risk to residual voids within the final landform. Table 6-13 shows immunity levels for each of the voids. Flood ingress was assessed against EA requirements with all voids meeting or exceeding the EA requirement of 0.1% AEP flood immunity with seven voids achieving PMF immunity from Twelve Mile Creek and surrounding waterways.

Table 6-13: Void Immunity

Void	Immunity Level
DOM2S	PMF
DOM2N	PMF
YES-Pit	PMF
YEN-Pit	PMF
A-Pit	PMF
DOM6	0.1% AEP
CE-North	PMF
DOM5	PMF

Source: (Appendix I).

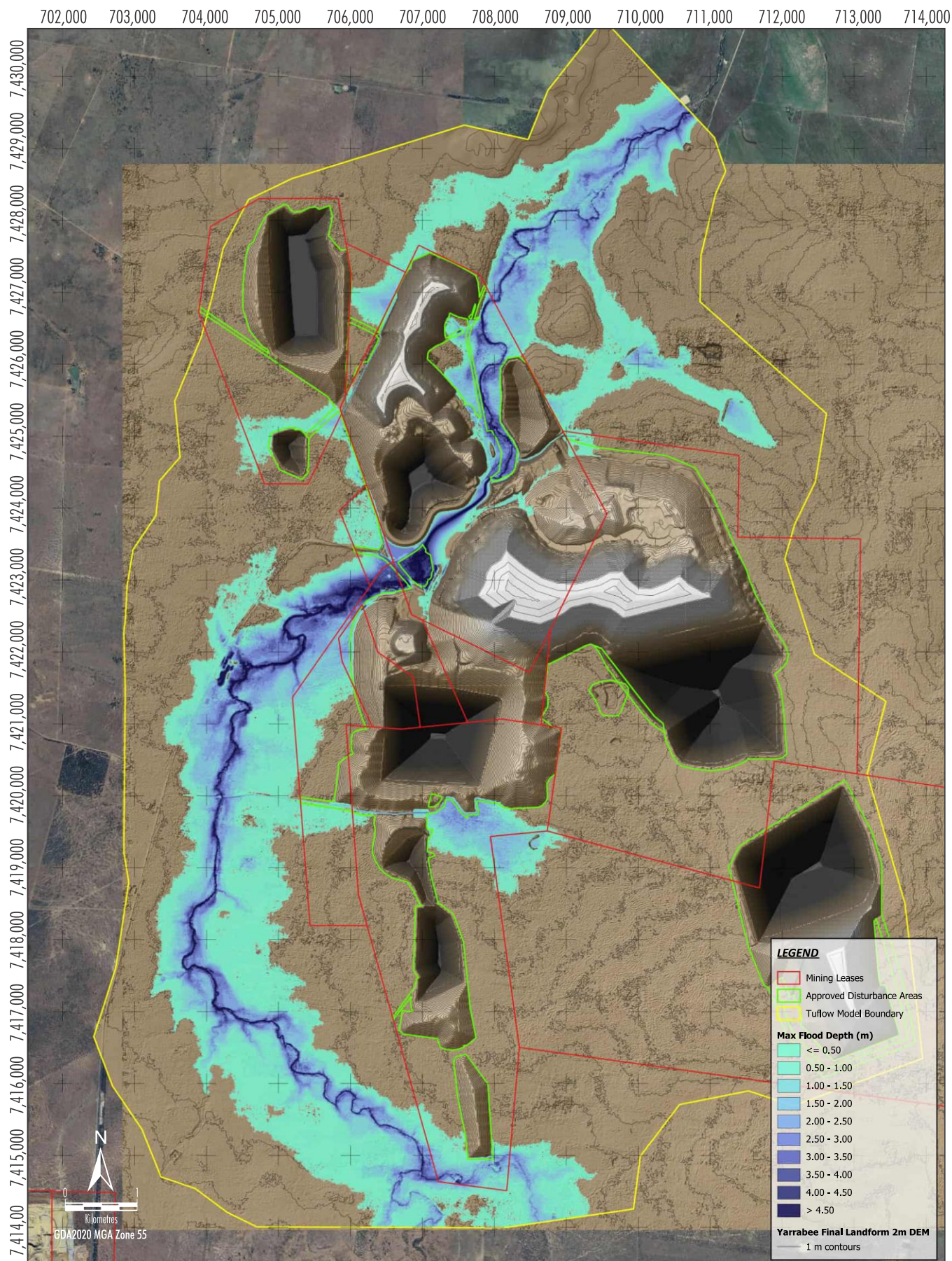
6.3.4.1 Channel Stability

The channel stability assessment focused on frequent and rare flood events, specifically 50% AEP and 2% AEP events as the most critical for stability. While some consideration was provided for very rare and extreme events, it was expected that even natural systems would experience elevated velocities with potential for localised scour in events of that magnitude.

Velocity profiles were extracted from the TUFLOW hydraulic model and used to undertake a screening assessment of the risk of excessive scour and instability caused by 50% and 2% AEP events. The DNRME document; *“Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorized under the Water Act 2000 (OSW/2019/4599)”* was used to inform velocities that were consistent with stable systems. Whilst this guideline provides threshold values, there are limitations when utilising these values outside of their intended use, these limitations are as follows:

- The limits and ranges provided by the DNRME guidelines were derived after assessing various waterways using a simplified but specific hydrology calculation method, different to the method adopted for this assessment. Hydrology calculations for this study were performed utilising WBNM, that typically yields a more accurate representation of predicted flows within the study area and will differ to the flows used in the guidelines. The adopted WBNM flows utilised for this study were conservatively high.
- The values in the DNRME guidelines were developed as ‘channel average values’ using HEC-RAS. The modelling performed for this study provides cell-specific values produced in 2D hydraulic model packages, which typically produce higher values.
- The actual tolerable upper limits of this waterway are unknown and would require further investigation through assessment of reference reaches.

Taking into consideration these limitations, the DNRME tolerable limits were utilised on a general basis, focusing on distribution and frequency of potential areas of exceedance.

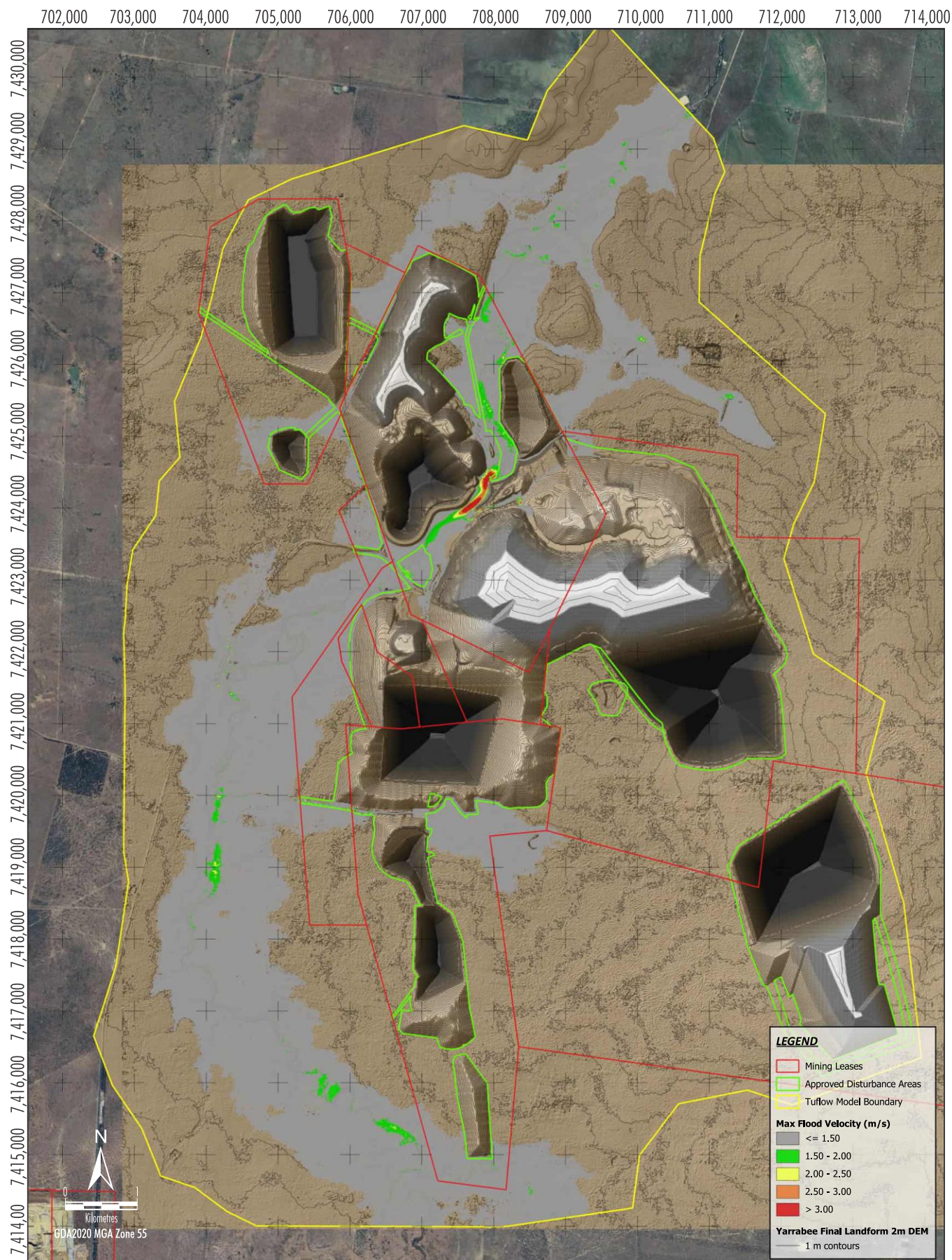


Source: Appendix I - Engeny Final Landform Flood Assessment



YARRABEE COAL MINE
0.1% AEP Maximum Flood Depth

Figure 6-24



Source: Appendix I - Engeny Final Landform Flood Assessment



YARRABEE COAL MINE
0.1% AEP Maximum Flood Velocity

Figure 6-25

6.3.4.2 Twelve Mile Creek

Twelve Mile Creek was the primary focus for this assessment, specifically the diversion alignment through the centre of the site and the affects the landform and diversion has on the natural creek upstream and downstream. Peak velocities in the 50% AEP event remained low (<1.5 m/s) throughout the diversion and generally throughout the upstream and downstream reaches. Velocities were observed to increase in the 2% AEP event while remaining below the 2.5 m/s guidelines value. Areas of increased velocity exceeding 3 m/s were observed at the downstream end of the diversion where the floodplain is constricted by the surrounding landform.

Limited change to flood behaviour within Twelve Mile Creek is expected upstream and downstream of the mine given the creek will not receive significant additional catchment inflows due to the final landform configuration. Although the catchment reporting to Twelve Mile Creek is expected to increase due to drainage adjustments and rehabilitation of disturbed areas, it is returning the contributing catchment in its current state to conditions closer to pre-mining. The catchment increase relative to current conditions is a minor increase relative to the total Twelve Mile Creek catchment.

6.3.4.3 Other locations and Landforms Stability

Potential flood interactions within other smaller drainage features within proximity of the Yarrabee Mine final landform are summarised in Table 6-14.

Table 6-14: Other Key Landform Results

Location ID	Location Description	Results
A	Landform to south of Twelve Mile Creek	Flow velocities on the rehabilitated spoil batter to the South of the Twelve Mile Creek Diversion are typically less than 1.5 m/s in the 50% AEP event and reach up to 2.0 m/s in the 50% AEP.
B	DOM2N/DOM2S Drain	Flow velocities through the proposed DOM2N/DOM2S drain are typically less than 1.5 m/s in events up to 2% AEP.
C	DOM5 to Twelve Mile Creek Drain	Flow velocities through the proposed DOM5 to Twelve Mile Creek drain are typically less than 1.5 m/s in events up to 2% AEP.

Source: (Appendix I).

6.3.5 Final Landform Flood Assessment Key Findings

The following key outcomes were identified during the final landform flood Assessment:

- All residual voids remain flood immune, up to and including a 0.1% AEP event.
- DOM5, CE-North, A-Pit, YES-Pit, YEN-Pit, DOM2S and DOM2N achieve PMF immunity.
- A screening assessment for areas with elevated velocity indicates the landform is exposed to low velocities during flooding events within Twelve Mile Creek and the surrounding waterways.

With all voids achieving or exceeding the EA requirement of 0.1% AEP flood immunity with seven voids achieving PMF immunity from Twelve Mile Creek and surrounding waterways, the Yarrabee Mine final landform is not susceptible to impacts of flooding. Subsequently, the final landform flood assessment did not result in any alterations to the Yarrabee Mine final landform or the proposed rehabilitation techniques detailed throughout this report.

6.4 WASTE CHARACTERISATION

RGS Environmental Consultants Pty Ltd (RGS) undertook a three-stage waste characterisation assessment (Appendix J) to support the development of the Yarrabee Mine final landform and to inform rehabilitation practices and strategies. The purpose of the geochemical assessment was primarily to characterise mine waste materials that are generated from processing coal from the open pits. A variety of geochemical testing methods were used in the assessment. Based on the characterisation results, the materials were classified as beneficial (e.g., non-acid forming [NAF]) or deleterious (e.g., potentially acid forming [PAF]) in order to assign a suitable use for each unit.

6.4.1 Geochemical Analysis Methodology

6.4.1.1 Material Samples

218 individual soil, overburden, coal, and interburden samples were collected from drilling programs undertaken at Yarrabee Mine between November 2023 and August 2024. Additional samples were provided from the CHPP in April and July 2024. Table 6-15 outlines a summary of the samples utilised in Geochemical analysis program.

Table 6-15: Geochemical Analysis Individual Samples

Material Type	Number of Samples
Soil	3
Overburden	64
Interburden/partings (including low quality coal)	129
Basement	7
Coal	3
Coarse reject	4
Fine reject	4
Tailings	4
Total	218

Source: (Appendix J).

Samples were subjected to initial static geochemical screening tests to determine variability within each material type. Based on initial static screening, individual samples were selected to produce composite sample materials with similar properties and to increase the available mass for each composite sample. This assessment utilised two composites:

- Multi-element (ME) composites – 26 individual samples of similar material type were combined into composite samples for multi-element testing.
- Kinetic Leach Column (KLC) composites – Samples of selected mine material types that may have the potential to influence surface water runoff and seepage water quality were prepared as composite samples.

6.4.1.2 Analytical Test Program

Static Geochemical Testing

Static Geochemical Testing were completed on individual mine material samples as summarised in Table 6-15. The test program was designed to assess the degree of risk from the presence and potential oxidation of sulphides and the generation and the presence/leaching of soluble metal(oids) and salts. Static geochemical tests provided a snapshot of the characteristics of sample material at a single point in time. These tests were completed to screen individual samples before selecting either individual and/or composite samples for more detailed static test work.

The Acid Base Account method was used as a screening procedure whereby the acid-neutralising and acid-generating characteristics of the samples were assessed. All samples were screened using the Acid Base Account method, which involved static geochemical testing for pH, EC, total sulphur, and Acid Neutralising Capacity (ANC).

After the results of the screening tests were established, selected samples with a total sulphur content greater than the median crustal abundance for sulphur (0.1%S) were tested for sulphide sulphur. From the total sulphur value (or S_{CR} value, where available), Maximum Potential Acidity (MPA) values were calculated.

After the results of the initial static geochemical tests were received and reviewed, 25 composite and individual samples were sent for whole rock multi-element testing. The composite samples were tested for:

- pH;
- EC;
- total major cations (Ca, Mg, K, Na);
- acidity and alkalinity as $CaCO_3$ mg/L;
- total metal(oids) (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, and Zn);
- soluble major cations (Ca, Mg, K, Na);
- soluble major anions (Cl, SO_4 , F, P, Si); and
- soluble metal(oids) (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, and Zn).

Kinetic Geochemical Testing

KLC tests simulated, under laboratory-controlled conditions, the weathering processes that can lead to acid and base generation and reaction. KLC tests enabled an assessment of the acid-forming and acid neutralising characteristics of a sample material and indicate the rate of acid/base generation, the period over which it will occur, and the management controls that may be required. Six free-draining KLC tests were undertaken on composite samples of various material types (Table 6-16). The mass of material in each KLC ranged from 1.5 to 2.0 kilograms (kg) and was generally dependent on material density.

Table 6-16: Kinetic Leach Column Set Up

KLC Number	Column Type	Material Type	Number of Samples in Composite	Mass of Material (kg)
KLC 1	AMIRA	Overburden	9.0	2.0
KLC 2	AMIRA	Interburden	22.0	2.0
KLC 3	AMIRA	Coal	3.0	1.5
KLC 4	AMIRA	Coarse reject	3.0	2.0
KLC 5	AMIRA	Fine reject	3.0	1.8
KLC 6	AMIRA	Tailings	3.0	2.0

Source: (Appendix J).

6.4.2 Static Geochemistry Results and Interpretation

6.4.2.1 pH

The pH_{1:5} values for the mine material samples were alkaline and range from 5.4 to 10.0. The soil samples and some of the overburden samples tend to be naturally circumneutral pH or slightly acidic. The majority of samples were alkaline and above the pH of the deionised water used in the test program (pH 6.2) and would be expected to add some alkalinity to contact water.

The pH_{1:5} values for the coal, coarse reject, fine reject, and tailings samples were alkaline and range from 8.3 to 9.9. The results were generally consistent overall and for each material type and have a median pH 9.3. The materials would be expected to add some alkalinity to contact water.

6.4.2.2 Electrical Conductivity

The EC_{1:5} values for mine materials were variable, ranging from 214 to 3,540 µS/cm and were typically slightly brackish (median 605 µS/cm). Slightly elevated EC values (>1,000 µS/cm) were associated with soil and overburden samples and appeared to correlate with lower pH values.

The EC_{1:5} values for the coal, coarse reject, fine reject, and tailings materials were variable, ranging from 293 to 1,740 µS/cm and were typically slightly brackish (median 958 µS/cm). Higher EC values (>1,000 µS/cm) were associated with fine reject and tailings materials and would likely be related to the proportion of fine particle sizes and large surface area within the material matrix.

6.4.2.3 Potential Acid

The total sulphur content of mine material samples ranged from 0.005 to 0.66%S (median 0.05%S) and were generally very low. Mine material with a total sulphur content less than or equal to 0.1%S were essentially barren of sulphur and had negligible capacity to generate acidity through sulphide oxidation when exposed to oxidising conditions.

The total sulphur content of coal, coarse reject, fine reject, and tailings samples ranged from 0.09 to 1.24%S (median 0.33%S) and were generally low. While the total sulphur content of some of the fine reject and tailings samples was greater than 0.1%S, it may not have been present in a sulphide form. Sulphides such as pyrite/marcasite had the potential to generate acidity.

6.4.2.4 Maximum Potential Acidity and Acid Neutralising Capacity

Based on the total sulphur content, the Maximum Potential Acidity (MPA) that could be generated by each sample of mine material, including carbonaceous materials was calculated. The MPA ranged from 0.15 to 38.0 kg H₂SO₄/t; and had a low median value of 1.5 kg H₂SO₄/t. This indicated that most samples had a low theoretical potential to produce any acidity.

The ANC measured the amount of acid (as kg H₂SO₄/t) that could be neutralised by acid neutralising minerals present in sample materials. The ANC for the samples ranged from 0.25 to 484 kg H₂SO₄/t and had a median value of 57.2 kg H₂SO₄/t.

The ANC:MPA ratio measures the proportion of ANC present in a sample compared to the MPA. If the ANC:MPA equals three or greater, there is an excess of ANC which is likely to buffer any acid produced and there is generally negligible risk of acid generation (INAP, 2024; Commonwealth of Australia, 2016). If the ANC:MPA ratio is less than one, there are equal or lesser proportions of ANC compared to MPA, and there may be insufficient ANC to neutralise the MPA, and therefore materials represented by the samples may have some overall acid generation risk.

The ANC:MPA ratio for the mine material samples ranged from 0.4 to 699 and had a median value of 38. Most mine materials (193 out of 203 samples) were essentially barren of sulphur and plot behind the sulphur equalled 0.1%. The results indicated that all but four sample of mine material tested plotted in the 'negligible' risk domain and/or had SCR values less than or equal to ($\leq$) 0.1%.

The ANC:MPA ratio for the coal, coarse reject, fine reject, and tailings samples ranged from 1.9 to 142 and had a median value of 18. Most samples (eight out of 15) were essentially barren of sulphur and plot behind the sulphur equalled 0.1%. The results indicated that all but four samples of mine material tested plotted in the 'negligible' risk domain and/or have an SCR value $\leq$ 0.1%. The results indicated that all but one sample of coal, coarse reject, fine reject, and tailings materials tested plot in the 'negligible' risk domain and/or have SCR values $\leq$ 0.1%. One tailings sample plotted in the 'possible' risk domain.

6.4.2.5 Net Acid Producing Potential

The Net Acid Producing Potential (NAPP) for the samples was calculated by subtracting the ANC from the MPA. Strongly positive NAPP values generally indicated some risk of acid production and that a material may be classified as PAF. Strongly negative NAPP values typically indicate that a material is NAF or Acid Consuming (AC). The NAPP value for the soil, overburden, interburden, and basement samples ranged from 0.4 to -483 kg H₂SO₄/t (median -55.2 H₂SO₄/t) and was negative for all, but one overburden samples. The NAPP values were variable and overburden and interburden samples generally had the most negative NAPP values. The NAPP value for the coal, coarse reject, fine reject, and tailings samples ranged from 1.4 to 84 kg H₂SO₄/t (median -30.6 H₂SO₄/t) and was negative for all samples. The NAPP values for carbonaceous materials were variable and typically less negative than for mine material samples.

6.4.2.6 Geochemical classification

Table 6-17 provides a summary of the geochemical criteria used to classify the acid forming nature of samples subjected to static geochemical testing. Overall, most materials represented by the samples tested were expected to have a very low risk and increased factor of safety with respect to potential acid generation. Based on the static Acid Base Account (ABA) data, all the soil, overburden, and basement samples were classified NAF (Barren) (Figure 6-26) and the majority of the interburden, coal, coarse reject, fine reject, and tailings samples were also classified NAF (Barren) and only a few samples of each material type classified as NAF (excluding soil and basement).

Table 6-17: Geochemical Classification Criteria

Geochemical Classification	Total Sulphur ¹ (%)	ANC:MPA Ratio	NAPP (kg H ₂ SO ₄ /t)	Number of Samples	% Samples*
Non-Acid Forming (Barren)	≤0.1	-	-	194	89%
Non-Acid Forming	>0.1	≥2	≤-5	23	11%
Uncertain	>0.1	<2	>-5 and ≤5	1	<1%
Potentially Acid Forming	>0.1	<2	>5	0	0%

Source: (Appendix J).

Note: * Total does not sum due to rounding.

1 Sulphide sulphur (using the SCR test) has been measured for selected samples and where available, sulphide sulphur has been used in place of total sulphur for sample classification and to calculate the MPA value.

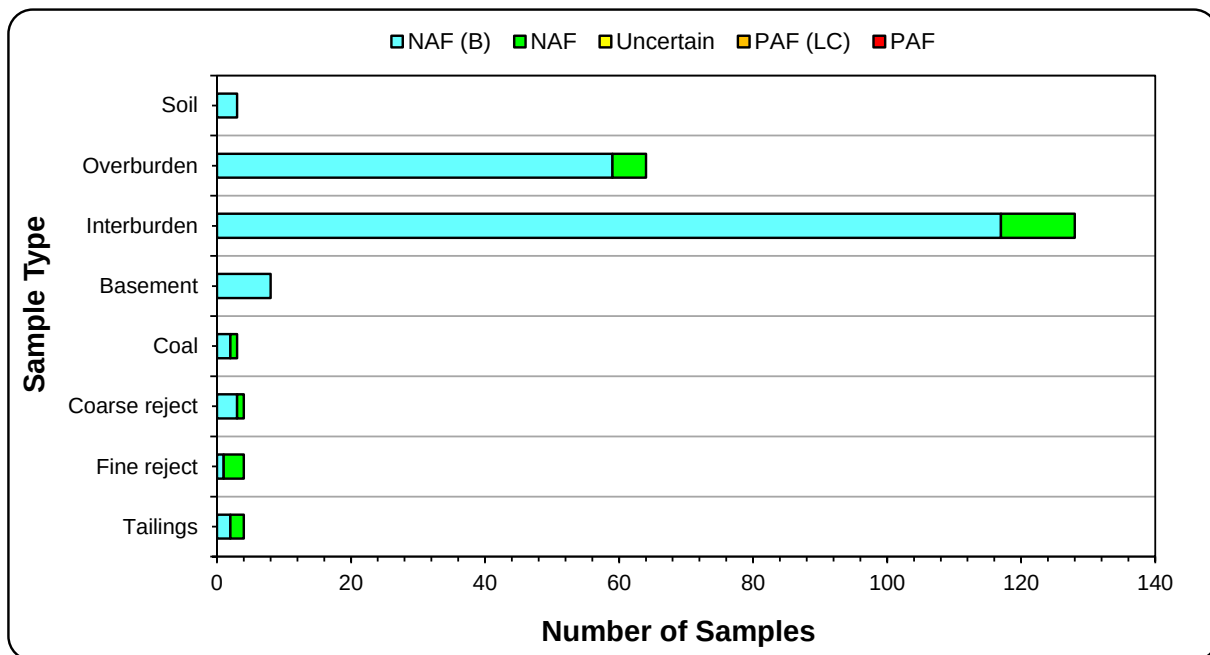


Figure 6-26: Geochemical Classification by Material Type (Appendix J)

6.4.3 Multi-Element Testing Results and Interpretation

6.4.3.1 Multi-Element Concentration

Multi-element tests were completed on 25 individual and composite samples of mine materials, including carbonaceous materials, to identify any elements present at concentrations of environmental concern with respect to material handling, storage, revegetation, and water quality.

The total metal/metalloid concentration in samples was compared to National Environmental Protection Council (NEPC) Health-based Investigation Levels (HIL[C]) applied to humans for soils in public open spaces (NEPC, 2013). The results indicated that the sample materials typically had low total metal and metalloid concentrations in solids, some below the laboratory LoR and all below the applied NEPC (HIL[C]) guideline for soils.

To provide additional context, the multi-element results were compared to the median crustal abundance of those elements in unmineralised soils (Bowen, 1979, CRC, 2000 and INAP, 2024). From this comparison, a geochemical abundance index (GAI) was calculated. Generally, a GAI of three or greater signifies enrichment that may warrant further examination. The results indicated that most of the metal(loids) tested in the samples had GAI values less than three and are therefore not enriched compared to unmineralised soils (Bowen, 1979, CRC, 2000 and INAP, 2024). The only minor exception is mercury (Hg), which has a GAI value of 3 in the composite sample of fine reject.

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from mine materials from mine sites in Queensland. As such, the multi-element results in water extracts were compared with Australian guideline values for freshwater aquatic ecosystems and livestock drinking water (ANZECC & ARMCANZ, 2018).

The pH of the water extracts from the samples ranged from 7.8 to 9.9 and was typically alkaline (median 9.5). Most samples, at least initially, added some alkalinity to contact water as the pH of the deionised water used in the test program was pH 6.2. Acidity in the water extracts from the samples ranged from <1 to 13 mg/L (as CaCO₃ equivalent) and was highest in the low-grade coal/siltstone sample (CO₂) from a shallower depth in the stratigraphic profile. The total alkalinity in the water extracts was variable and ranged from 117 to 13,200 mg CaCO₃/L.

The EC value for the water extract from the samples ranged from 266 to 1,930 µS/cm and had a relatively low median of 728 MS/cm. The concentrations of major ions in the water extracts were relatively low and typically dominated by sodium (Na⁺) and chloride (Cl⁻), and sulphate (SO₄²⁻).

The concentrations of dissolved trace metals/metalloids tested in water extracts were typically low and predominantly below the laboratory LoR. Most dissolved metal/metalloid concentrations were below the applied water quality guideline criteria. As the samples were pulverised to pass 0.075 mm, they have a very high surface area in contact with the water extracts and the results are likely to represent a 'worst-case' scenario for pore water and initial contact water for mine materials.

6.4.4 Kinetic Testing Results and Interpretation

The dynamic quality of contact water (if the coal and mine materials were left unmanaged and exposed to oxidising conditions) and the potential risk to water resources over time at was investigated using a KLC test program on six composite samples. The KLC test results indicated that:

- Leachate collected from the KLC tests on most of the mine materials, including carbonaceous materials, had a pH value that was typically in the pH neutral to slightly alkaline range.
- The EC value in leachate collected was generally low after, most sample materials produced a leachate with an EC value less than 1,000 $\mu\text{S}/\text{cm}$.
- Acidity levels in leachate over the test period were typically low (≤ 4 mg/L, as CaCO_3 equivalent).
- The alkalinity values in leachate were typically higher than the acidity levels leading to a positive net alkalinity value (i.e. the alkalinity was greater than the acidity) in all leachate samples.
- The concentrations of major ions in leachate from the KLC tests was relatively low and typically dominated by sodium, chloride and sulphate (and bicarbonate).
- The concentration of sulphate in leachate was relatively low and generally < 200 mg/L.
- The sulphate concentration in the KLC leachate collected was less than the applied livestock water quality guideline criterion for this anion (1,000 mg/L) over the test period.
- The sulphate generation rate results obtained have been used to determine the rate of sulphide oxidation in the materials.
- Most sulphate salts generated from sulphide reaction involving materials with a relatively low sulphide sulphur concentration were highly soluble. The dissolved sulphate (and calcium) concentrations in the leachate were typically much less than the solubility limit, which indicates that sulphate generation is not controlled by gypsum dissolution.
- The sulphate generation rate and associated sulphide oxidation rate for the KLC test materials are presented in Table 6-18.

Table 6-18: Sulphate Generation and Sulphide Oxidation Rates for KLC Test Materials

KLC Sample Number	Sample Description	Sulphate Generation Rate (mg/kg/week)	Oxidation Rate (kg $\text{O}_2/\text{m}^3/\text{s}$)
KLC 1	Overburden	3.4	1.4×10^{-9}
KLC 2	Interburden	7.3	3.1×10^{-9}
KLC 3	Coal	13.9	4.7×10^{-9}
KLC 4	Coarse reject	21.9	7.3×10^{-9}
KLC 5	Fine reject	25.5	8.6×10^{-9}
KLC 6	Tailings	20.5	6.9×10^{-9}

Source: (Appendix J).

6.4.5 Mineralogy Results and Interpretation

Four composite samples of mine materials and three individual samples of coarse reject, fine reject, and tailings materials underwent mineralogical analysis by semi-quantitative x-ray diffraction (XRD). The samples contained a mixture of quartz (10% to 24%), muscovite (2% to 6%), plagioclase feldspar (2% to 16%), single and mixed-layer clays (kaolinite 1% to 7% and smectite 23% to 35%), ankerite (1% to 11%), and siderite (3% to 10%), as well as iron sulphide and iron oxide minerals.

6.4.6 Physical Testing Results and Interpretation

6.4.6.1 Bulk Density

Bulk density is the weight of soil in a given volume. Soil generally has a bulk density ranging from 1.1 g/cm³ to 1.7 g/cm³. Soils with a bulk density >1.6 g/cm³ tend to restrict root growth. Bulk density increases with compaction and depth and is generally higher in sandy soils.

Coarse reject had the highest bulk density of the three material types (1.2 g/cm³). By comparison, the tailings sample had the lowest bulk density (0.90 g/cm³). Overall, the coarse reject, fine reject, and tailings samples are low in density compared to typical soil materials and would not be expected to impede plant growth based on this property, if used as growth medium.

6.4.6.2 Emerson Class

The coarse reject, fine reject, and tailings samples ranged from Emerson Class 3, Class 4, and Class 7. The materials behave as aggregated soils and were generally stable with negligible to slight dispersion and were unlikely to be susceptible to tunnelling erosion (Hazelton and Murphy, 2016). Emerson Class 3, Class 4, and Class 7 are described as:

- Class 3 – Aggregates generally stable, suitable for most earthworks.
- Class 4 – Aggregated, may not hold water in a dam. Improved stability due to presence of gypsum or carbonate.
- Class 7 – Aggregated material.

6.4.6.3 Particle Size

Figure 6-27 shows particle size distribution (PSD) results for three selected individual and composite samples of coarse reject, fine reject, and tailings materials. The coarse reject sample had the highest proportion of large (gravel) particles (54%), while tailings sample had the highest proportion of fine clay (30%). Fine reject was comprised mostly of sand (88%).

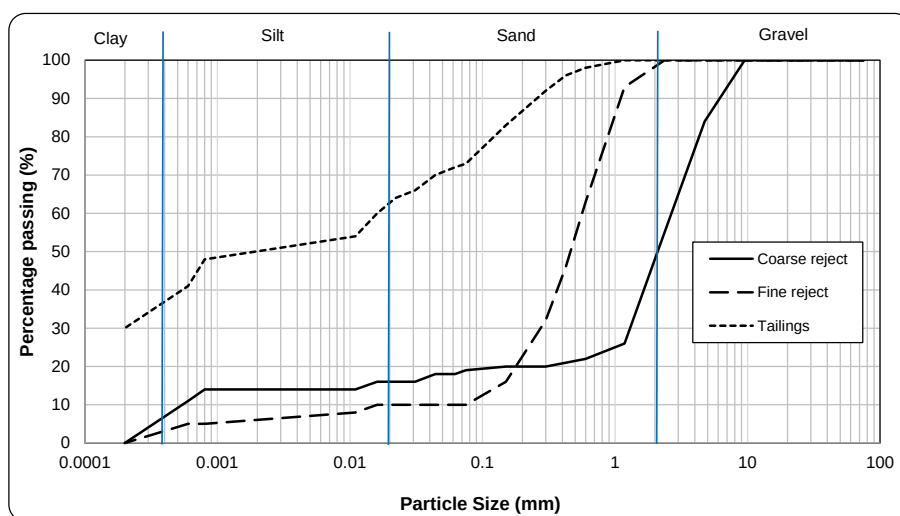


Figure 6-27: Particle Size Distribution Curves for Coarse Reject, Fine Reject, and Tailings (Appendix J)

6.4.6.4 Soil Texture Classification

Using only the fine (excluding gravel) proportions of clay (<0.002 mm), silt (>0.002 to <0.06 mm), and sand (>0.06 to <2.0 mm) the PSD results were plotted on a soil texture classification triangle (Figure 6-28). Soil texture classifications ranged from clay loam for the tailings, to sand for the fine reject. The soil classification for coarse reject excludes gravel and was based only on the proportion of clay, silt, and sand in the sample. The coarse reject contained a higher ratio of silt to sand than the fine reject and thus were classified as a sandy loam.

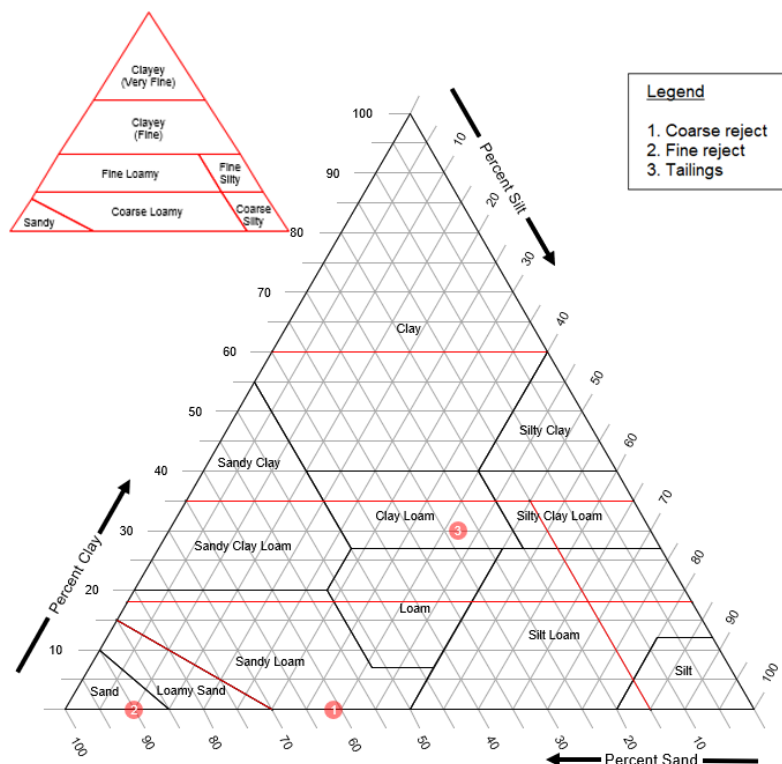


Figure 6-28: Soil Texture Classifications (Appendix J)

6.4.6.5 Atterberg Limits

The single tailings sample contains clay and underwent analysis for Atterberg Limits. The coarse and fine reject samples did not contain clay and were unsuitable for Atterberg testing, which is performed on the 'as received' sample. The Plasticity index (PI) percentage is the water content at which the soil begins to display plastic properties. It can be non-plastic (0%), slightly plastic (1% to 6%), medium plastic (7% to 17%), or highly plastic (18% to 100%) (Sowers, 1979). Sand had very low or no plasticity.

6.4.6.6 Permeability

The tailings samples were subjected to permeability analysis by the falling head method, conducted at field capacity (K_{FC}). The tailings samples were repeatedly tested four times to verify the permeability result. The wet placement density ranged from 1.87 t/m³ to 2.17 t/m³ and water retention was 10.9% to 24.3% (Table 6-19). The variability is likely caused by the propensity of the clay minerals to absorb water. The permeability at field capacity for the tailings samples ranged from 1.8×10^{-5} m/s to 6.9×10^{-5} m/s and indicated that the tailings materials were moderately permeable.

Table 6-19: Permeability Results for Tailings Samples

Material Type	Wet Density t/m ³	Water Retention (%)	Permeability: Falling Head: K _{fc} (m/s)
Tailings	1.87	13.4	5.4 x 10 ⁻⁵
Tailings	1.95	24.3	6.9 x 10 ⁻⁵
Tailings	2.08	10.9	1.8 x 10 ⁻⁵
Tailings	2.17	15.2	3.5 x 10 ⁻⁵

Source: (Appendix J).

6.4.6.7 Column settlement

The column settlement test measured how quickly particles flocculate and settle from a turbid mixture. Individual and composite samples of coarse reject, fine reject, and tailings samples were sieved to <2.36 mm and underwent column settlement testing. Results verified that the coarse reject and fine reject samples had poor settlement and elevated turbidity, while the tailings samples flocculate and settle rapidly.

6.4.6.8 Soil water characteristics curves

Water retention data was collected for three samples of coarse reject, fine reject, and tailings materials. A Soil water characteristics curve (SWCC) can be utilised to determine van Genuchten parameters for cover system modelling. These parameters include the residual water content (q_r) and the saturated water content (q_s). The inflexion point of the SWCC indicates the field capacity of the soil, and upper and lower transition zones infer the wilting point and saturation, respectively.

The data obtained from the water retention curves has been summarised in Table 6-20 and confirm that tailings had a higher water retention capacity than coarse or fine reject materials. Water retention correlates strongly to the proportion of fine particles (i.e. silt and clay) in the material. The tailings sample had the most clay (30%), whereas coarse reject and fine reject had negligible clay. The proportion of silt was higher in coarse reject (18%) compared to fine reject (10%), and this may explain why the volumetric water content at saturation was higher in coarse reject (45.67 m³/m³) compared to fine reject (37.56 m³/m³). The results confirmed that tailings were likely to have high water retention and would drain slowly after a rain event, whereas coarse and fine reject materials would tend to drain more rapidly. The capacity to retain water is a favourable characteristic if the materials are used growth medium for plants.

Table 6-20: Summary of Soil Water Characteristic Curve Data

Material ID	Volumetric Moisture Content (m ³ /m ³) – based on bulk density				
	0 kPa (Saturation)	10 kPa	33 kPa (Field Capacity)	100 kPa	1,500 kPa (Writing Point)
Coarse reject	45.67	28.90	27.09	13.16	9.68
Fine reject	37.56	29.48	27.85	13.22	9.24
Tailings	50.12	42.33	33.29	26.94	17.63

Source: (Appendix J).

6.4.7 Spoils Materials Characteristics

The results of the ABA tests, the water extract and KLC test results, demonstrated that the Acid Mine Drainage (AMD) potential of the mine materials represented by the samples tested was low. Typically, spoil was classified as NAF-Barren or NAF and generally had low oxidisable sulphur content and excess ANC. Spoil materials represented by the soil, overburden and interburden samples had a low risk of acid generation and a high factor of safety with respect to potential AMD (including Neutral Mine Drainage [NMD] and Saline Drainage [SD]).

The concentration of trace metals/metalloids in mine materials was expected to be low compared to the median crustal abundance in un-mineralised soils and was not expected to present any environmental issues associated with revegetation and rehabilitation.

The static and kinetic geochemical test results demonstrate that surface runoff and seepage from NAF materials was likely to have a pH that is circumneutral to slightly alkaline and would have a slightly brackish salinity based on EC values.

The concentrations of major ions in leachate from sample materials were relatively low and were dominated by sodium, chloride, sulphate, and bicarbonate with lower concentrations of other major ions. Occasionally fluoride had a concentration greater than the livestock drinking water value (ANZECC & ARMCANZ, 2018).

The concentration of most dissolved trace metals/metalloids in water in contact with the sample materials was low, predominantly below the laboratory LoR, and below the applied livestock water quality guideline criteria. The only exceptions were arsenic, cadmium, and molybdenum, which can sporadically have concentrations greater than the applied livestock drinking water value (ANZECC & ARMCANZ, 2018) under ideal oxidising conditions.

Overall, dissolved metal/metalloid concentrations in surface runoff and seepage from the mine materials were unlikely to present a significant risk to surface and groundwater resources with the expectation that the material will be handled according to standard industry mine waste management practices.

6.4.8 Carbonaceous Materials Characteristics

The results of the ABA tests, the water extract and KLC test results, demonstrated that the AMD potential of the coal, coarse reject, fine reject, and tailings materials represented by the samples tested was low. Typically, these materials were classified as NAF-Barren or NAF and generally had low oxidisable sulphur content and excess ANC. Materials represented by the carbonaceous samples had a low risk of acid generation and a high factor of safety with respect to potential AMD. The NAF-Barren or NAF classification is consistent across all coal seams.

The concentration of trace metals/metalloids in coal materials was expected to be low compared to the median crustal abundance in un-mineralised soils and was not expected to present any environmental issues associated with revegetation and rehabilitation.

The static and kinetic geochemical test results demonstrated that surface runoff and seepage from NAF materials was likely to have a pH that is circumneutral to slightly alkaline and would have a slightly brackish salinity based on EC values.

The concentrations of major ions in leachate from coal, coarse reject, fine reject, and tailings materials were relatively low and were dominated by sodium, chloride, sulphate, and bicarbonate with lower concentrations of other major ions. The concentration of most dissolved trace metals/metalloids in water in contact with the carbonaceous materials was low, predominantly below the laboratory LoR, and below the applied livestock water quality guideline criteria.

Overall, dissolved metal/metalloid concentrations in surface runoff and seepage from the coal, coarse reject, fine reject, and tailings materials were unlikely to present a significant risk to surface and groundwater resources.

The tailings had a balanced proportion of clay, silt, and sand and classifies as a clay loam, whereas reject materials were typically sand and gravel. While both single and mixed-layer clays were present in the tailings, the relatively high proportion of illite/smectite can produce shrink/swell behaviour. The tailings had high plasticity and have higher water retention than the coarse reject and fine reject materials, although excessive water infiltration into the TSF via heavy rain events may create instability in these materials. In general, the carbonaceous materials had moderate permeability and were expected to produce minor seepage that will be slightly brackish.

6.4.9 Key Geochemical Findings

The results obtained from the geochemical assessment are consistent with previous studies completed at Yarrabee Mine. The main findings of the assessment were as follows:

- Mine materials, including carbonaceous materials, in general had low oxidisable sulphur content, excess ANC, and were classified as NAF-Barren or NAF. With respect to AMD potential, materials had a low risk of acid generation and a high factor of safety.
- Initial and ongoing surface runoff and seepage is expected to be pH neutral to slightly alkaline and slightly brackish.
- The concentration of major ions in surface runoff and seepage is expected to be low and largely dominated by sodium, chloride, sulphate, and bicarbonate.
- The concentration of trace metals/metalloids is expected to be low compared to applied guideline criteria for soils and median crustal abundance in un-mineralised soils. Except for mercury in fine reject, mine material solids are not expected to present any environmental issues associated with revegetation and rehabilitation.
- Trace metals/metalloids are sparingly soluble at the neutral to slightly alkaline pH of leachate.
- Dissolved metal/metalloid concentrations in surface runoff and seepage from bulk NAF materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources.

The geochemical assessment identified that the Yarrabee materials have a low risk of acid generation and a high factor of safety. Subsequently, the Yarrabee Mine final landform rehabilitation practices including landform construction and cover designs have been developed in consideration of the low risk of acid generation from mine materials.

6.5 EROSION AND LANDFORM EVOLUTION ASSESSMENT

Material characterisation and erodibility assessments were undertaken by Landloch to determine design constraints for the Yarrabee Mine final landform. WEPP modelling and flume testing were undertaken to inform the erosion assessment for a range of landform and rehabilitation options to support the development of the Yarrabee Mine final landform (Appendix K and Appendix L). The results of this modelling was used to develop three-dimensional rehabilitation shapes that could in turn be subjected to landform evolution modelling using the SIBERIA model. Results of targeted WEPP modelling was also used to produce SIBERIA input parameters for the Yarrabee materials. In this way, the SIBERIA model has been calibrated to both the Yarrabee Mine's climate and material erosion characteristics (Appendix M).

6.5.1 Erodibility Measurements on Bulk Samples

Erodibility parameters required for WEPP and SIBERIA modelling were determined using measurements of runoff, erosion, and sediment properties. These were determined from plots exposed to simulated rainfall and flumes where soil samples were exposed to simulated overland flow conditions.

In 2016 bulk samples were taken of three soil types to support the erodibility studies:

- YEN-Pit topsoil;
- DOM2 topsoil; and
- YEN-Pit mudstone.

In 2020 bulk samples were taken of coarse and fine mudstone waste and topsoil to develop three different mixed growth mediums. The growth mediums were as follows:

- 3:1 coarse to fine mix with no additional topsoil;
- 2:1 coarse to fine mix with 0.255 litres of topsoil per litre of waste; and
- 1:1 coarse to fine mix with the addition of 0.855 litres of topsoil per litre of waste.

Simulated rain with a kinetic energy equivalent to natural rainfall at intensities >40 millimetres per hour (mm/h) was applied to the samples from both sampling events. Simulated rain was applied to 0.75 square metres (m²) plots with a depth of 0.2 m, set at a gradient of 20%. The plots were lightly compacted, ensuring they were consistent with naturally consolidated soil. The samples were also subject to wetting and drying to further consolidate the surface. Runoff generated by the simulated rainfall was sampled at regular intervals (2 to 3 minutes) and sediment concentrations were gravimetrically measured.

Rill erodibility measurements were undertaken using flumes 2 m long and 0.4 m wide. For both the 2016 and 2020 samples a range of flume gradients were run to ensure a wide range of flow tractive force was applied. Samples were lightly compacted during placement in the flumes and then exposed to several wetting and drying cycles over several days. A sequence of increasing overland flow rate was applied to each flume, flow was maintained for 5 minutes and samples of runoff collected at 1, 2, 3, and 5 minutes.

The results of laboratory runoff were utilised to calculate the interrill erodibility (K_i), rill erodibility (K_R) hydraulic conductivity (K_e) and critical shear for rill initiation (τ_c) of the different materials. These parameters were then utilised to predict changes in the erosion process and changes to erosion rates due to changes to runoff, slope length and land management. Values for the above parameters calculated from rainfall simulation and overland flow are presented in Table 6-21 (2016) and Table 6-22 (2020).

Table 6-21: Erodibility Inputs for 2016 WEPP Modelling

Material	Interrill erodibility K_i (kg.s/m ⁴)	Critical shear τ_c (Pa)	Rill erodibility K_R (s/m)	Hydraulic conductivity K_e (mm/h)	Measured steady infiltration rate (mm/h)
YEN-Pit topsoil	1,177,663	15.0	0.00651	0.5	5.3
DOM2 topsoil	1,740,392	7.2	0.00411	0.8	8.4

Source: (Appendix K).

Note: kg.s/m⁴ = the rate of soil erosion per unit of force exerted on the soil surface; Pa = Pascal; s/m = seconds per metre.

Table 6-22: Erodibility Inputs for 2020 WEPP Modelling

Material	Interrill erodibility K_i (kg.s/m ⁴)	Critical shear τ_c (Pa)	Rill erodibility K_R (s/m)	Hydraulic conductivity K_e (mm/h)	Measured steady infiltration rate (mm/h)
Waste (3:1)	346,534	25.8	0.000299	100	123.6
Waste/Topsoil (2:1)	688,712	22.6	0.002102	11.0	29.3
Waste/Topsoil (1:1)	568,078	21.4	0.002277	12.0	32.1

Source: (Appendix L).

6.5.2 WEPP Model Build

The WEPP model was developed to predict runoff, erosion and deposition for hillslopes and watersheds. WEPP is a simulation model with a daily input time step, that utilises the following climate data for each day, the amount and duration of rainfall, time to peak intensity, and ratio between peak intensity and average intensity. The climate data is used in infiltration calculations to ensure the model considers rainfall intensity and duration. For each day, plant and soil characteristics important to the erosion process are updated. When rainfall occurs, plant and soil characteristics are considered in determining whether runoff occurs. If runoff is predicted, the model computes sediment detachment, transport, and deposition at points along a slope profile. Conceptually, WEPP can be divided into six components:

- climate generation;
- hydrology;
- plant growth;
- soils;
- management; and
- erosion.

The erosion component of the model uses a steady-state sediment continuity equation. Soil erosion in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate (Appendix K). The findings of the 2016 and 2020 modelling are detailed in Section 6.5.3 and Section 6.5.4 respectively.

6.5.3 2016 WEPP Model

The goal of the 2016 WEPP model assessment was to determine the profile options (slope and vegetation cover) that would erode at rates low enough to provide long-term stability for the Yarrabee Mine final landform. A soil loss of 5 tonnes per hectare per year (t/ha/y) has been widely accepted for mining landforms on the basis that rilling is largely if not completely absent and a landform achieves an acceptable level of stability to erosion. Subsequently, 5 t/ha/y was the targeted soil loss for this assessment (Appendix K).

Three landform slope options were modelled, 10%, 12.5% and 16.6%. An initial model was run on bare slopes which presented a high erosion potential, which increased as the slope gradient increased (Figure 6-29). As a result, vegetation cover was included in subsequent model runs, with 35% grass cover and 50% grass cover modelled.

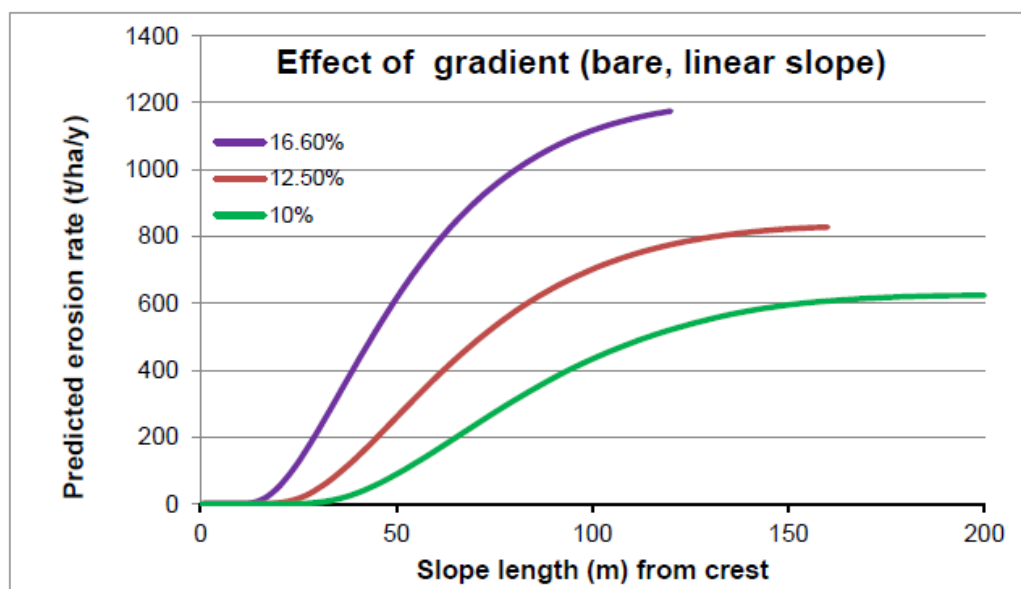


Figure 6-29: Predicted Erosion Potential for Bare Soil Slopes (Appendix K)

The hydraulic conductivity parameter (K_e) was utilised to account for the impacts of cover on steady infiltration rates. Cover C factors were derived for 35% and 50% cover options using The Revised Universal Soil Loss Equation (RUSLE) to account for direct effect of cover on erosion. The estimated C factors for 35% and 50% cover are 0.051 and 0.024 respectively. Generally, infiltration rates increase by 7 to 10 mm/h for each 10% increase in surface cover (Table 6-23).

Table 6-23: Effects of Cover on Infiltration, Hydraulic Conductivity and Average Annual Runoff

Cover (%)	Steady Infiltration rate (mm/h)	Hydraulic conductivity (mm/h)	Predicted average annual runoff (mm/y)
0	5.3	0.5	329
35	29.8	9	98
50	40.3	15	90

Source: (Appendix K). Note: mm/g = millimetres per gram.

Model runs considered the impacts of vegetation and slope gradient on average and peak erosion rates on linear batter slopes 10 m high, with gradients of 10% and 12.5%. As outlined in Table 6-24, 12.5% gradient slopes with 50% cover achieved a maximum erosion rate of 3.9 t/ha/y.

Table 6-24: Effects of Cover and Slope Gradient on Erosion Rates for a 10 m High Better Slope

Gradient (%)	Cover Level (%)	Predicted maximum erosion rate (t/ha/y)	Predicted average annual erosion rate (t/ha/y)
10	35	6.8	2.0
	50	2.9	0.8
12.5	35	8.9	2.7
	50	3.9	1.2

Source: (Appendix K).

Additional model simulations were run on profiles with heights ranging from 20 to 60 m. For each batter height, erosion along a concave option was compared against that from a linear batter of 10% gradient (Table 6-25). The simulations considered infiltration rates, C factors and rill spacing consistent with 50% vegetative cover. Generally, the concave profiles resulted in a reduction in average and maximum erosion rates and increases in effective gradient.

Table 6-25: Predicted Average and Maximum Erosion Rates for 20, 40, 50, and 60 m Slope Heights

Slope height (m)	Average gradient (%)	Predicted maximum annual erosion rate (t/ha/y)	Predicted average annual erosion rate (t/ha/y)
20	10 (linear)	4.45	1.9
	12.3 (concave)	1.9	1.00
40	10 (linear)	4.2	2.6
	13.8 (concave)	3.5	2.0
50	10 (linear)	4.1	2.7
	12.5 (concave)	3.5	1.75
60	10 (linear)	4.0	2.7
	12.8 (concave)	3.4	2.22

Source: (Appendix K).

6.5.4 2020 WEPP Model

The goal of the 2020 WEPP model assessment was to assess the feasibility of utilising rock-dominated growth media to stabilise steeper slopes rehabilitated to a native vegetation PMLU. The slope model ranged between a gradient of 12.5% and 33.3%, were 40m high and were modelled with 30% and 50% vegetative cover. As coarse waste is likely to be utilised during rehabilitation, it was determined that the Yarrabee landform was considered a medium risk site, for which an average erosion rate (soil loss) of 6 t/ha/y and a maximum rate of 12 t/ha/y would be acceptable. Consequently, these target values were applied to the WEPP model.

To simulate the impact of 30% vegetative cover on infiltration capacity, hydraulic conductivity (K_e) was modified to account for impacts of cover on steady state infiltration. For every 10% surface cover increase, steady state infiltration was increased by 7 to 10 mm/h. For 50% cover, surface impacts were considered, however hydraulic conductivity consistent with 30% cover was applied as it was considered unlikely that the grass component, having the greatest impact on infiltration, would be a major component of vegetation establishment.

The initial simulations were run on bare material and indicated that the Permian waste material generates a maximum erosion rate of 1 t/ha/y on a 25% gradient at the toe of a 40 m high slope. The waste presented a high steady infiltration rate of 123 mm/h and was predicted to reduce minimal surface run-off of 2 mm/y. The high pH and EC of the Permian waste material would result in only vegetation with severe to extreme salinity tolerance growing within the landform. Model runs for the 2:1 Coarse to fine mix presented moderate annual run off (26.3 mm/y) and high erosion rates (>100 t/ha/y) on a bare 25% slope >50 m in length. The 1:1 coarse to fine mix presented similar model results for a bare slope and as a result it was determined that the mixes would perform similarly in all scenarios. It was therefore determined that all subsequent simulations would be run on the 2:1 mix only (Figure 6-30). As the 12 t/ha/y erosion rate was adopted, a rock-soil mix on batters in the order of 40 m high can only be expected to be stable if adequate vegetation cover is achieved.

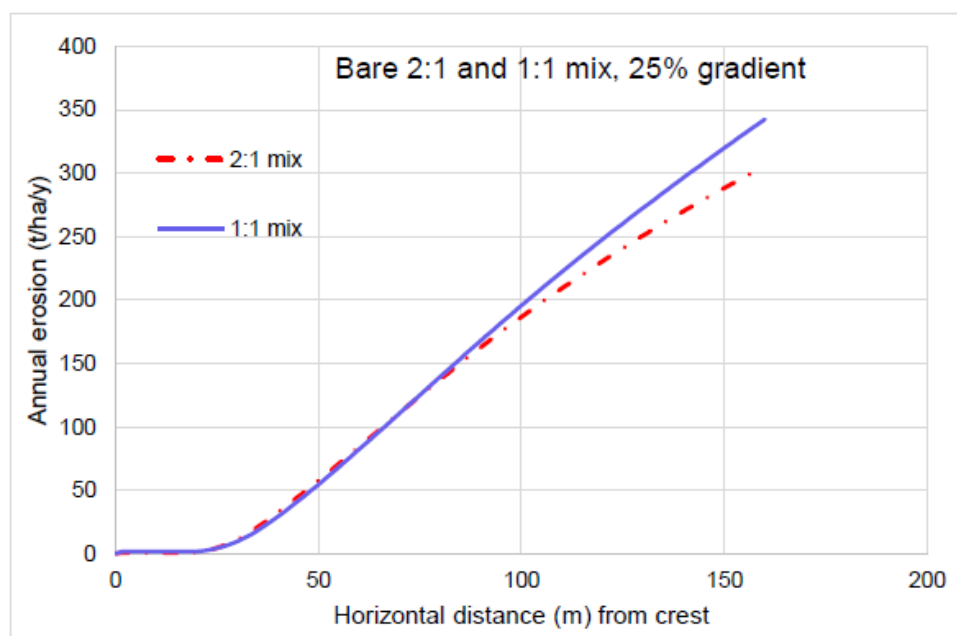


Figure 6-30: Predicted Erosion Potential for 40 m High Slopes on 25% Gradient of Bare 2:1 and 1:1 Mix Surfaces (Appendix L)

Additional model runs incorporated slopes gradients between 16.6% and 33.3%, with vegetation cover of 30% and 50%. The model run on 40 m high slopes with 30% vegetation cover and gradients between 16.6% and 33.3% presented erosion rates considerably higher than the target 12 t/ha/y. For most gradients, the maximum slope achieving less than the target erosion rate was approximately 20 m. For 50% vegetation cover on slopes with a 16.6% and 20% gradient, the model predicted erosion rates lower than the target rate. A stable batter height was also present between 30 m and 40 m for gradients of 25% and 33.3%. Figure 6-31 and Figure 6-32 show the predicted erosion rates with 30% and 50% vegetation cover, respectively.

Similarly to the 2016 modelling, simulations were run on concave slope profiles. These simulations were run on the 2:1 mix material with 30% vegetation cover however were unable to develop an effective option for a batter slope with a height greater than 30 m.

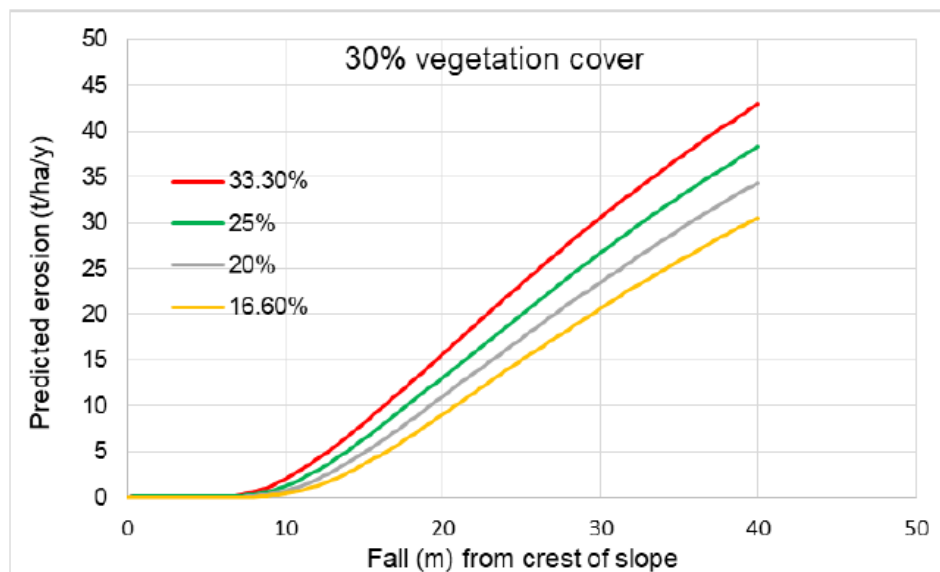


Figure 6-31: Predicted Erosion Rate for Slope Gradients on 2:1 Material Mix and 30% Vegetation Cover (Appendix L)

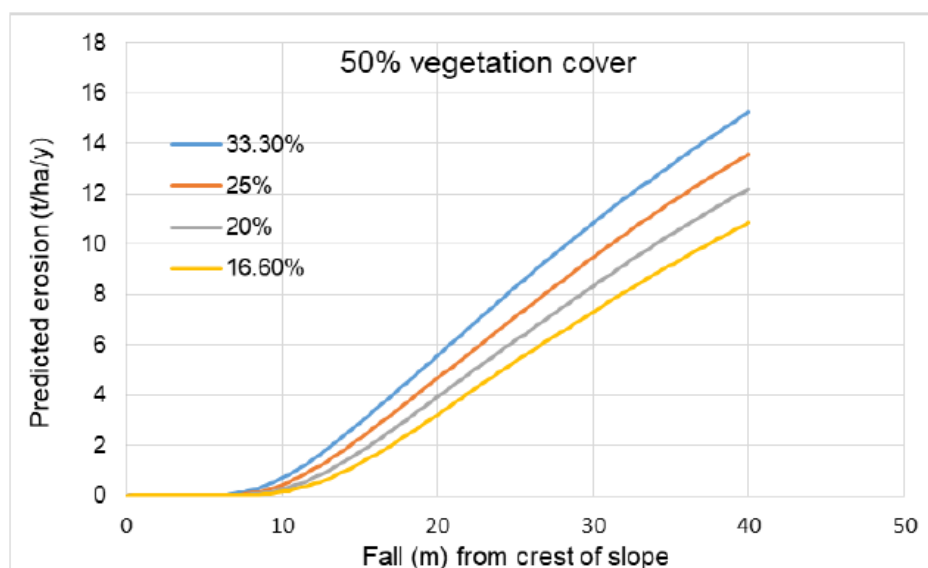


Figure 6-32: Predicted Erosion Rate for Slope Gradients on 2:1 Material Mix and 50% Vegetation Cover (Appendix L)

6.5.5 WEPP Model Findings

Landform Design and vegetation cover

The 2016 WEPP model runs considered the impacts of vegetation and slope gradient on average and peak erosion rates on linear batter slopes 10 m high, with gradients of 10% and 12.5%. As outlined in Section 6.2.3, 12.5% gradient slopes with 50% cover achieved a maximum erosion rate of 3.9 t/ha/y on 10 m slope lengths. Landloch (Appendix K) highlighted that the maximum slope gradient suitable for a stable grazing PMLU is 12.5%.

The 2020 WEPP simulations identified that waste-only slopes can be expected to be stable at gradients of up to 33.3%, as they would generate virtually no runoff. However, given the properties of the waste material, it can be expected that the vegetation established would be predominantly highly salt tolerant tree and shrub species. As a result, modelling was completed on slope gradients between 16.6% and 33.3%, with vegetation cover of 30% and 50%. The model runs determined that the erosion rate was lower than the target 12 t/ha/y when 50% vegetation cover was applied to slopes between 16.6% and 20%. A stable batter height was also present between 30 m and 40 m for gradients of 25% and 33.3%.

As a result of the above findings, it has been determined that slopes steeper than 12.5%, while not suitable for grazing, will support native vegetation as PMLU with appropriate erosion control measures to provide long-term stability.

Concave profiles

As outlined above, simulations of concave slope profiles were unable to develop an effective model output for 2:1 mix material with a 30% vegetation cover on batter slopes higher than 30 m. If a section of Permian waste was placed on a batter to cover the upper 10 m, then a concave profile with 30% cover could be successfully designed. However, Permian waste can only support vegetation with extreme tolerance with salinity. The inclusion of Permian waste material at the top of the batter would impact vegetation species able to be planted as vegetation would require a severe to extreme salinity tolerance. Following Landloch (Appendix K), concave profiles were constructed at YEN-Pit as part of a rehabilitation trial (refer Section 2.13). Monitoring of the landform indicated that in practice, concave landforms were not conducive to a successful final landform. Therefore, no concave landforms have been proposed in the final landform.

Model Assumptions and Limitations

The following model Assumptions and limitations have been identified:

- Simulations of landform evolution considered surfaces that had 30% or 50% vegetative cover.
- Simulations were run and developed using a 100-year climate sequence.
- Soil availability and quality are based on soil test sites located at an appropriate density.
- Waste characterisation is based on appropriately selected representative samples.
- Simulations assumed that all rainfall on the waste emplacements will be retained by perimeter and cross-bunding and therefore did not consider any discharge from the top of the landform onto outer batter slopes.

6.5.6 SIBERIA Model Build

The SIBERIA model is a 3-dimensional topographic model that predicts the long-term development of channels and hillslopes in a catchment on the basis of runoff, erosion, and deposition. The location and speed with which rills and gullies develop is controlled by a channelisation function. SIBERIA does not input actual rainfall or material erodibility parameters, rather the input parameters define this channelisation function that is related to both runoff and soil erodibility (Willgoose et al., 1989) and must be derived for each particular material at each particular site.

SIBERIA solves for two variables:

1. elevation, from which slope geometries are determined; and
2. an indicator function that determines where channels exist.

SIBERIA has been applied to explain aspects natural landform geomorphology (Willgoose, 1994) and has been extensively used in the context of mining, for assessment of the development of constructed landforms on a range of mine sites across Australia and overseas (Willgoose, 1995, Willgoose and Riley, 1993, Hancock et al., 2003, Hancock and Willgoose, 2004, Hancock 2004, Mengler et al., 2004, Hancock and Turley, 2006). The model is applicable to any climatic regime as its input parameters are derived by calibration to runoff and erosion data.

SIBERIA has been subjected to extensive validation and generally, the validation work indicates that provided the model is adequately calibrated, SIBERIA predictions of landform development appear to be reasonable (Hancock et al., 2000, Hancock et al., 2002, Hancock et al., 2003).

Input Parameters

SIBERIA predicts the long-term average change in elevation of a point by predicting the volume of sediment lost from a node. The rate of sediment transport through a node (q_s in units of m^3/y) is determined by the equation:

$$q_s = \beta_1 \times q^{m_1} \times S^{n_1}$$

where β_1 is the sediment transport rate coefficient, q is discharge (m^3/y), m_1 is the discharge exponent, S is the slope (m/m), and n_1 is the slope exponent.

SIBERIA does not directly model runoff, but uses sub-grid effective parameterisation which relates discharge to area draining through a point as:

$$q = \beta_3 \times A^{m_3}$$

where β_3 is the coefficient between discharge and area, A is area (m^2), and m_3 is the exponent of the area in discharge.

Derivation of SIBERIA Input Parameters

The β_1 and m_1 input parameters for SIBERIA are derived by fitting the SIBERIA model equations to time series data of runoff and erosion. However, in most instances, sufficient record lengths of time series data are not available for the landforms being considered. Subsequently, Landloch has developed an alternative approach for deriving the β_1 and m_1 SIBERIA input parameters:

- a) Make measurements of runoff and erosion on materials using laboratory-based flume and rainfall simulations to derive calibrated WEPP erodibility parameters.
- b) Generate time-series data of runoff and erosion using the WEPP runoff/erosion model set up with:
 - a. Batter geometries consistent with the geometries of the landform being considered (allowing values for β_3 , n_1 , and m_3 to be fixed).
 - b. Long-term climate sequences (100-years) that is site specific, and that contains a wide range of rainfall events, including rare and very rare events.
 - c. Material erodibility set based on the values measured using laboratory-based techniques.
- c) Fit the WEPP runoff and erosion model data to the SIBERIA model equations to derive values for β_1 and m_1 that are both material and site specific, and that have been adjusted to account for vegetation groundcover impacts on erosion using the RUSLE.

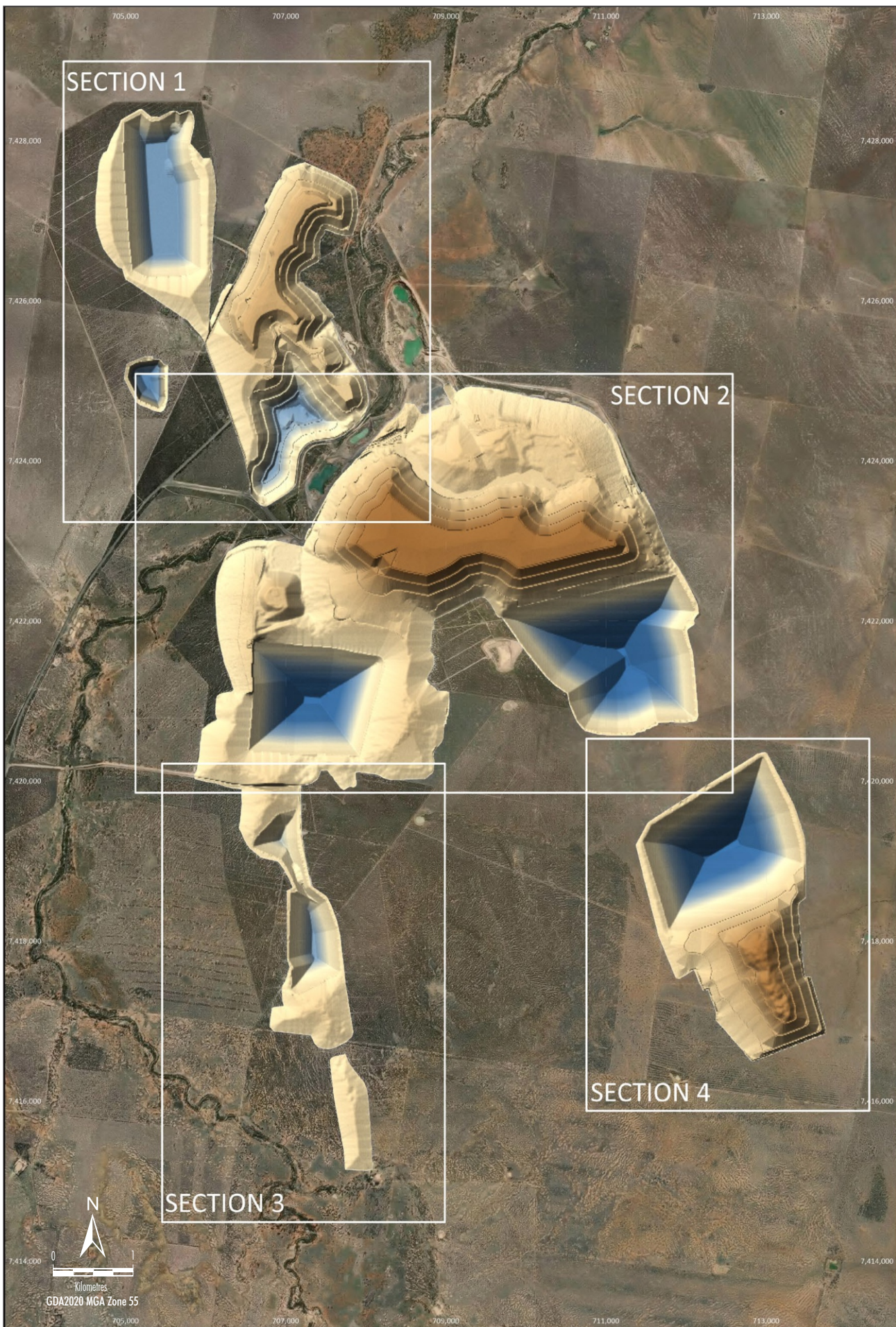
In this way, the SIBERIA parameters will represent a vegetated surface specific to the climate and surface materials available at Yarrabee.

Landform Design

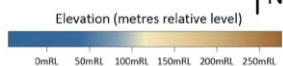
A Digital Elevation Model (DEM) of the Yarrabee Mine final landform was modified by Landloch to remove obvious anomalies in the elevations. For example, spikes and troughs were removed, and long sections of batter slopes were smoothed. A roughness of $\pm 0.1\text{m}$ was also added to the DEM to reduce gridding artefacts and to provide a more realistic surface for modelling.

The landform modelled is shown in Figure 6-33. The landform was modelled in 4 sections.

YAN-23-48 PRCP_Section_034A



Legend



Source: Appendix M. Rehabilitation Landform Design: Yarrabee Coal Mine — Landloch Pty Ltd



YARRABEE COAL MINE
SIBERIA Modelled Landform

Figure 6-33

Model Settings and Assumptions

SIBERIA modelling was undertaken on the Yarrabee Mine final landform with the vegetated soil-waste mixture applied to all surfaces. The following erosion statistics were produced for each SIBERIA simulation:

- Outputs at year 50, 100, 150, 200, 250, and 300.
- Average erosion in t/ha/yr for each output year.
- Depth of gully formation at each output year. A minimum depth of 0.3m is used to define a gully.

Erosion statistics for the Yarrabee landform were developed for each of the 4 sections, as shown in Figure 6-33. The outputs from the SIBERIA model were processed to produce a series of visual outputs for each model run. For each model run visuals of:

- Erosion and deposition on the modelled surface are given with scaling to show erosion/deposition ± 0.3 m in green, deposition >0.3 m in blue; and erosion >0.3 m in red.
- Erosion rates on the modelled surface are given with scaling to show long-term average annual erosion rates <5 t/ha/yr in green (low erosion), 5–10 t/ha/yr in yellow and orange, and >10 t/ha/yr in purple (high erosion).

The following assumptions were applied to the SIBERIA modelling and its results:

- Input parameters are based on a single material being present on the outer surface of a given landform.
- Vegetation has been included.
- All soils and wastes used near the surface have been gypsum treated to reduce the risk of dispersion.

6.5.7 SIBERIA Modelling Results

SIBERIA modelling was completed with a vegetation groundcover level of 50% and a soil-waste mixing ratio of between 1:1 and 1:2 (both mixing ratios yield similar results). Using input parameters derived for this surface material and groundcover level, the SIBERIA model was run for 300 years, with outputs provided for every 50 year period. At each output year, visualisations of the rate and depths of erosion are provided. Visualisations of erosion depths after 300 years are given in Figure 6-34 to Figure 6-37 for the four sections modelled.

All visualisations of erosion rates and depth (50, 100, 150, 200, 250, and 300 years) are provided in Appendix M.

Table 6-26 presents the predicted maximum erosion depth and long-term average erosion rates for each section modelled. The erosion rates are those of the batter slopes and do not include erosion of the low gradient top surfaces of the landform, which have little to no erosion.

Table 6-26: Predicted Maximum Gully Depths and Long-Term Erosion Rates for the Yarrabee Final Landform when Sheeted with a Soil-Water Mixture with 50% Groundcover

Simulation Year	Maximum Gully Depth (m)	Average Annual Erosion (t/ha/yr)	Cumulative Erosion (mm)
Landform Section 1			
50	-	1.4	6
100	-	1.5	12
150	0.3	1.5	24
200	0.4	1.9	40
250	0.5	1.3	50
300	0.6	1.3	61
Landform Section 2			
50	-	2.4	10
100	-	1.7	17
150	-	1.5	30
200	0.3	1.4	41
250	0.4	1.3	52
300	0.5	1.3	63
Landform Section 3			
50	-	1.7	7
100	-	1.2	12
150	-	0.9	20
200	-	0.8	27
250	0.3	0.8	33
300	0.4	0.7	39
Landform Section 4			
50	-	2.6	11
100	-	1.9	19
150	-	1.6	33
200	-	1.5	45
250	-	1.5	58
300	0.3	1.4	70

Source: (Appendix M).

Table 6-26 indicates that when a soil-waste mixture of 1:1 or 1:2 soil:waste ratio is utilised in landform rehabilitation and the final landform supports a vegetation groundcover level of 50%, the predicted long-term erosion rates are below the long-term average annual erosion target level of <5 t/ha/yr. At this level of erosion, the surfaces are not prone to significant levels of rill or gully erosion.

The average annual erosion rates for the landform are predicted to reduce through time. There is a slight increase in erosion rates in Section 1, which is likely due to its more complex shape compared to the rest of the landform. Despite this slight increase, erosion rates in Section 1 are not predicted to become unacceptably high for the period modelled.

A trend of reducing erosion rates over time indicates that the landform is predicted to trend towards increased erosional stability through time, and any gullies that may be present are predicted to reduce in activity over time. Some gully erosion is predicted to occur after 150–300 years, however, given the underlying material is likely to be more erosion-resistant Permian waste, the risk of exposing more erodible materials over the long-term is considered low in areas where gully erosion may occur.

Section 1

Figure 6-34 indicates gully development is focussed on the lower western portion of the larger waste landform and the interface between the upper two lifts of the same landform. Interrogation of the DEM shows that there are approximately 5–16 m (vertical height) portions of the slope that are much steeper (80%) in these locations than the remainder of the slope (30%). Therefore, the gullying predicted by SIBERIA is an artefact of the modelling where the design is not exactly meshed with the DEM of the surrounding surfaces. As these areas will not be built at such steep gradients, the risk of gully erosion in these areas is likely less than predicted.

Section 2

Figure 6-35 presents gully development focussed on the lower northern portion of the waste landform and the bund at the top of the void. Interrogation of the DEM of the waste landform shows that there is an approximately 10 m (vertical height) portion of slope at this location that is much steeper (130%) than the remainder of the slope (25%). Subsequently, the gullying predicted by SIBERIA at this location is an artefact of the modelling where the design is not exactly meshed with the DEM of the surrounding surfaces. Provided this section is not built at these steep gradients, the risk of gully erosion at this location is likely less than is predicted.

For the bund at the top of the void, interrogation of the DEM showed that when it was gridded (as is needed to input to SIBERIA) small (approximately 1.0 m) imperfections in the bund height were generated. This led to SIBERIA predicting that the bund breached, causing gully erosion to be predicted. However, this is also an artefact of the model and if the bund is constructed as intended, gully erosion is likely to not occur at this location.

Section 3

Similarly to Section 1 and Section 2, gully erosion predicted for Section 3 (Figure 6-36) is located in steep-gradient areas that are not intended to be present in the implemented design, or in portions of the bund around the void that had imperfections when gridded in preparation for modelling.

Section 4

In Section 4 (Figure 6-37), gully development is focussed on the lower eastern and southern portions of the landform. Interrogation of the DEM supplied in these locations show that there are approximately 10–20 m (vertical height) portions of slope that are much steeper (100–200%) than the remainder of the slope (30%). Therefore, the gullying predicted by SIBERIA is an artefact of the modelling where the design is not exactly meshed with the DEM of the surrounding surfaces. As these areas will not be built at such steep gradients, the risk of gully erosion in these areas is likely less than predicted.



Legend

■	Erosion (gully) < -0.3 m	■	Deposition > 0.3 m
■	Movement < -0.3 m	■	Excluded from Modelling

Source: Appendix M. Rehabilitation Landform Design: Yarrabee Coal Mine — Landloch Pty Ltd



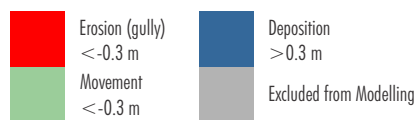
YARRABEE COAL MINE

Predicted Erosion and Deposition Depths
of Section 1 of the Final Landform After
300 Years Using Vegetated Soil-waste
Mixture with 50% Groundcover

Figure 6-34



Legend



Source: Appendix M. Rehabilitation Landform Design: Yarrabee Coal Mine — Landloch Pty Ltd



YARRABEE COAL MINE

Predicted Erosion and Deposition Depths
of Section 2 of the Final Landform After
300 Years Using Vegetated Soil-waste
Mixture with 50% Groundcover

Figure 6-35



Legend

■	Erosion (gully) < -0.3 m	■	Deposition > 0.3 m
■	Movement < -0.3 m	■	Excluded from Modelling

Source: Appendix M. Rehabilitation Landform Design: Yarrabee Coal Mine — Landloch Pty Ltd



YARRABEE COAL MINE

Predicted Erosion and Deposition Depths
of Section 3 of the Final Landform After
300 Years Using Vegetated Soil-waste
Mixture with 50% Groundcover

Figure 6-36



Legend

■	Erosion (gully)	■	Deposition
■	< -0.3 m	■	> 0.3 m
■	Movement		Excluded from Modelling
■	< -0.3 m		

Source: Appendix M. Rehabilitation Landform Design: Yarrabee Coal Mine — Landloch Pty Ltd



YARRABEE COAL MINE

Predicted Erosion and Deposition Depths
of Section 4 of the Final Landform After
300 Years Using Vegetated Soil-waste
Mixture with 50% Groundcover

Figure 6-37

6.5.8 Final Landform Stability

The stability of the Yarrabee Mine final landform was determined through the use of WEPP runoff and erosion modelling and SIBERIA Modelling. WEPP and erosion modelling was utilised to identify landform batter options that would erode at rates low enough to provide long-term erosional stability. The results of this modelling was used to develop three-dimensional rehabilitation shapes that could in turn be subjected to landform evolution modelling using the SIBERIA model.

The results of the SIBERIA modelling indicate that the Yarrabee Mine final landform is predicted to be erosionally stable in the long-term, provided that a suitable soil-waste mixture is achieved, and suitable levels of groundcover are achieved. To achieve stability, a soil-waste mixing ratio of between 1:1 and 1:2 (soil:waste) and a groundcover level of >40% is required. Gully erosion risk is predicted to be low, which much of the gully erosion shown resulting from artefacts in the DEM that will not be present when the landform design is implemented.

The results from the erosion modelling and landform evolution modelling indicate that vegetated soil-waste mixtures (1:1 or 1:2 mixing ratio with >40% groundcover) can be used to create a rehabilitated landform that is erosionally stable in the long-term. Geometries of the surfaces used on the Yarrabee landform are based on:

- Erosion rates consistent with surfaces with a low tendency for rill erosion (soil erosion targets).
- Erodibility testing of Yarrabee's soils and soil-waste mixtures.
- Suitability of the soils and fresh Permian waste as a primary growth media and the wastes as second growth media (underlying the primary growth media layer).
- Predicted long-term erosion rates for land surfaces found in the current final landform design for Yarrabee.

The soils were assessed as being suitable for use as a primary growth medium (i.e. at the surface of the rehabilitated final landform) once amended with gypsum and assuming that salt tolerant species are part of the species targeted for establishment. The fresh Permian waste was also assessed as being suitable for use as a growth medium once amended with gypsum and mixed with soil. Tertiary and Quaternary wastes should not be placed within 2.0 m of the soil surface of the rehabilitated final landform.

The potential for gully development on the batter slopes and low-gradient surfaces is predicted to exist but be low. The long-term erosion rates within the final landforms are predicted to be consistent with the rates predicted to occur in undisturbed vegetated areas in the vicinity of Yarrabee Mine.

The WEPP runoff and erosion modelling and SIBERIA Modelling results align with the rehabilitation requirements detailed in *Attachment 1* of EA EPML00844613, which have been transitioned into the PRCP. Therefore, the outcomes of the erosion and landform evolution modelling did not result in any alterations to the Yarrabee Mine Final Landform or the proposed rehabilitation techniques detailed throughout this PRCP.

6.6 SOIL AND CAPPING MATERIAL ASSESSMENT

Soil and overburden materials at Yarrabee Mine have been sampled and analysed for numerous studies (Soil Conservation and Environmental Services, 1990; Natural Resource Assessments, 1997; ESys Consulting, 2003; Baker, 2010; Landloch, Appendix K). The findings of the historic assessments are detailed in Section 6.6.1.1. In 2024, additional assessments were undertaken by GT Environmental Pty Ltd (GTE) to assess soil quality (Appendix N), the findings of which are outlined in Section 6.6.2.

6.6.1 Historic Material Assessments

The general material characteristics from historic studies undertaken across Yarrabee Mine, including Landloch (Appendix K) as summarised in Table 6-27. The overburden sampled is assumed indicative of overburden across Yarrabee Mine. Chemical characteristics of samples taken from the DOM2, DOM5, A-Pit and YEN-Pit areas and of Yarrabee topsoil are summarised in Table 6-28 (Appendix K). Landloch (Appendix K) identified that materials at Yarrabee are generally alkaline, saline, and sodic in nature:

- The mudstone is typically alkaline with high EC and high chloride concentration and is more resistant to erosion than the sandstone.
- The sandstone is consistently more saline than the mudstone (especially when chloride concentration is considered rather than just EC) and is strongly sodic.
- The high EC and sodicity of the overburden are reflected in the overlying subsoils, with subsurface clays recording the highest levels of EC and sodicity (Appendix K).

Table 6-27: Summary of Overburden Characterisation Findings

Issue	Yarrabee South (1997)	Yarrabee North (2003)	Yarrabee East (2010)
Alkalinity	High to very high.	High to very high.	Likely to generate alkaline surface run-off and seepage.
Sodicity	High to very high.	High to very high.	Are sodic and may have structural stability problems related to potential dispersion and erosion.
Dispersion	Dispersive with respect to the R2 test, that is, susceptible to tunnel erosion, but not dispersive according to the R1 test.	Most materials were dispersive with only the sands, laterite and some Rangal sandstone being weakly or non-dispersive.	Inferred.
Erodibility	Fine fraction of all materials was assessed as being highly erodible although the hard sandstones less so given the presence of more competent gravel and rock.	The gravelly and clayey sands were less susceptible to erosion than the remaining materials; actual erodibility will depend largely on the proportion of competent rock fragments within the spoil.	Inferred.
Fertility	All materials were deficient in nitrogen and phosphorus.	All materials were deficient in nitrogen and phosphorus.	N/A
Acid producing potential	All overburden groups were non-acid forming.	No overburden group is expected to be acid forming.	Have negligible risk of acid generation and high FoS.
Metal toxicity	All overburden groups recorded metal levels below trigger levels.	No overburden group exhibits sufficiently high levels of metals to warrant further investigations nor selective handling.	Have total metal concentrations in solids within applied guideline criteria for soils.
Salinity (EC)	Salinity was high but less than salinity in some subsoils.	Very high in the surface clays and Rangal sandstones and siltstones; low in laterite, sands and sandy clay.	Likely to generate surface run-off and seepage that is moderately saline.

Source: (Appendix K).

Table 6-28: Chemical Characterisation of Overburden

Analyses	Unit	DOM2		DOM5		A-Pit		YEN-Pit		Topsoil
		Mdst.	Sst.	Mdst.	Sst.	Mdst.	Sst.	Mdst.	Sst.	
pH (water)	pH units	9.74	9.20	9.55	9.00	9.48	8.69	8.03	7.71	8.45
Electrical Conductivity	dS/m	0.71	1.62	0.54	1.01	0.30	0.28	1.99	2.50	0.45
Chloride	mg/kg	915	3,035	259	1260	55	770	162	3570	0.0314
Cation Exchange Capacity	meq/100g	13.0	18.1	17.6	6.5	18.5	2.9	17.6	26.3	13.8
Exchangeable Calcium	%	25.3	35.2	20.4	37.3	23.7	34.9	25.6	16.2	56.36
Exchangeable Magnesium	%	43.4	36.7	47.1	33.2	45.0	30.3	42.2	49.1	34.03
Exchangeable Potassium	%	1.49	0.31	1.41	2.78	1.58	5.07	1.43	0.94	1.17
Exchangeable Sodium	%	29.8	27.8	31.0	26.7	29.6	29.6	30.7	33.7	8.39

Source: (Appendix K).

Note: Mdst = Mudstone; Sst = Sandstone; dS/m = decisiemens per metre; mg/kg = milligrams per kilogram of soil; meq/100g = milliequivalents per 100 grams of soil

6.6.2 Soils and Land Suitability Assessment

A Soils and Land Suitability Class Assessment was undertaken by GTE (Appendix N) to assess soil and land quality within the Yarrabee MLs. The assessment included the following:

- Soil Profile Classes (SPCs) identification and description.
- Assessment of cropping land uses and agricultural land classes for all SPCs identified.
- A Regional Planning Interests assessment for the area.
- An assessment of potential and actual acid sulphate soils.
- An assessment of the soil values and suitability of each SPC for rehabilitation activities.
- Soil management requirements, including stripping, stockpiling, spreading and amelioration.

6.6.2.1 Soil Surveys

Soil surveys undertaken by GTE were scoped and conducted in accordance with the Guidelines for Surveying Soil and Land Resources (McKenzie et al., 2008), Queensland Soil and Land Resource Survey Information Guideline (DoR, 2021) and Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment (DES, 2021). The surveys were conducted between 17 and 21 June 2024 and 19 and 24 July 2024.

Preliminary sampling locations were derived from a review of background information, existing soils information and a review of satellite imagery patterns. Specific locations for the survey were further refined in the field based on access, and whether the location was representative of the SPC being described.

Free survey and transect techniques (Gunn et al., 1988; McKenzie et al., 2008) were used to verify the SPCs and assign a boundary to each. Free survey is commonly used in land assessment as it enables flexibility in site selection, compared to grid mapping techniques. It is well suited to detailed surveys and is often utilised in soil surveys for resource projects in Queensland.

Transect techniques were also utilised in areas with accessible tracks of varying topography, providing a detailed cross section of the landscape, and assisting in identifying patterns of soil variation. Surveyed polygons were identified as individual Unique Mapping Areas (UMAs).

Detailed site locations were assessed prior to each fieldwork event and distributed across the study area. If an area was observed to benefit from additional detailed sites, these were undertaken. Check sites were conducted at regular intervals to define SPC boundaries or alternatively to confirm an area based on the landform, vegetation, surface conditions, or soil morphological conditions.

The detailed survey sites for the study area were generally conducted to 1.50 mbgl. Deep borings, where a soil profile is taken to a depth equal to or greater than 2 m, were also undertaken as part of this assessment.

Medium intensity (McKenzie et al., 2008; DES, 2021) soil surveys have been undertaken for the study area. Surveys of similar intensity have previously been submitted for areas in the central and north Queensland regions and were deemed acceptable based on the complexity of the landscape.

The nominated soil survey intensity considered the layout of the study area while being in accordance with the relevant guidelines for the proposed mine site components for the study area.

Detailed sites without SALS analysis were undertaken at 24 locations, detailed sites with SALS analysis undertaken at 14 locations. One location was selected for a deep boring detailed site, which was randomly selected within SPCs that enabled for the exposed soil profile to be observed below 1.50 mbgl.

The sites were used to describe the range of soil profile morphological attributes as per the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain [NCST], 2009) including landforms, slope, surface conditions, rock cover, major vegetation, and soil colour (as per Munsell Color [2009] Soil Colour Charts). At each detailed site, an assessment was also made of the quality, depth and quantities of reusable soil resources.

Soil characteristics and soil profiles were described in accordance with the Australian Soil and Land Survey Field Handbook (Gunn et al., 1988; NCST, 2009), DoR (2021) and DES (2021). Soils were grouped according to parent material and position in the landscape and classified in accordance with The Australian Soil Classification (Isbell, 2021). Soils were also correlated to soils mapped in Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land System boundaries (*Lands of the Dawson-Fitzroy Area* [Perry et al., 1968]) within the study area and identified proposed SPCs.

6.6.2.2 Soil Assessment Techniques

Laboratory analysis was undertaken to assist in determining the characterisation of the soils and to establish any physical and chemical limitations. Laboratory analysis also identified any soils that require specific management measures. Soil samples were analysed for a laboratory suite, based on recommended standard suites.

Soil sample collection for laboratory analysis was undertaken as per the Land Suitability Assessment Techniques (LSAT) outlined in the Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (Department of Mines and Energy [DME], 1995), (DoR, 2021) and (DES, 2021).

Physical and chemical properties of soils relevant to the potential for erosion were determined for analysed site samples within the soil profile based on field and laboratory assessment of dispersive attributes including but not limited to texture, R1 dispersion and Emerson Aggregate Test (EAT) results.

6.6.2.3 Land Capability and Suitability

Land Suitability classification was based on the Land Capability Classification in Queensland, outlined in the Guidelines for Agricultural Land Evaluation (GALE) (Department of Science, Information Technology and Innovation [DSITI] & Department of Natural Resources and Mines [DNRM], 2015), QDPI (1994) and DME (1995). This classification covered evaluation of land attributes for arable, pastoral and other agricultural land uses.

GALE (DSITI and DNRM, 2015) was utilised to assess Land Suitability Classes and ALC. Table 6-29 details the land suitability for agriculture which decreases progressively from Land Suitability Class 1 to Class 5, based on the severity of the land use limitations.

Land rated in Land Suitability Classes 1 to 3 is considered suitable for agricultural land use with negligible to moderate limitations.

Land rated as Land Suitability Class 4 is considered currently unsuitable for agricultural land use due to the severity of one or more limitations. However, it may be possible to upgrade Class 4 land to a Class 3 or better with the implementation soil improvement measures.

Land rated as Land Suitability Class 5 is considered unsuitable for the agricultural land use as limitations are so severe that the inputs required to initiate and maintain an agricultural land use are not sustainable.

Table 6-29: Land Suitability Classes (DSITI & DNRM, 2015)

Land Suitability Class	Suitability	Limitations	Definition
1	Suitable	Negligible	Highly productive land requiring only simple management practices to maintain economic production.
2	Suitable	Minor	Land with limitations that either constrain production or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable	Moderate	Land with limitations that either further constrain production or require more than those management practices of class 2 land to maintain economic production.
4	Unsuitable	Severe	Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics, or technology.
5	Unsuitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

Source: (Appendix N).

6.6.2.4 *Soil Suitability*

Soil suitability for rehabilitation was assessed using field and laboratory assessment of texture, fertility, dispersive and structural attributes. Groupings of soils with similar attributes are described as Soil Types in Land—EIS Information Guideline (DES, 2022).

6.6.2.5 *Soil Assessment Results*

Fourteen SPCs were observed and mapped encompassing 65 UMAs within the study area. Table 6-30 outlines the SPCs identified and provides a description of each including soil morphology, position in the landscape, and applicable UMAs and detailed sites.

SPCs were classified in accordance with the Australian Soil Classification (ASC) (Isbell, 2021) in which five of the 14 ASC were observed. Associated land systems and soils have been reviewed and linked to SPCs where relevant as detailed in Table 6-30.

Table 6-30: Land Summary of Soil Profile Classes in the Study Area

SPC map code	SPC Concept	ASC (Dominant to sub-order)	UMAs (Analysed)	Detailed sites (Analysed)	Cropping Suitability	Beef Cattle Grazing Suitability	Agricultural Land Class	Topsoil Thickness for Use in Mine Rehabilitation (mbgl)	Total Area (ha)
Pg (Yb1)	Very deep, grey, shrink/swell, dispersive subsoil clay soils on plains, with microrelief	Grey Vertosol	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	D1d/m, D2m/d, D22, D24, D25, D26, D34m/d, D35, D36, D38	Cotton, Maize, Mungbean, Soybean (Class 4). Barley, Millet (Class 5)	Class 3	C1	0.10	1293.83
Rs (Yb2)	Very deep, brown, dispersive subsoil clay soils on plains with no microrelief	Brown Dermosol	12, 13	D3	All six land uses (Class 5)	Class 4	C1	0.10	42.45
Pg (Yb3)	Very deep, brown, self-mulching, shrink/swell, dispersive subsoil clays on plains with microrelief	Brown Vertosol	14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	D4, D5d/m, D23, D27, D28, D29, D30, D31, D32, D37, D45	All six land uses (Class 5)	Class 4	C1	0.10	1986.23
Rs (Yb4)	Very deep brown, surface crust, dispersive clay soils on plains with no microrelief	Brown Dermosol	26, 27, 28, 29, 30, 31, 32, 41	D7, D20, D46	Cotton (Class 4). Remaining five land uses (Class 5)	Class 4	C1	0.10	103.68
Pg (Yb5)	Very deep, grey, self-mulching, shrink/swell, dispersive clays on plains with microrelief	Grey Vertosol	33, 34, 35, 36, 37	D8d/m, D9, D11, D12, D43	Cotton (Class 4). Remaining five land uses (Class 5)	Class 4	C1	0.10	319.33
Rs (Yb6)	Very deep, grey, cracking, dispersive clays on plains	Grey Vertosol	38, 39	D10, D13	Cotton (Class 4). Remaining five land uses (Class 5)	Class 4	C1	0.10	33.57
Rt (Yb7)	Very deep, brown single grain structured, sandy loam soils on plains	Brown Tenosol	40	D14	Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5)	Class 4	B	0.50	3.35

Table 6-30 (Continued): Land Summary of Soil Profile Classes in the Study Area

SPC map code	SPC Concept	ASC (Dominant to sub-order)	UMAs (Analysed)	Detailed sites (Analysed)	Cropping Suitability	Beef Cattle Grazing Suitability	Agricultural Land Class	Topsoil Thickness for Use in Mine Rehabilitation (mbgl)	Total Area (ha)
Rt (Yb8)	Very deep, brown, gradational textured, clays on plains and open depressions	Brown Dermosol	42, 60	D15, D17	Cotton (Class 4). Remaining five land uses (Class 5)	Class 4	C2	0.25	31.63
An (Yb9)	Very deep, red single grain to weak structured, sandy loam soils on rises	Red Tenosol	43, 44, 45, 46, 47	D16, D19	Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5)	Class 4	B	0.50	8.31
Rt (Yb10)	Moderately deep, brown, texture contrast loam soil on rises	Brown Chromosol	48	D18	Cotton (Class 4). Remaining five land uses (Class 5)	Class 4	C2	0.10	22.80
Lx (Yb11)	Very deep, red, moderately structured, sandy clay loam soil on plains	Red Dermosol	49, 50, 51	D21, D47	Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5)	Class 3	B	0.40	15.74
Pg (Yb12)	Very deep, grey, crusty, shrink/swell, dispersive clays on plains with microrelief	Brown Vertosol	52, 53, 54, 55, 56, 57	D6, D33d/m, D39, D42, D44	All six land uses (Class 5)	Class 5	C3	0.10	336.32
Tv (Yb13)	Shallow, brown, hard setting, dispersive subsoil clay soils on plains	Brown Dermosol	58	D40	Cotton, Maize, Mungbean, Soybean (Class 4). Barley, Millet (Class 5)	Class 3	C1	0.10	10.80
Rt (Yb14)	Very deep, red weakly structured loam to clay loam soils on plains	Red Kandosol	59, 61	D41	Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5)	Class 3	B	0.40	24.60

Source: (Appendix N).

6.6.2.6 Cropping Suitability Assessment Results

Desktop, field, and laboratory data collected from analysed sites in the study area were reviewed against the Regional Frameworks (Department of Natural Resources and Mines and the Department of Science, Information Technology, Innovation and the Arts, 2013). Table 6-31 provides a detailed description of the land attributes and the corresponding Land Suitability Classes providing a summary of the limitations for each SPC. The distribution of each SPC is presented in Figure 6-38.

Individual UMAs of each SPC were assessed for land suitability classes against the rule set selected. This is to ensure that the Land Suitability Class reflects specific SPC UMAs with observed differences to the analysed site UMA.

Table 6-31: Soil Profile Classes for Regional Frameworks, Suitability Subclasses for Land Uses

Regional Frameworks Assessment	SPCs	Area (ha)
Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5).	Rt (Yb7), An (Yb9), Lx (Yb11), Rt (Yb14)	52.00
Cotton, Maize, Mungbean, Soybean (Class 4). Barley, Millet (Class 5).	Pg (Yb1), Tv (Yb13)	1,304.63
Cotton (Class 4). Remaining five land uses (Class 5).	Rs (Yb4), Pg (Yb5), Rs (Yb6), Rt (Yb8), Rt (Yb10)	511.01
All six land uses (Class 5).	Rs (Yb2), Pg (Yb3), Pg (Yb12)	2,365.00

Source: (Appendix N).

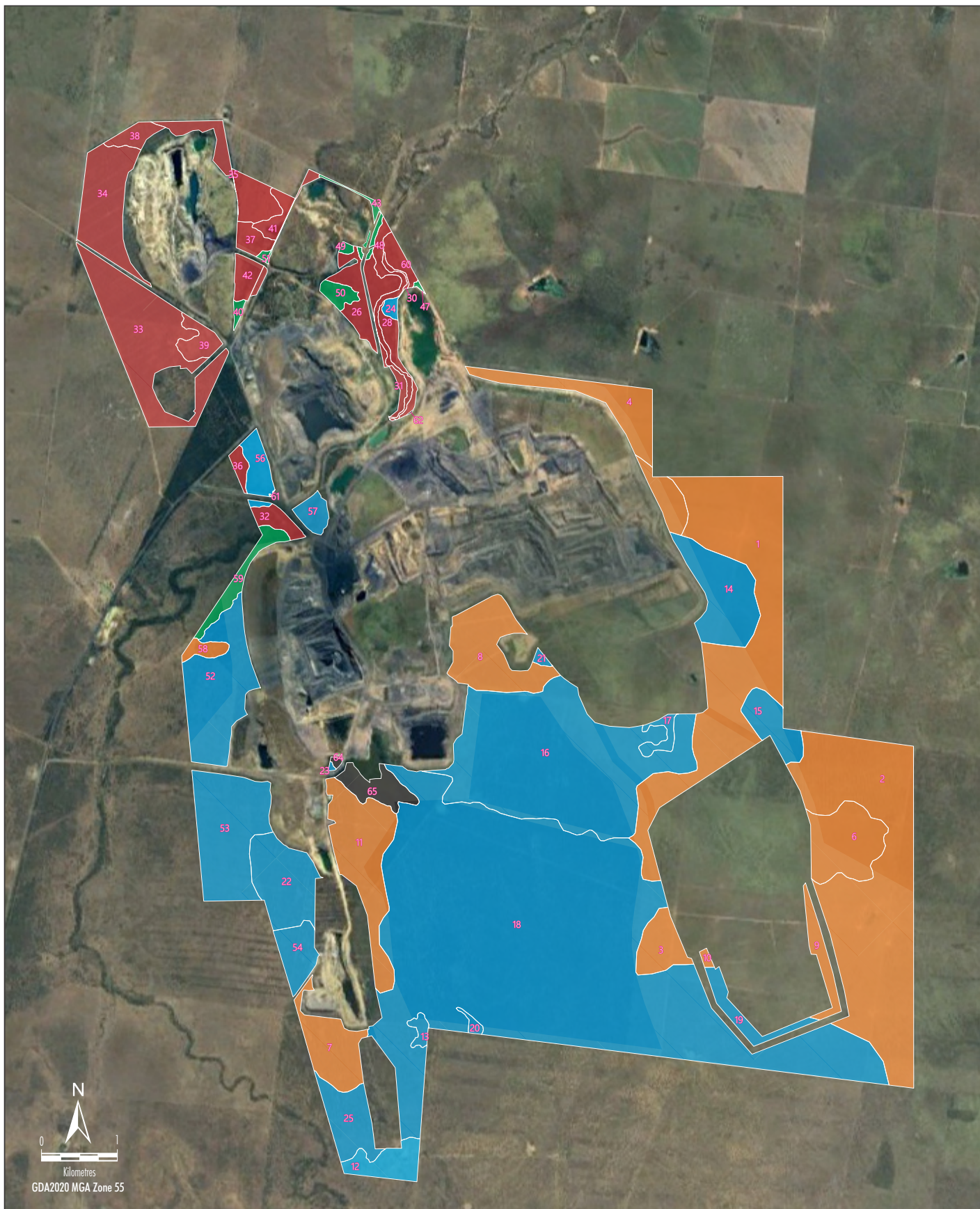
6.6.2.7 Beef Cattle Grazing Assessment Results

Suitability for Beef Cattle Grazing LSAT (DME, 1995), with reference for beef cattle grazing in the Land resource survey and evaluation of the Kilcummin area, Queensland (Shields & Williams, 1991). Were used to assess the SPCs suitability for Cattle Grazing. The assessment is summarised in Table 6-32 and presented in Figure 6-39.

Table 6-32: Soil Profile Classes for Beef Cattle Grazing, Suitability Subclasses for Land Uses

Beef Cattle Grazing Assessment	SPCs	Area (ha)
Beef Cattle Grazing (Class 3).	Pg (Yb1), Lx (Yb11), Tv (Yb13), Rt (Yb14)	1,344.97
Beef Cattle Grazing (Class 4).	Rs (Yb2), Pg (Yb3), Rs (Yb4), Pg (Yb5), Rs (Yb6), Rt (Yb7), Rt (Yb8), An (Yb9), Rt (Yb10)	2,551.35
Beef Cattle Grazing (Class 5).	Pg (Yb12)	336.32

Source: (Appendix N).



LEGEND

- Study Area
- Proposed disturbance area
- Existing mining disturbance
- Unique mapping area
- Cotton (Class 3). Maize, Mungbean, Soybean (Class 4). Barley, Millet, (Class 5)
- Cotton, Maize, Mungbean, Soybean (Class 4). Barley, Millet (Class 5)
- Cotton (Class 4). Remaining five land uses (Class 5)
- All six land uses (Class 5)

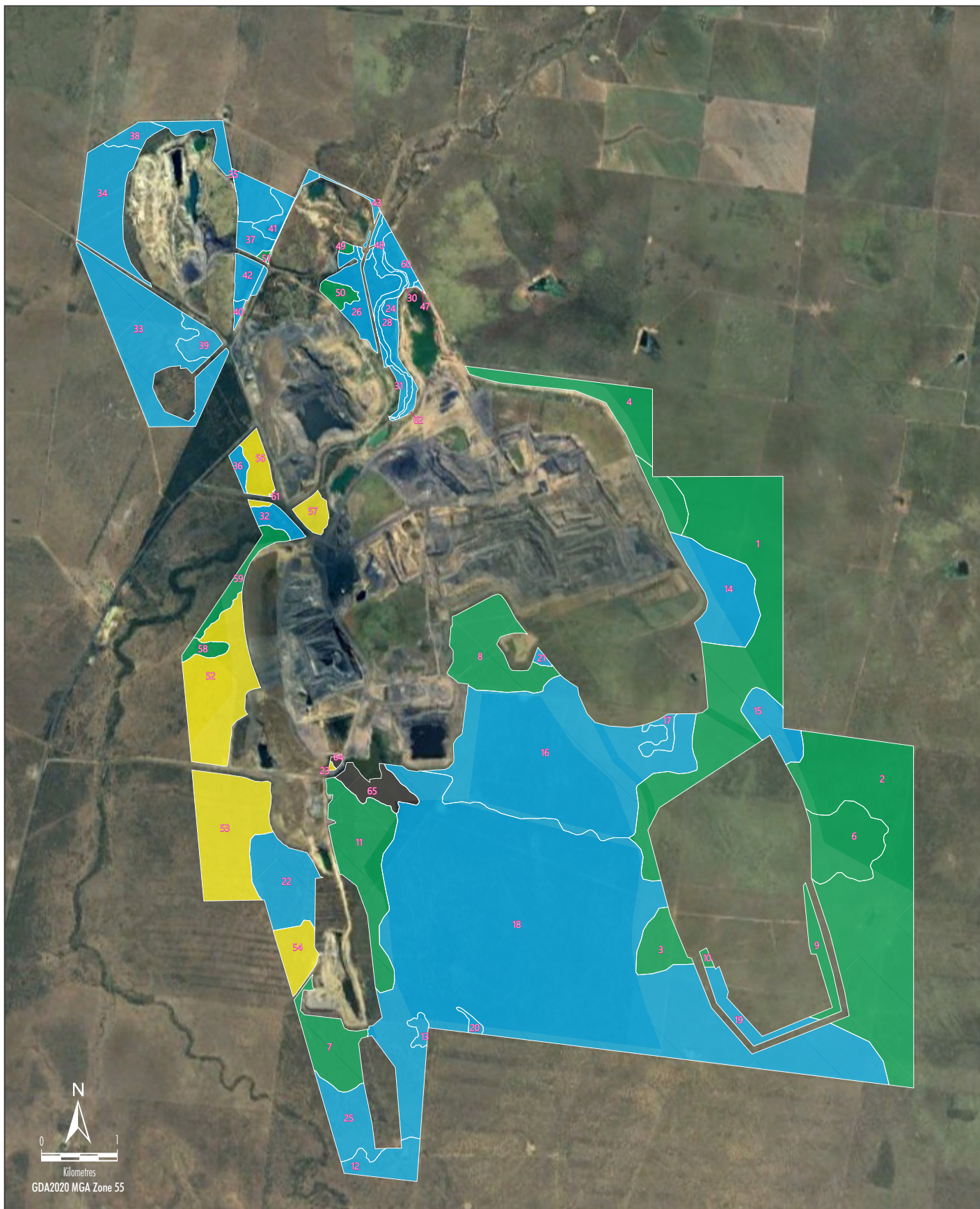
Source: Appendix N. Soil Material Assessment — GT Environmental Pty Ltd



YARRABEE COAL MINE

Regional Frameworks
Cropping Suitability

Figure 6-38



LEGEND

- Study Area
- Proposed disturbance area
- Existing mining disturbance
- Unique mapping area
- Class 3
- Class 4
- Class 5

Source: Appendix N. Soil Material Assessment — GT Environmental Pty Ltd



YARRABEE COAL MINE
Beef Cattle Grazing Suitability

Figure 6-39

6.6.2.8 Acid Sulphate Soils Assessment

GTE undertook a review of available Acid Sulphate Soils (ASS) mapping for the study area within datasets available in Queensland Globe (2024) and ASRIS (2024). The review indicated that no known ASS was identified within or adjacent the study area.

Field observations were undertaken during the soil surveys, which were reviewed against the State Planning Policy 2/02, Planning and Managing Development involving Acid Sulfate Soils (Queensland Government, 2002) Appendix 2: Soil and Water Field Indicators.

Field pH was conducted using a pH indicator kit and meter and laboratory pH analysis was also reviewed. All other indicators were visually inspected within the soil profile and field as part of the soils and land suitability survey.

Three of the 14 SPCs reported field and laboratory observation indicators of strongly acidic pH within subsoil and where therefore assessed as very low field indication of PASS. The remaining 11 of the 14 SPCs, did not report indicators of PASS or AASS. This result of very low to no field indicators, is consistent with the desktop review against the Atlas of Australian Acid Sulfate Soils mapping (ASRIS, 2024) which presented the study area as “low to very low probability of occurrence”.

6.6.2.9 Soils and Land Suitability Assessment Key Findings

The key conclusions of the soil and land suitability assessment are as follows:

- In general, the soils consisted mostly of deep, structured clay soils associated with non-rigid clays with microrelief. Other soils observed included deep red earths and texture contrast soils.
- SPCs were classified into five ASC orders, consisting of Chromosols, Dermosol, Kandosols, Tenosols, and Vertosols.
- The cropping and cattle grazing suitability of each SPC was determined by assessing against the nominated Regional Frameworks (DNRM and DSITIA 2013) for the Inland Fitzroy and Southern Burdekin Area land uses. Four SPCs were identified as suitable for limited cropping (Cotton, furrow irrigated) with moderate limitations.
- Beef cattle grazing suitability was determined by assessing against DME (1995) with reference to Land resource survey and evaluation of the Kilcummin area, Queensland (Shields and Williams, 1991). Four SPCs were identified as suitable for beef cattle grazing with moderate limitations.
- Desktop review of available resources indicated that no known ASS was observed, with ASS mapping summarised as either extremely low probability of occurrence, based on very low confidence or low probability of occurrence, based on low confidence.
- Field observations of SPCs were undertaken during the soils and land suitability assessment with the following observed.
 - Three of the 14 SPCs reported field and laboratory observation indicators of strongly acidic pH within subsoil and shells, therefore assessed as very low field indication of PASS.
 - The remaining 11 of the 14 SPCs, did not report indicators that would be assessed as PASS or AASS.

In summary, topsoil resources from the majority of SPCs contain topsoils that are suitable for reuse in rehabilitation activities:

- The topsoil consisted of fair structured, low to moderate (favourable) fertility levels, moderately deep to very deep clay soils which are indicative of the area, most of the topsoil and subsoil suitable for reuse for rehabilitation.
- Soil amelioration recommendations such as organic matter/fertiliser application, management, storage, and handling recommendations have been provided in Section 6.6.3 to retain and improve the quality of topsoil for rehabilitation reuse pending the final post mine land use.

6.6.3 Soil Stripping and Management Measures

Topsoil resources are stripped prior to mining at an average stripping depth of 200 mm. All soil resources suitable for landform development and/or revegetation are salvaged for re-use and either spread directly on rehabilitation areas or stockpiled for future use. Seasonal considerations (e.g., high rainfall, drought) are considered when planning soil stripping activities.

The preference for soil placement is for soil to be directly placed onto areas that have been prepared for rehabilitation (i.e., already recontoured to the correct final landform profile). However, this is not always possible. The secondary preference is for stockpiles on the top of dumps at a location where minimal rehandle is required for rehabilitation. Stockpile locations should also consider the direction of progression of the pit, dumps and ancillary activities, surface water runoff, proposed or future water pipes or access track locations to ensure they remain undisturbed.

Soil stockpiles are permitted to be up to, but not higher than 3 m. However, in stockpiling to 3 m, the soil is not to be compacted by wheels or other parts of machinery utilised in stockpiling. Stockpiles are surveyed within one week after completing to obtain an accurate volume of stockpiled topsoil.

GTE assessed topsoil during their soils survey. Topsoil was moderately structured, with low to very high fertility (phosphorus), generally consisting of deep clay soils and minor moderately to deep loam, clay loam soils. Topsoil limitations included acidic and alkaline pH, sodicity and dispersivity, poor surface soil structure, salinity, low fertility indicators, and firm to hard setting surfaces restricting seedling emergence. It was determined that amelioration and management may be beneficial to improve topsoil resource quality.

A discussion of ameliorant and fertilizer use is detailed in Section 6.6.3.1. Any amelioration recommendation undertaken on a topsoil resource should be monitored to ensure the objective of the treatment has been met.

6.6.3.1 Ameliorant and Fertiliser Requirements

Soil ameliorant use is designed to reduce the erodibility of the prepared surface, prevent surface crusting, increase organic content, infiltration and moisture retention and buffer surface temperatures to improve germination. Landloch (Appendix K) provided broad recommendations for amelioration requirements for topsoil through the incorporation of:

- A minimum of 2.5 tonnes per hectare (t/ha) of gypsum;
- 50 kilograms per ha (kg/ha) diammonium phosphate (DAP) with added zinc;
- 100 kg/ha of urea; and
- 100 kg/ha of coated (slow release) urea.

The soil ameliorants and application rates outlined above are indicative and further sampling and testing will be undertaken throughout rehabilitation. Sampling of topsoil stockpiles will occur prior to landform development and ameliorant application rates will subsequently be updated to align with the results of sampling.

Findings from GTE's soil and land suitability assessment provided recommendations for potential ameliorant and fertiliser spreading requirements. These findings are detailed in the following sections.

pH Amelioration

pH levels across the majority of SPCs were generally moderately acidic to moderately alkaline. Strongly acidic (pH <5.5) or strongly alkaline (pH >9.0) SPC profiles would reduce availability of nutrients or inhibit root growth. It was observed that overall, the vegetation species present in the study area appeared to be healthy during the fieldworks period in June and July 2024. pH amelioration may be recommended where required through the application of lime to increase pH.

Sodicity and Dispersion Amelioration

ESP results from GTE's soil sampling indicated the proportion of the cation exchange capacity occupied by exchangeable sodium cations. Soils with elevated ESP may be prone to disperse on contact with water and can provide unfavorable soil conditions such as surface crusting, low infiltration, hard and dense subsoils and be susceptible to erosion. Management of soils which are sodic (ESP 6 and above) may require an application of fine grade gypsum at an approximate value of 2.5 t/ha.

Fertiliser Amelioration

SPCs were observed in general to have low to very high fertility as measured by indicators of phosphorus, nitrogen, potassium, and varying levels of micronutrients. Native vegetation species within central Queensland are adapted to the low nutrient levels and may not require fertiliser application where native vegetation is the desired PMLU. If an application of fertiliser is required, it is recommended that the laboratory analysed nutrient levels be reviewed against target nutrient levels, dependent upon the nominated PMLU.

Application rates for nitrogen fertiliser between 100 to 450 kg/ha may be appropriate, however for native vegetation PMLUs an initial application of 20 kg/ha may be more suitable. Nitrogen fertilisers such as Urea, Monoammonium phosphate and Diammonium phosphate should be considered for use to boost nutrient levels.

Application of fertiliser should be approached cautiously as it can be costly and result in limitations including but not limited to acidic soil conditions, contaminated runoff, and the encouragement of weed growth. Soil sampling and analysis of soil resources throughout the LOM to assess potential fertiliser application should be undertaken. Other variables including landform slope, soil texture, structure, surface, and PMLU should also be considered prior to application of fertiliser.

The use of fertiliser amelioration is only recommended if the desired outcome of the PMLU has not been achieved with all other potential amelioration avenues undertaken.

Organic Matter Amelioration

Organic matter incorporated into the topsoil can increase organic levels, improve soil structure, increase cation exchange capacity (CEC), reduce erosion, and increase water holding capacity. SPCs that may benefit from receiving amelioration with organic matter are generally sandier, firm setting soils with low CEC and plant available water capacity (PAWC).

Where possible the use of organic matter generated from land clearing and vegetation stripping undertaken close to the rehabilitation area is recommended. However, the timing between clearing of vegetation and the commencement of rehabilitation may render organic matter unavailable. The establishment of vegetation cover on stockpiled areas may assist in providing organic matter. Application of organic matter may be dependent upon the desired PMLU, and vegetation species utilised in revegetation.

The application of organic matter should be treated similarly to fertilisers amelioration, it is only recommended if the desired outcome of the PMLU has not been achieved with all other potential amelioration avenues undertaken.

6.6.3.2 Overburden Use and Treatment

Where possible mudstone materials will be utilised during landform development on the outer slopes of waste rock emplacement areas. A minimum of 1 m of cover will be placed where possible, reducing the need for more saline sandstone materials to be utilised during landform development. Prior to topsoil spreading, mudstone will be ameliorated with gypsum where required.

Gypsum spreading depths will be determined during rehabilitation through site specific material sampling and testing, however an indicative average spreading rate of 13 t/ha will be utilised where required.

Where sandstone placement on outer slopes is required, thorough sampling and testing (e.g. salinity and sodicity) will be undertaken to determine the required material treatments. If the material is highly saline and sodic, then gypsum will be spread at a rate consistent with measured exchangeable sodium. Preference should be given to seeding salt-tolerant grasses and shrubs, such as saltbush. In some instances, particularly on the steeper upper slopes, soil stabiliser products may be required to reduce erosion risk during the initial vegetation establishment phase. Management of overburden materials with very high levels of salinity (i.e., EC >0.93 dS/m) (Hazelton and Murphy, 2016) will be addressed in the Mining Waste Management Plan.

The risk of acid forming materials being present in significant enough quantities to produce detrimental environmental outcomes (restriction/prevention of vegetative growth and/or waters with pH less than five) has not been detected or expressed in water quality monitoring and is therefore considered low.

6.6.4 Topsoil Balance

Material required for rehabilitation includes vegetation growth media and tailings capping material. Overall, the mine area does not contain extensive reserves of good quality topsoil. Soils used in rehabilitation are applied at depths of 200 (+/- 50 mm), thereby providing sufficient depth for re-ripping should follow-up maintenance work be required. Topsoil requirements and availability estimates are shown in Table 6-33 and the location of topsoil stockpiles is shown in Figure 6-40.

Table 6-33: Estimated Soil Resources

Material Source	Topsoil Volume (m ³)
Topsoil required for rehabilitation	5,900,000
Topsoil stockpiled as of 28/09/2024	610,290
Future mining areas (assumed average stripping depth 200 mm)	2,114,000
Total Deficit	3,175,710

Over the remaining mine life, approximately 2,724,290 m³ of topsoil is estimated to be available. Approximately 5,900,000 m³ of topsoil is estimated to be required for rehabilitation, indicating a topsoil deficit of approximately 3,175,710 m³. Actions being considered to address topsoil deficit include:

- stripping to greater depth where soil properties are suitable;
- possible changes to topsoil spreading strategies;
- possible use of subsoil/overburden mix or overburden (rock mulch) use as a growth medium substitute;
- potential selective placement of topsoil, subsoil/overburden mix or overburden relative to post-mining landform and land use type; and
- possible use of other growth media enhancers such as biosolids to substitute for, or extend, topsoil.



YAN-23-48-PRCP_Section6_2024

- LEGEND**
- Mining Lease Boundary
 - Yarrabee Disturbance Footprint
 - Topsoil Stockpiles

Source: The State of Queensland (2023); Yancoal Australia (2024)
Orthophoto: Yancoal Australia (2023)



YARRABEE COAL MINE
Location of Topsoil Stockpiles

Figure 6-40

6.7 VOIDS

6.7.1 Minimisation of Residual Voids

YCC has conducted extensive studies to improve the land outcomes of the Yarrabee Mine final landform. This has included significant engineering, life of mine planning, closure planning and closure cost analysis to:

- reduce the spatial extent of the residual voids through progressive backfilling;
- isolate residual voids from flood events up to and including a 0.1% AEP flood event; and
- identify outcomes for the proposed residual voids in consideration of historical commitments and approval documents, and advice from DETSI.

The Yarrabee Mine has been designed to:

- Backfill the C-Pit, D-Pit final voids to be integrated into the permanent realignment of Twelve Mile Creek.
- Backfill DOM3 and H-Pit.
- Partially backfill A-Pit to provide 0.1% AEP flood immunity for the residual void (Section 6.1.4).
- Backfill and cap the DOM1 and DE-Pit TSFs (Appendix R).

Subsequently, the C-Pit, D-Pit, DOM3, H-Pit and DOM1 ex-mining domains will not form residual voids post-closure and will be rehabilitated to a PMLU.

6.7.2 Residual Void Dimensions and Slope Angles

The NUMA dimensions and slope angles are detailed in Table 6-34. Where a PMLU has been assigned within the residual void, the landform and PMLU must be constructed in line with the landform design requirements detailed in the PRCP Schedule.

Table 6-34: Approved Non-Use Management Area Design

Void	NUMA high wall competent rock maximum slope (degrees)	NUMA high wall incompetent rock maximum slope (degrees)	NUMA low wall competent rock maximum slope (degrees)	NUMA low wall incompetent rock maximum slope (degrees)	NUMA Maximum Depth (m)	NUMA Maximum Area (ha)	NUMA Maximum Volume (Mm ³)
A-Pit	70	45	37	37	113	126	40
CE-North	70	45	37	37	40	53	8
DOM2N	70	45	37	37	100	103	41
DOM2S	70	45	37	37	59	45	7
DOM5	70	45	37	37	50	133	41
DOM6	70	45	37	37	54	25	10
YEN-Pit	70	45	37	37	129	223	121
YES-Pit	70	45	37	37	129	174	87
Total						882	355

Source: (Appendix A).

6.7.3 Residual Void Geotechnical Stability

ATC Williams Pty Ltd undertook a geotechnical stability assessment (Appendix O) of the Yarrabee Mine final landform residual voids to address how the residual voids will achieve post-closure slopes that exhibit stability. The geotechnical assessment and residual void design includes the following:

- Assessment of existing geotechnical data and structural features provided by YCC.
- Assessment of rock mass properties.
- Assessment potential instability mechanisms for the pit walls based on the above data.
- Provide recommendations for the residual voids closure process.

The findings of the stability assessment are detailed in the following sections.

6.7.3.1 Current Geotechnical Environment

Geotechnical challenges affecting pit wall stability are linked to geological and hydrogeological factors, including variations in material strength, structure, durability against weathering and erosion, and permeability across different geological layers. Primary mechanisms of failure are either sliding or composite failures. Stability can be further compromised by persistent planes of weakness, such as faults, shears, and bedding-parallel structures, as well as elevated groundwater pressures, which are also influenced by geological controls.

Field geotechnical inspections are undertaken on a weekly basis and geotechnical observations and data recorded and documented. Current geotechnical hazard mapping indicates that instability of the active Yarrabee Mine may occur due to the presence of highly weathered rock mass as presented in Figure 6-41, which shows a current rock mass failure within an active pit.

Multiple erosion instances have been identified within the active Yarrabee pits due to surface water runoff down the slopes related to Tertiary/Quaternary sediments, which consist mainly of clays and sandy gravel at the surface and shallow depths. This runoff sometimes leads to dissection and undercutting of the slopes. The observed stand-up performance of the pit walls, which consist of weaker rock mass, varies with some areas performing well and showing no signs of slumping. Other areas show fair performance with only minor local slumping, and some poor performance with widespread slumping. It is noted that due to the shallow nature of the current active pits and the dominant sandstone - siltstone lithology, large scale destabilisation is not expected to occur.

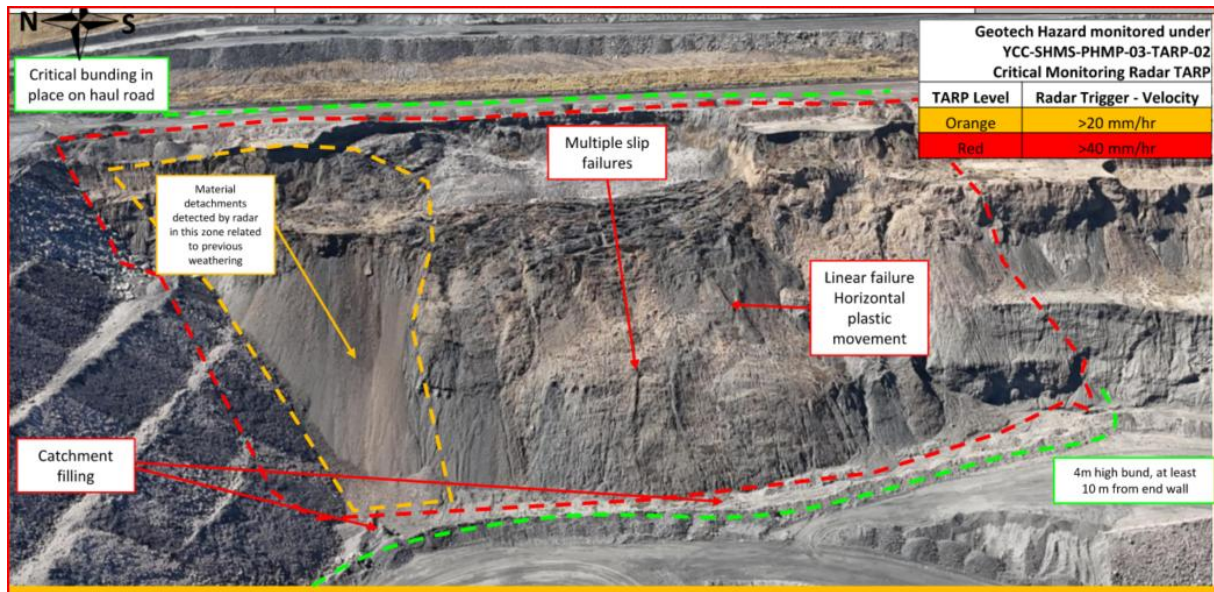


Figure 6-41 General Rock Mass Failure (Appendix O)

6.7.3.2 Seismic Site Classification

The importance of seismic events in open pit design is dependent on factors including subsoil conditions, the behaviour of softer zones and materials during an earthquake and the magnitude, duration, and frequency of ground motions. Based on general rock mass Uniaxial Compressive Strength (UCS) ranges, it was assumed that Standard Penetration Test (SPT-N) values for most rock zones exceed 50, with vertical seismic profiling (VSP) likely exceeding 400 m/s. Using a 10% probability of exceedance in 50 years in Table 6-35, as per NBCC (2015), the following provisions of the National Building Code were utilised.

Table 6-35: Probability of Exceedance

Probability of exceedance	PGA	Sa (0.05)	Sa (0.1)	Sa (0.2)	Sa (0.5)	Sa (1.0)	Sa (2.0)
10% in 50 years (475 AEP)	0.023g	0.025g	0.039g	0.042g	0.035g	0.023g	0.012g

Source: (Appendix O).

Note: PGA = Peak Ground Acceleration; g = Acceleration due to Gravity; Sa = Spectral Acceleration.

For seismic assessment, Peak Ground Acceleration (PGA) of 0.012 g was considered for the pseudo static analysis replicating 10% probability of exceedance in all models.

6.7.3.3 Spoil, Soil and Rock Materials

Rock material assessments were initially undertaken by reviewing the available laboratory data for spoil, soil, and rock materials from Yarrabee Mine.

Spoil

Available spoil materials, consisting of bulk broken rock and fine materials, are expected to be used as a cover system for the landform development.

Spoil plasticity is one of the primary criteria used to assess the potential for liquefaction. According to the approach by Seed et al., (1983), the backfill materials are unlikely to liquefy.

An estimated frictional angle between 22-35 degrees and cohesion strength of between 10-15 kPa was assumed for Mohr Coulomb constitutive model on tailings material as per Macedo & Vergaray (2022).

Sandstone was consistently more saline than mudstone, with elevated chloride levels, while mudstone was generally less saline, some samples also presented high chloride concentrations.

Silt and clay fines made up 7.9% to 49.5% of the sandstone analysed and of this clay made up between 5.6% to 31.1%. The fines of the mudstone were of similar composition and make up between 11.6% to 31.6%; of this clay made up between 4.2% to 16.6%. Sand made up most of the spoil samples analysed, 41.3% to 61.6%. PSD of the spoil is presented in Table 6-36.

Table 6-36: Spoil Material Particle Size Distribution

Particle size	Unit	Dom2		Dom5		A-pit		Yen pit	
		m/stone	s/stone	m/stone	s/stone	m/stone	s/stone	m/stone	s/stone
Gravel >2.0 mm	%	15.2	9.6	11.3	13.8	17.7	35.3	30	6.1
Coarse Sand 0.2 - 2.0 mm	%	15.4	6.6	5	34.1	9.2	41	21.5	2.1
Fine Sand 0.02-0.2 mm	%	38.3	34.7	52	27.5	42.7	15.7	33.9	42.3
Silt 0.002-0.02 mm	%	14.5	18.1	22.9	9.6	17.1	2.3	7.4	34.5
Clay <0.002 mm	%	16.6	31.1	8.7	15	13.3	5.6	4.2	15
ISSS Texture Classification	-	Sandy clay loam	Sandy clay loam	Sandy loam	Sandy loam	Sandy loam	Loamy sand	Loamy sand	Loam

Source: (Appendix O).

Soil

Fines (silt and clay) made up 42.4% to 60.2% of the analysed topsoil, with clay making up between 35.4% to 47.7% of the total. Sand made up 37.2% to 57.3% of the soil analysed and gravel a further 0.3% to 4.1%. Topsoil samples had a similar clay content of approximately 40%.

Topsoil materials were typically sodic and vulnerable to dispersion and structural instability. Dispersed soils can have reduced infiltration and hydraulic conductivity leading to an increased risk for erosion and build-up of salts in the root zone. The topsoil PSD is detailed in Table 6-37.

Rock

31 UCS samples from two geotechnical boreholes were tested by Cardno Limited on various depths which were dominated by sandstone and siltstone units. 19 point load tests were performed on the selected samples at various depths.

Table 6-37: Topsoil Particle Size Distribution

Particle size	Unit	2015	2015	2015	2019
		YEN-Pit	A-Pit	DOM2	Topsoil
Gravel >2.0 mm	%	4.1	1.1	2.6	0.3
Coarse Sand 0.2-2.0 mm	%	5.1	6.2	7.7	22.3
Fine Sand 0.02-0.2 mm	%	35.8	36.8	29.5	35.0
Silt 0.002-0.02 mm	%	14.5	15.1	12.5	7.0
Clay <0.002 mm	%	40.5	40.8	47.7	35.4
ISSS Texture Classification	-	Clay	Clay	Clay	Sandy Clay

Source: (Appendix O).

6.7.3.4 Geotechnical Interpretation

According to Look (2007) rock mass is classified as mainly “Soft” to “Medium” strength rock mass. Based on the UCS range, it was concluded that down to approximately 80 mbgl rock mass is classified soft to medium, and below 80 mbgl can be varied between medium to hard rock. As per the log normal distribution for UCS results, it was concluded that 90% of tested samples have UCS values between 1.80 MPa and 27.81 MPa.

Point load results indicate that the tested samples were predominantly classified as soft to medium strength, except one sample which returned higher strength. As shown on the log normal distribution, 90% of samples indicate the strength between 0.030 MPa and 0.038 MPa. Disregarding a high strength value determined for sample GT0100, a very weak correlation was present between point load results with the depth.

6.7.3.5 Rock Mass Interpretation

To inform the rock mass parameters for the model, drone imagery and routine geotechnical inspection were used. Rock mass parameters were adopted considering laboratory point load, UCS, slacking and other geotechnical parameters. Routine assessment and mapping were also utilised to determine the appropriate Geological Strength Index (GSI) for the stability assessment. GSI is a system of rock mass characterisation that was developed in engineering rock mechanics to meet the need for reliable input data related to rock mass properties. General range of rock mass and associated GSI values are presented in Figure 6-42.

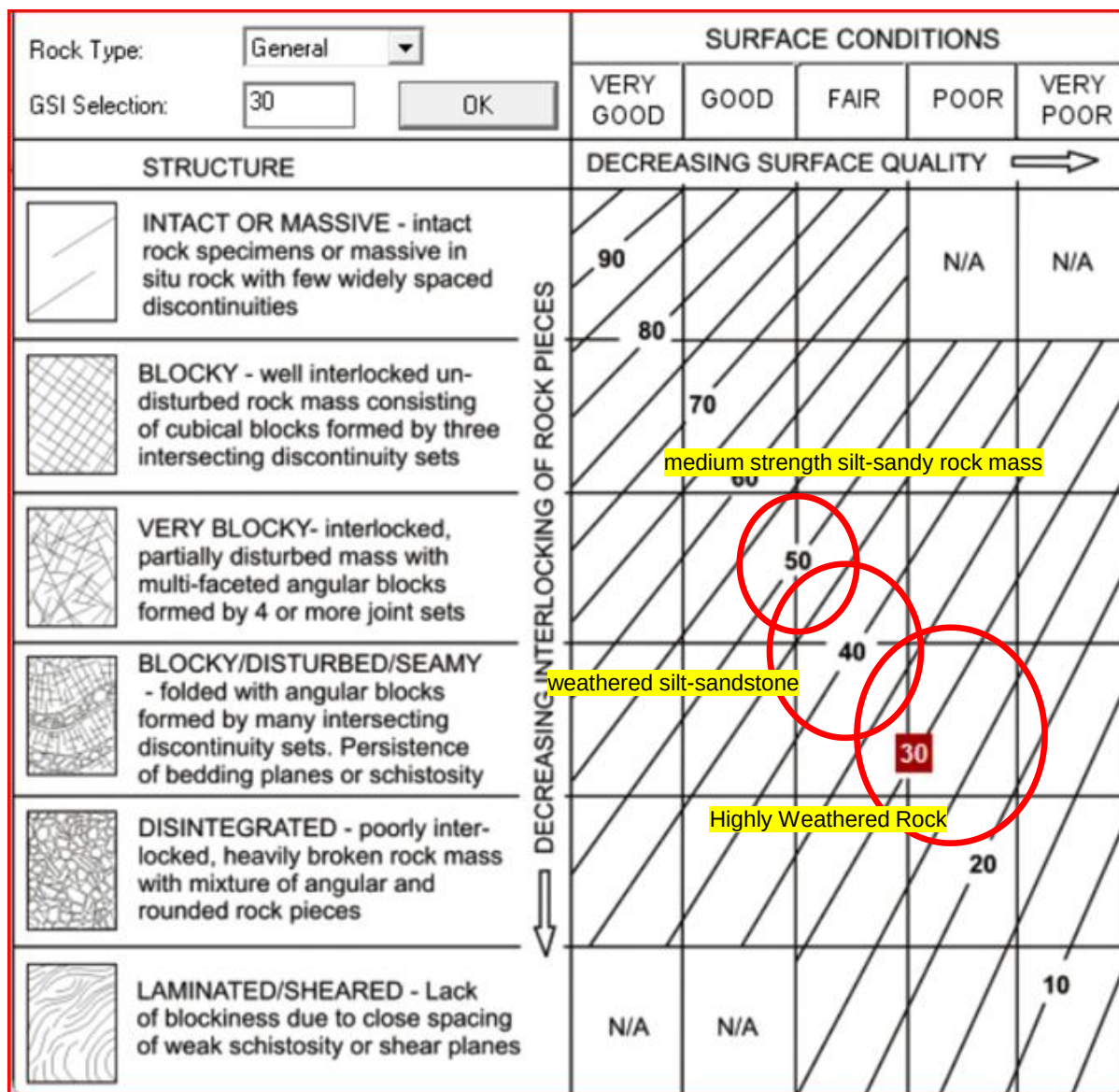


Figure 6-42: General Chart for GSI Estimates from Geological Observations (Appendix O)

Based on reports of the existing faults within various current active pits and the shear strength ranges for the major mapped discontinuities, the following parameters were recommended for consideration:

- Cohesion, c' : 0 kilopascal.
- Friction Angle, ϕ : 25-30°.

In the event of failure along existing faults or evidence of local water ingress, the lower range of the friction angle may be applied. Given the uncertainty regarding the condition of the faults, a value of 25° was adopted. Rock mass properties can be defined in three main units, based on the Generalised Hoek-Brown failure criterion, and are presented in Table 6-38.

Table 6-38: Generalised Hoek-Brown Parameters

Rock Mass Unit	Unit Weight (kN/m ³)	Estimated Depth (m)	Mi	GSI	Compressive Strength (MPa)
Highly weathered Rock	20	<10	8	30-40 (35)	5
Weathered silt-sandstone	22	10-35	15	40-50 (40)	15
Medium strength silt-sandy rock mass	24	>35	19	50-60 (55)	35

Source: (Appendix O).

Mi = rock mass constant value in Hoek Brown failure model; GSI = geological strength index.

The GSI estimates are adopted from the Yarrabee Mine geotechnical mapping and reporting data, which were utilised to correlate rock mass properties for the Hoek–Brown or equivalent Mohr-Coulomb criteria in the stability analysis. The correlation between failure criteria follows the approach proposed by Hoek and Brown (2019), with the conversion data summarised in Table 6-39 and Table 6-40.

Table 6-39: Rock Mass Estimated Parameters for Mohr-Coulomb Failure

Rock Mass Unit	Parameter	Mean	Minimum	Maximum
Highly weathered Rock	Cohesion (kPa)	32	37	43
	Friction Angle (°)	25	27	29
Weathered silt-sandstone	Cohesion (kPa)	96	111	128
	Friction Angle (°)	41	43	45
Medium strength silt-sandy rock mass	Cohesion (kPa)	321	382	465
	Friction Angle (°)	59	60	61

Source: (Appendix O).

Table 6-40: Rock Mass Estimated Parameters for Hoek-Brown Failure

Rock Mass Unit	Parameter	Mean	Minimum	Maximum
Highly weathered Rock	a-parameter	0.522	0.516	0.511
	mb- parameter	0.171	0.225	0.296
	s-parameter	0.0001	0.0001	0.002
Weathered silt-sandstone	a-parameter	0.511	0.508	0.506
	mb- parameter	0.55	0.731	0.962
	s-parameter	0.0002	0.0003	0.0007
Medium strength silt-sandy rock mass	a-parameter	0.506	0.504	0.503
	mb- parameter	3.189	3.89	4.55
	s-parameter	0.004	0.006	0.011

Source: (Appendix O).

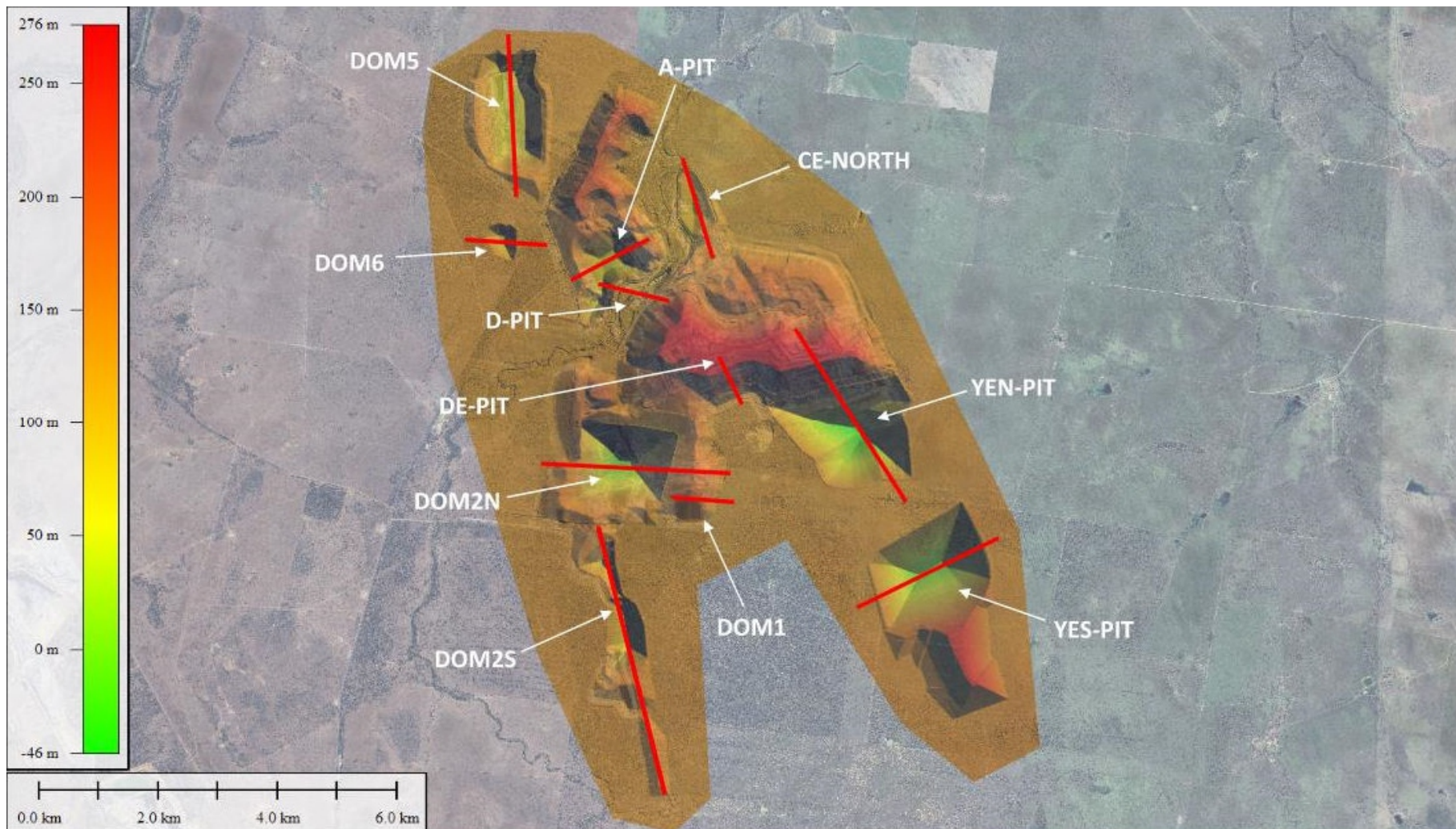
6.7.3.6 *Geotechnical Approach and Assumptions*

Geotechnical analysis of the final landform was undertaken to assess the geotechnical stability of the residual voids, which was informed by assessing the geotechnical stability of the current active pits. The assessment evaluated the general failure conditions and plastic deformation including stress-strain behaviour, deformation, and potential plastic failures for the current active pits and residual voids.

Rocscience's RS2 software is a 2D finite element analysis tool which was utilised for the geotechnical analysis. The primary focus of the analysis was to identify any potential large-scale, deep-seated failures or destabilisation mechanisms that could compromise the integrity of the voids.

For each of the current active pit and residual voids, 2D cross-sections were created, with locations of each cross section shown in Figure 6-43. The cross-sections were generated based on the provided survey and design files and are provided in Figure 6-44 to Figure 6-54.

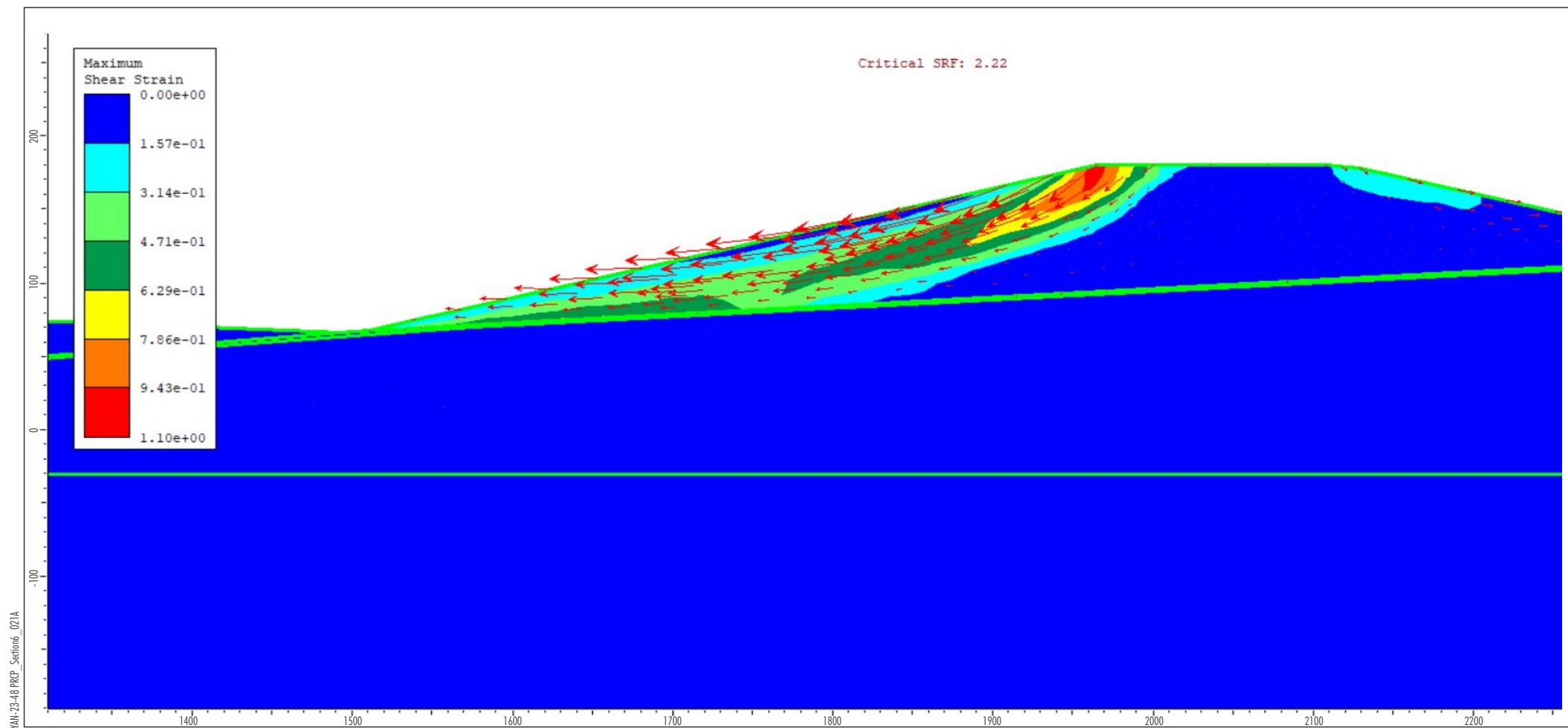
The key features of the Final Landform (Figure 2-12) include rehabilitated in-pit and out-of-pit overburden emplacements, rehabilitated TSFs, residual voids, backfilled and partially backfilled open-cut pits, and rehabilitated infrastructure areas. Where feasible and practical, the final landform will align with and reflect the topography and general character of the surrounding and regional areas.



Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

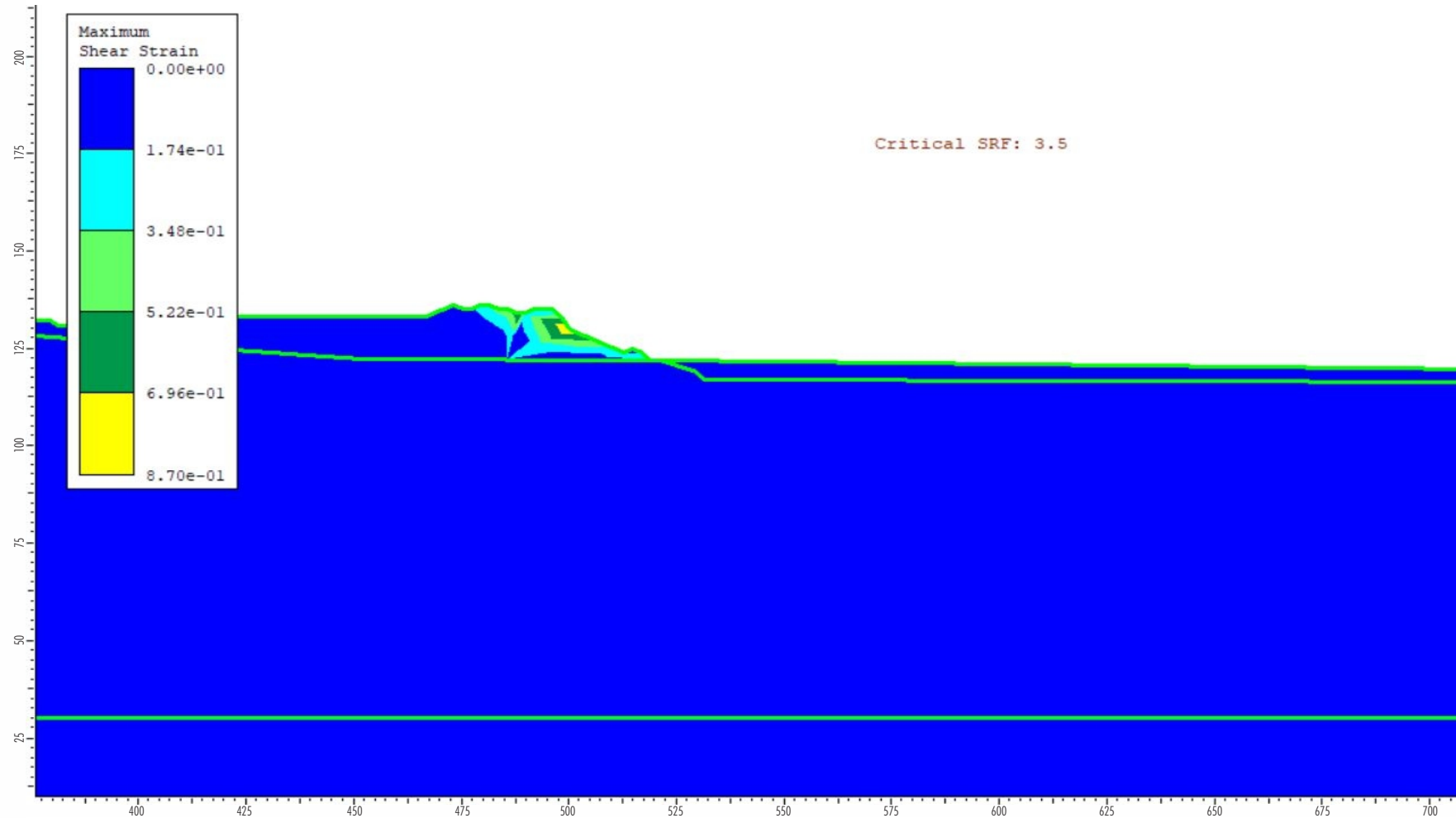
YANCOAL
YARRABEE COAL MINE
Location of Final Void
Geotechnical Cross Sections

Figure 6-43



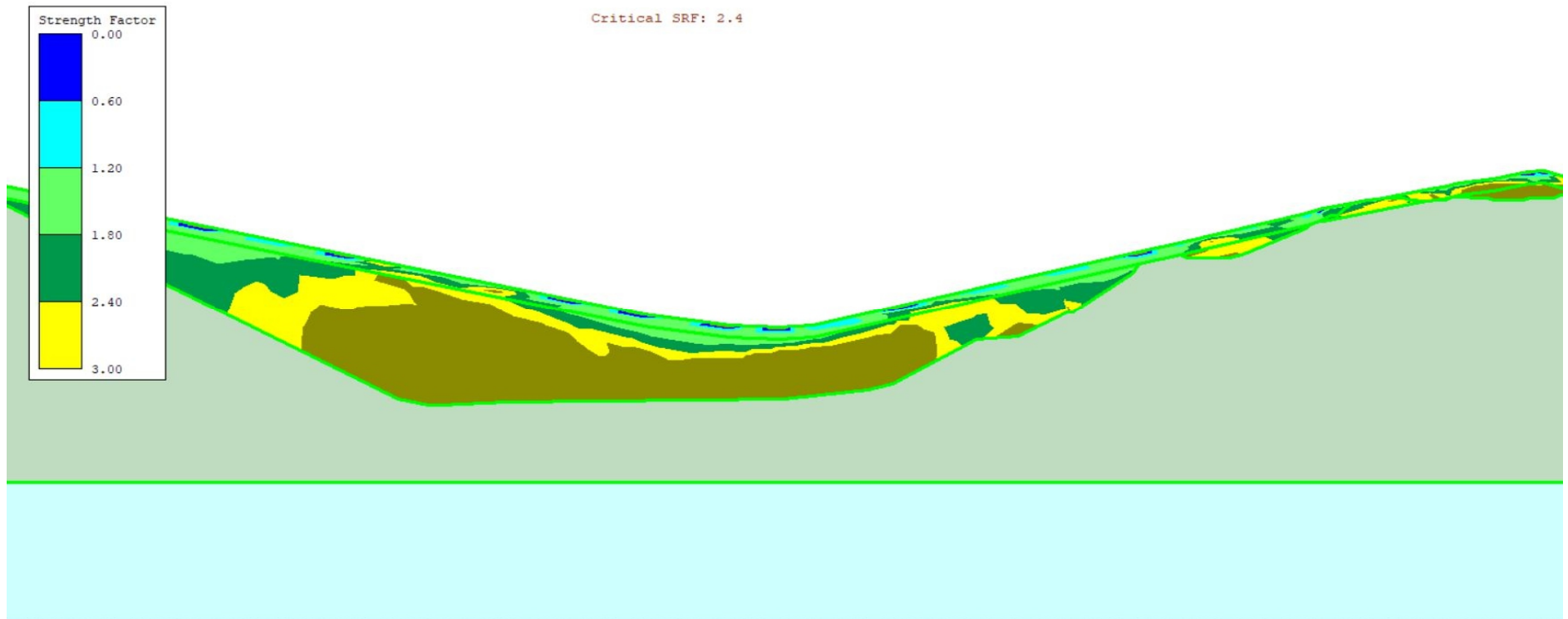
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-44



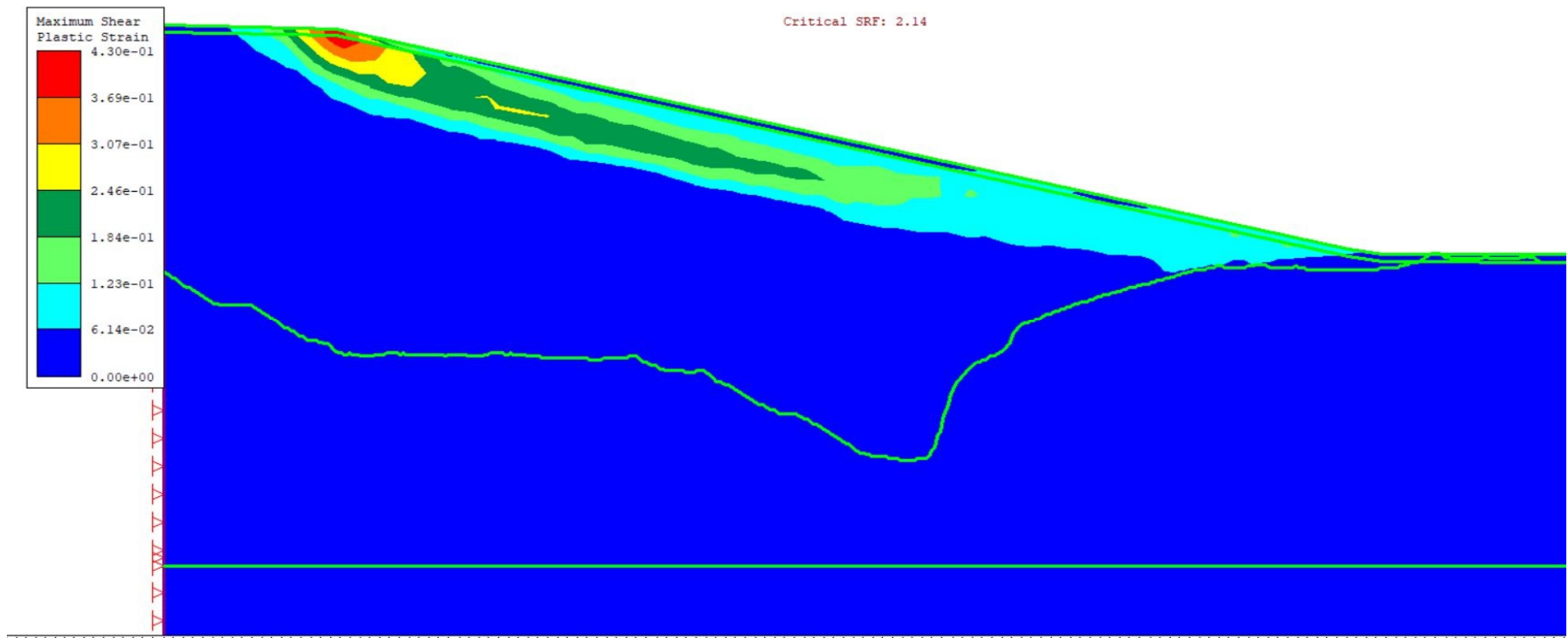
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-45



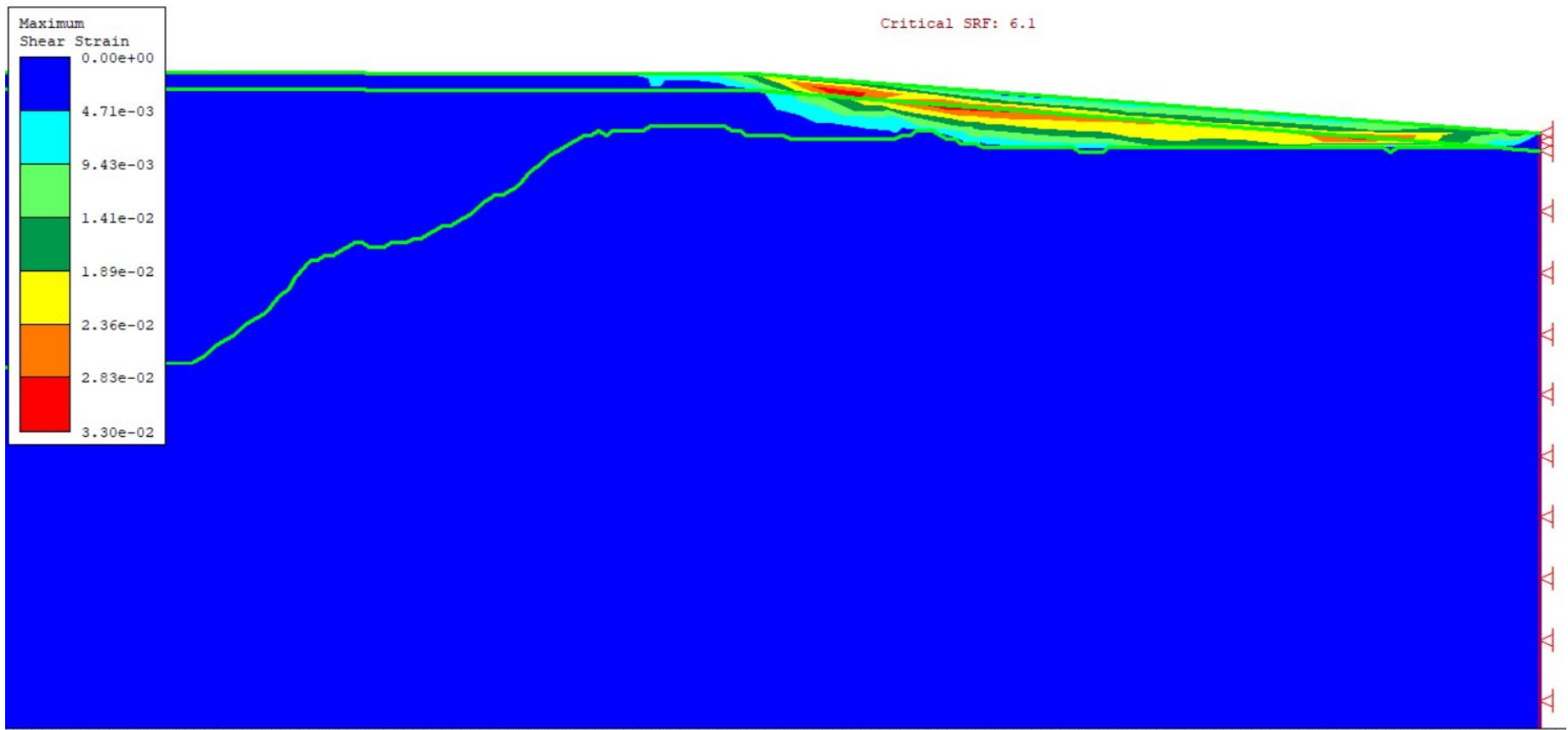
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-46



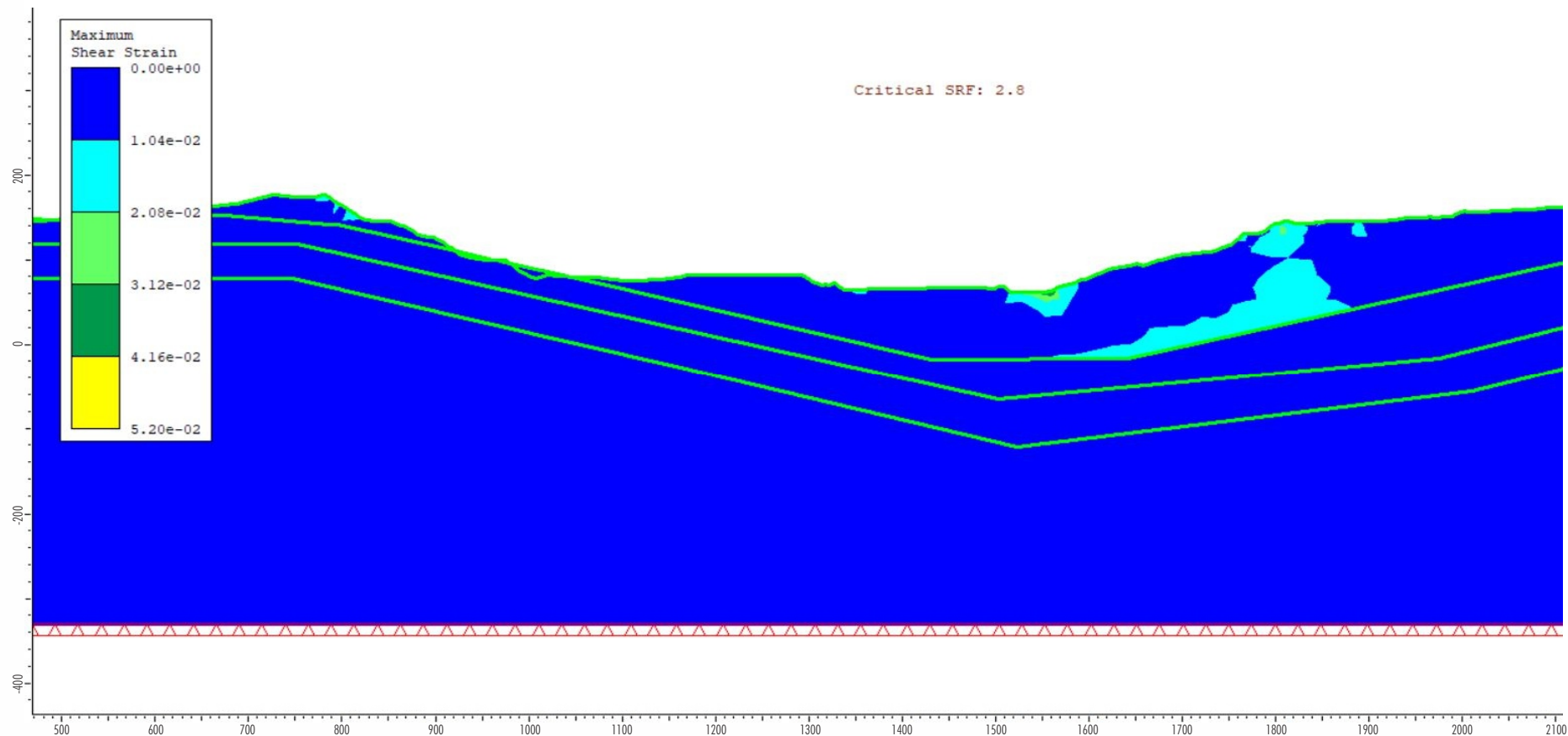
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-47



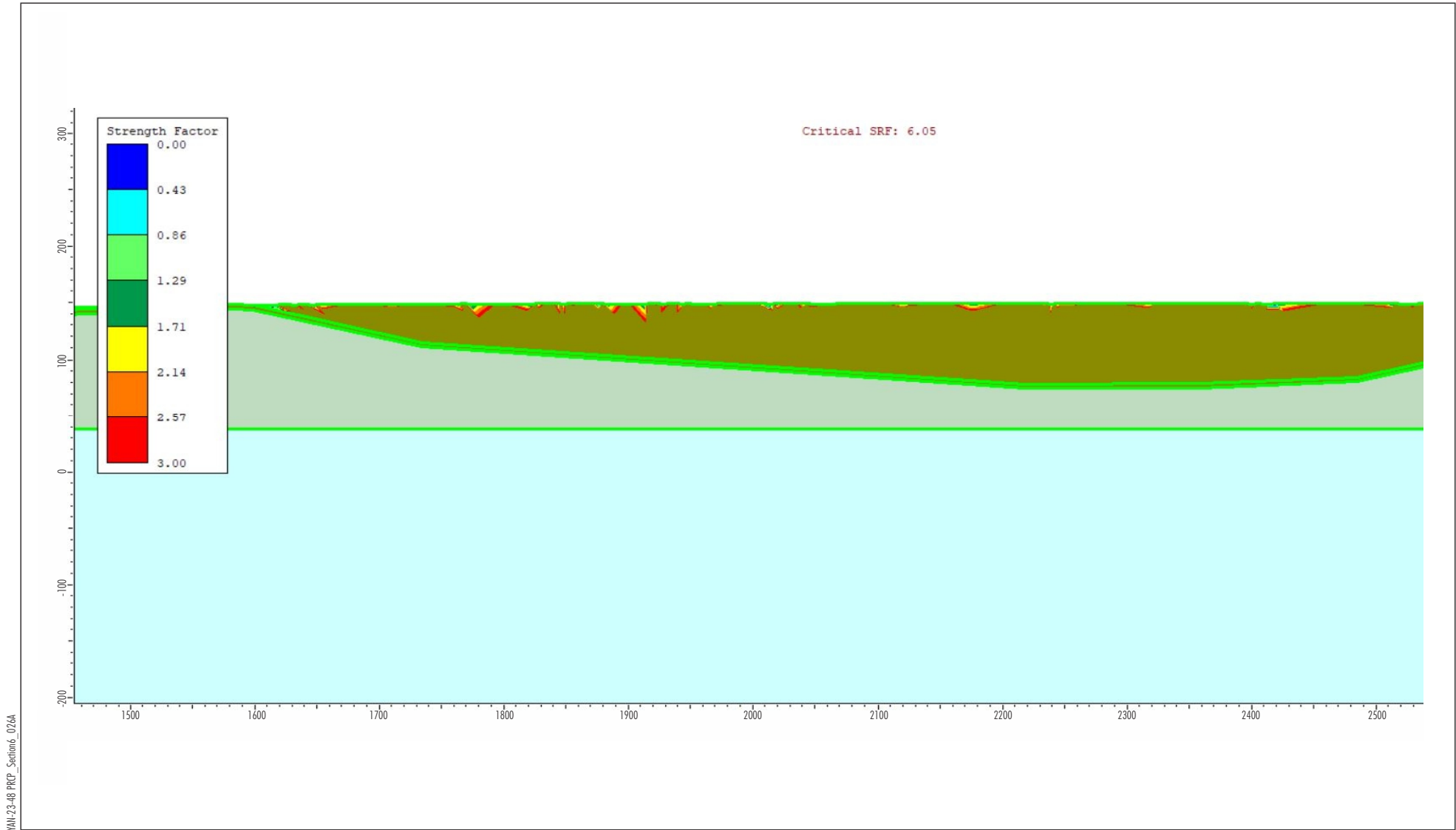
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-48



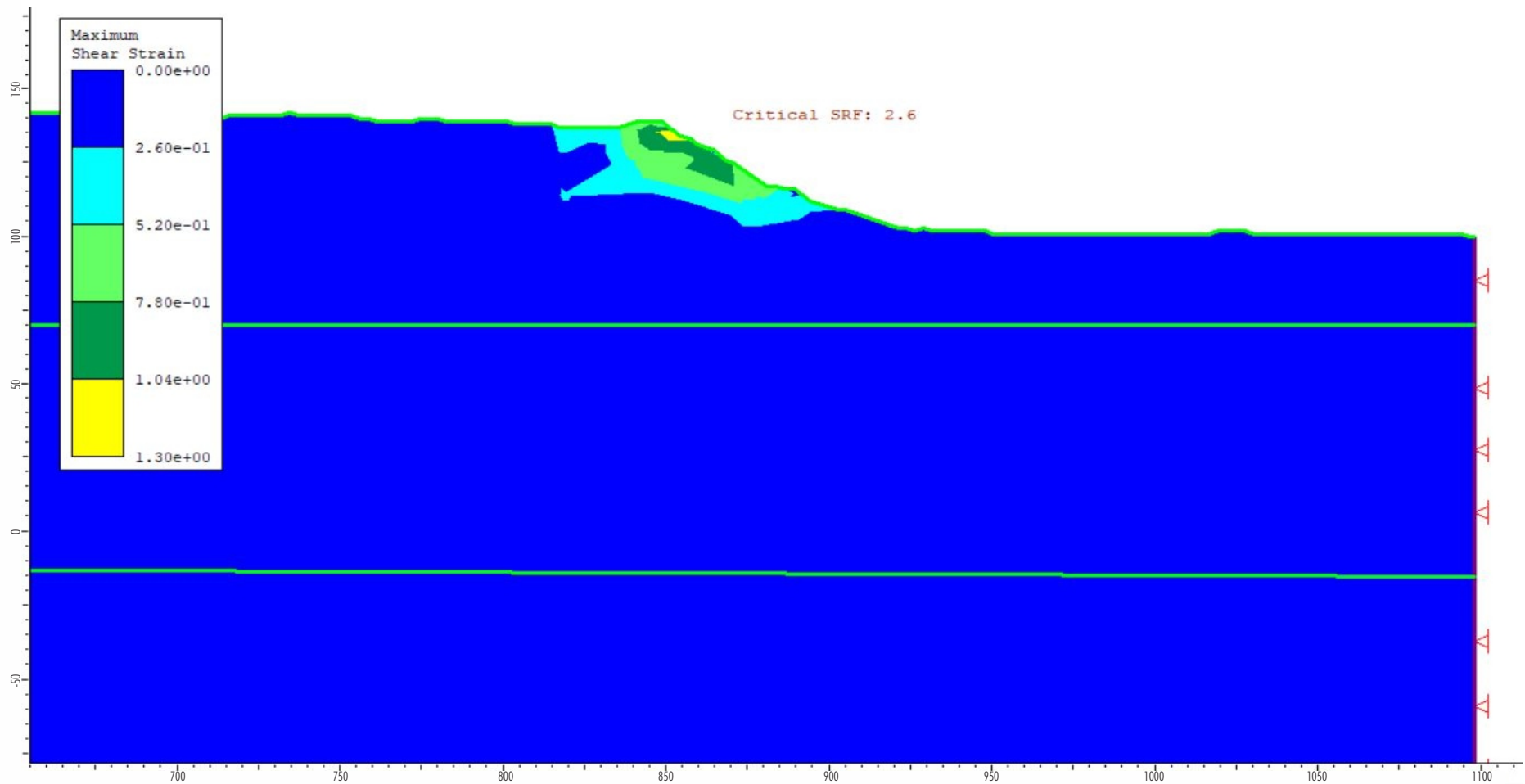
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-49



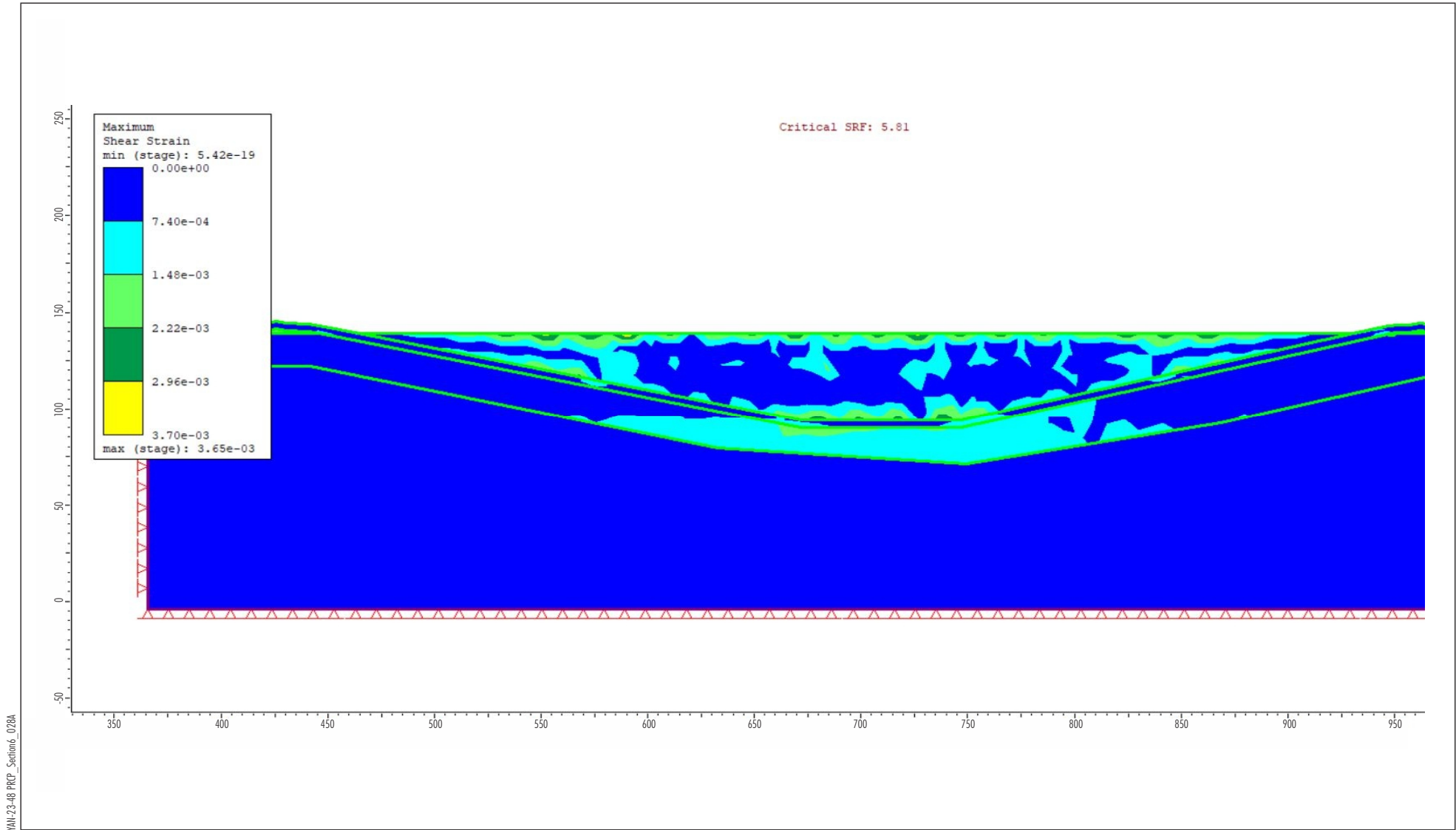
Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-50



Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-51

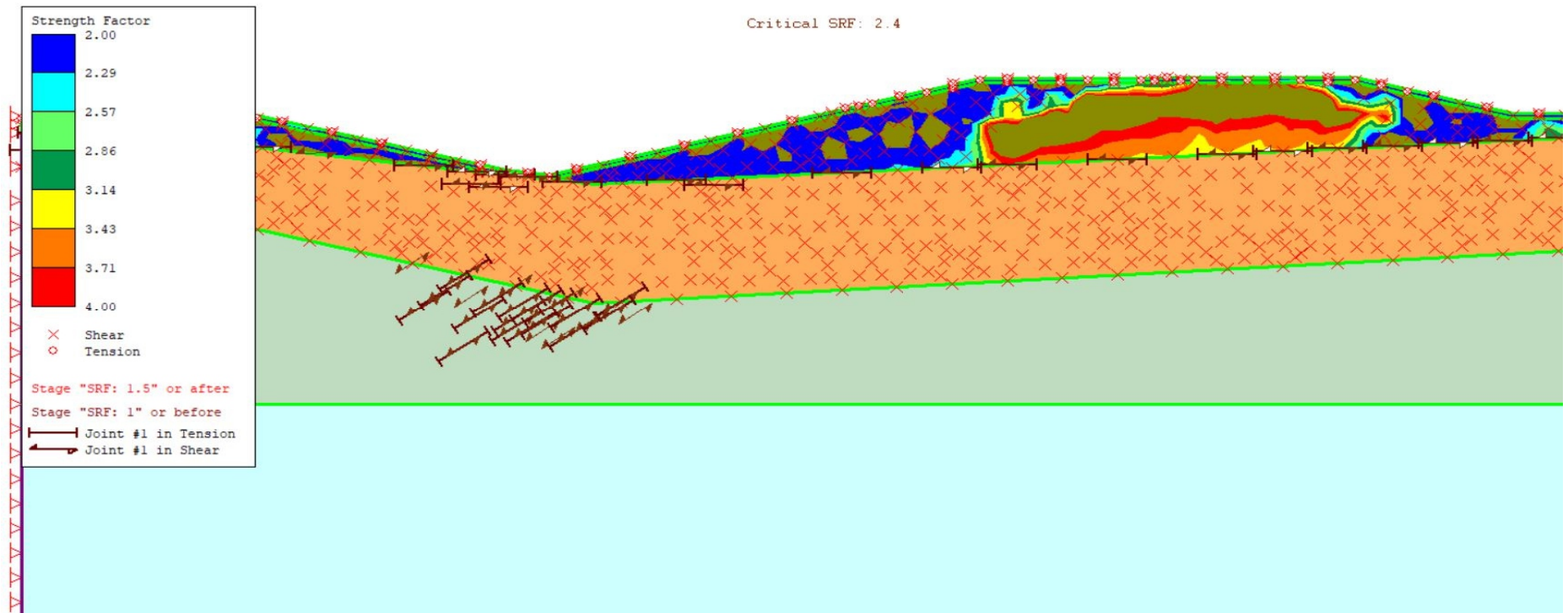


Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-52



Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd



Source: Appendix O. Residual Void Geotechnical Stability Assessment — ATC Williams Pty Ltd

Figure 6-54

6.7.3.7 Current Active Pits Stability Assessment

The primary instability of the current active pits results from the intersection of existing faults with the pit walls, exposing highly weathered rock mass units along the benches and void batter slopes. As noted in weekly geotechnical assessments, pit walls steeper than 65 degrees present potential instability risks.

Improving the stability of steeper pit walls, particularly within transitional or faulted zones and around filling voids, is crucial as these areas could be prone to further destabilisation or reactivation of movement, especially in the presence of water ingress or undercutting.

Results from RS2 modelling indicate that in pit locations intersecting faults and areas with highly weathered surface rock mass have a higher susceptibility to failure due to lower strength factors. Instability from these failures can be mitigated through routine inspections and remediation efforts, with risk levels minimised by adopting partial or sequential backfilling.

Applying seismic loading using a pseudo-dynamic approach revealed potential shallow instability in most of the faulted pits. The main concerns for the dynamic impact were the shallow lateral displacement and localised failures which will require consideration in the ground risk management system. Table 6-41 presents the calculated FoS for the current active pits.

Table 6-41: Current Active Pits Long Term Stability Assessment Results

Pit ID	Pit Base RL	Pit Max RL	Calculated FoS
CE-North	97.78	154.6	1.2
DOM5	69.8	154.7	1.2
D-Pit	64.7	149.2	1.5
DOM2N	-16.9	181.8	1.4
DOM2S	126.1	165.4	2.6
DOM1	97.4	155.3	1.4

Source: (Appendix O).

Figure 6-55 illustrates a pit with joints and faults identified across the southwest and northeast areas of the site. As shown, longer faults are prone to wider plastic zones, which increase the radius of potential instability. Discontinuities should be continuously mapped and dewatered as required to prevent ponding or the buildup of groundwater.

Maximum deformation is expected to occur at the edges of the pits, which must be considered during the construction of the bund. As shown in Figure 6-56, the bund should be designed to ensure the inner toe remains at least 10 m outside of the calculated zone of instability as per the requirements of EA EPML00844613.

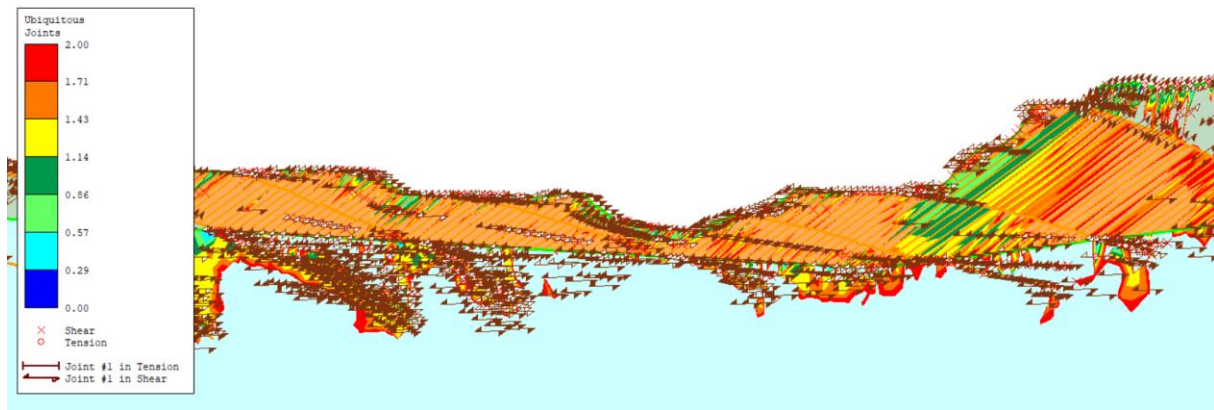


Figure 6-55: Tensile Shears Across the Fault Systems in Operational Voids (Appendix O)

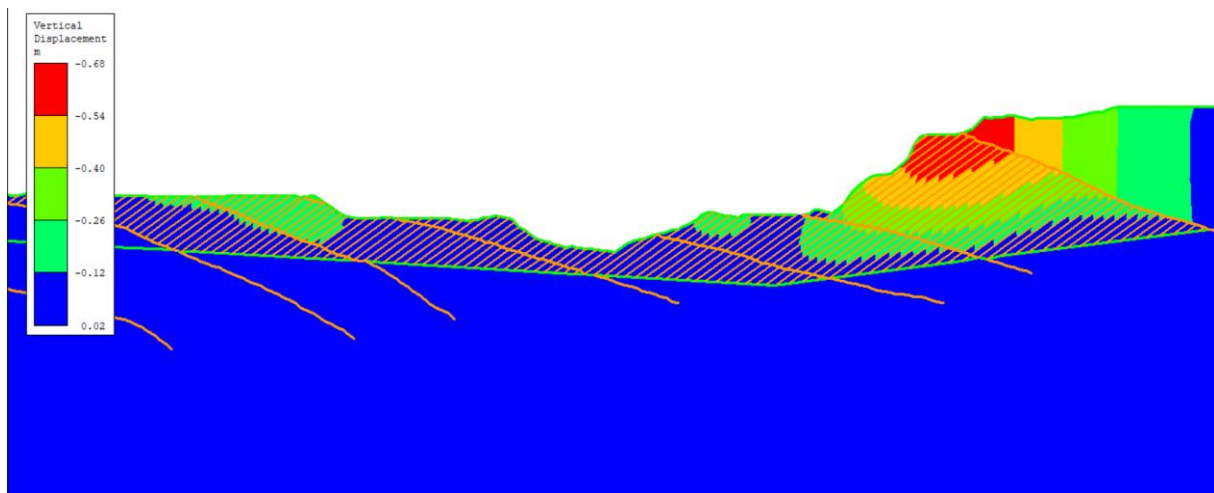


Figure 6-56: Maximum Deformations at the Crest (Appendix O)

6.7.3.8 Residual Void Stability Assessment

The approach and assumptions utilised to assess the FoS for the current active pits were adopted to assess stability of the final landform voids. A typical strength contour presented in Figure 6-57. Maximum shear strength was adopted to identify the possible creditable failure surface and associated FoS for final landform. The outcome of stability assessment for final landforms are summarised in Table 6-42 and cross sections of the final landform residual voids are provided in Figure 6-44 to Figure 6-54.

As required in Attachment 1 of the Yarrabee Mine EA, residual voids within the landform must be safe, stable, and non-polluting. Key requirement of voids being assessed as stable is achieving a minimum FoS of 2 and slopes no greater than 25%. The geotechnical analysis conducted revealed that the residual voids within the final landform all achieved a FoS greater than 2.0, meeting the rehabilitation requirements of the EA.

Table 6-42: Long Term Geotechnical Stability Results

Pit ID	Pit Base RL	Pit Max RL	Calculated FoS
CE-North	97.78	183.4	3.5
DOM5	69.8	157.3	2.6
D-Pit	64.7	140.1	2.4
DE-Pit	147.3	193.1	2.14
YEN-Pit (NS)	-45.0	273	2.4
DOM2N	17.4	178.5	2.8
DOM2S	74.1	172.8	6.08
DOM1	97.4	186.1	6.1
YES-Pit (EW)	-24.5	160.2	2.4
DOM6	90.0	141.4	5.8
A-Pit	67.0	180.0	2.2

Source: (Appendix O).

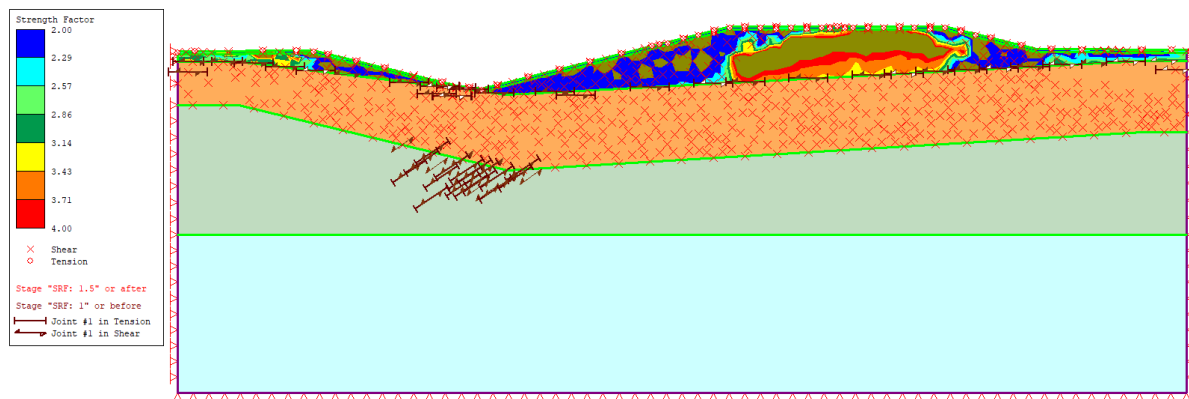


Figure 6-57: Typical Shear and Tensile Strength in YES-Pit (Appendix O)

As per the requirements of Appendix R, 4 m of cover material was used to cap the tailings storage facilities (DE-Pit and DOM1). Given the inherent variability and uncertainty in geotechnical parameters, conservative ranges of material properties were adopted for the analysis. The maximum shear strain for final landform assessment was a critical parameter used to evaluate the deformation behaviour of backfilled material and cover systems under applied loads. Shear strain provides insights into the stability of the landform and backfill material, particularly in response to factors including settlement, slope stability, a typical shear strain contour is presented in Figure 6-58.

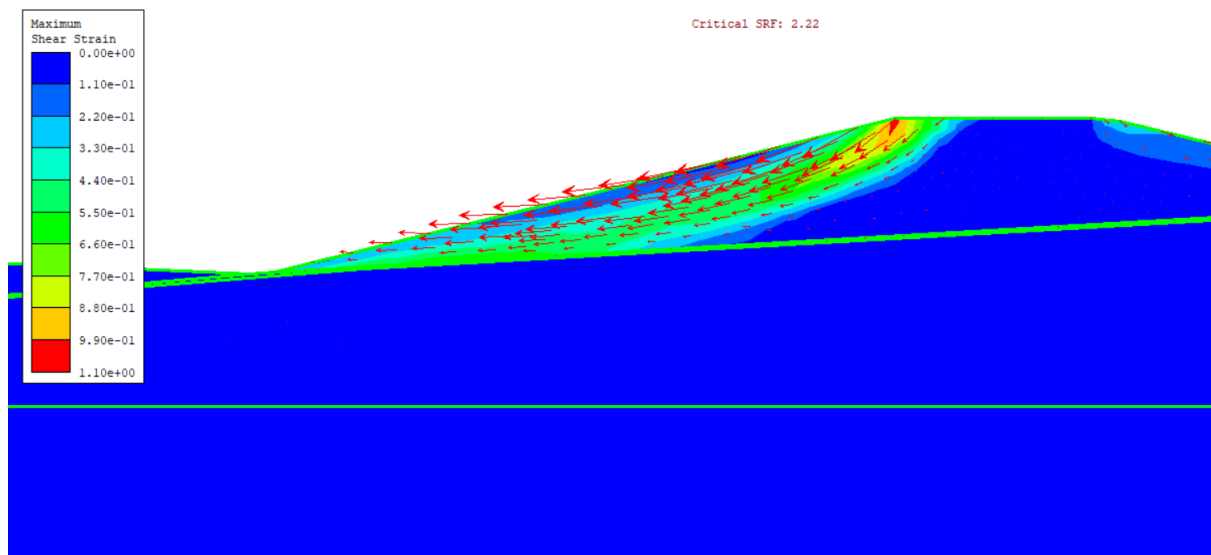


Figure 6-58: Maximum Shear Strain for A-Pit (Appendix O)

6.7.4 Residual Void Hydrology Assessment

Engeny undertook a Residual Void Water Hydrology Assessment (Appendix P) to inform the Yarrabee Mine final landform design and associated rehabilitation requirements. The Residual Void Hydrology Assessment included drainage and catchment mapping of the final landform, development of a GoldSim water balance model of the final voids to assess equilibrium lake levels, water quality, void filling rates and overtopping risk and an assessment of long-term groundwater interactions and seepage potential. The details and findings of the assessment are detailed in Section 6.7.4.1 to 6.7.4.8.

6.7.4.1 Model Overview and Climate Inputs

The residual void hydrology model was developed using the GoldSim software and was used to simulate the long-term water quantity and quality for each void using the Australian Water Balance Model (AWBM) to produce rainfall runoff relationships. The model used the GoldSim “Contaminant Transport Module” to calculate the salt mass balance to determine salt concentrations (as TDS) within each void. The model ran as a probabilistic simulation with 134 realisations (representative of each year of available historical climate data) for a 500-year duration.

Climate data for the model was derived from the SILO climate database using a Data Drill extract at Yarrabee Mine. SILO climate data provides rainfall, and evaporation estimates since 1889 and is based on the best available historical climate data in the vicinity of the site. This data set was used to enable a continuous simulation of the residual void scenarios to determine long term void storage equilibrium volumes and impacts on water quality.

Morton’s lake evaporation represents a theoretical calculation of lake evaporation based on other observed climate parameters. Morton’s lake evaporation was used to calculate the evaporation rate from the void water bodies.

Corrections to the water body evaporation rates were applied in the model to reflect the reduction in the freshwater evaporation rate that occurs for a saline water body. The evaporation reduction relationship proposed by Grayson, et al., (1996) was utilised:

- Evaporation reduction factor = $1/[1+\text{TDS (mg/L)}/10^6]$.

This equation predicts a relatively small evaporation correction for salinity of approximately 1% reduction per 10,000 mg/L TDS for TDS values up to 50,000 mg/L (i.e. 5% reduction for 50,000 mg/L TDS).

6.7.4.2 Residual Void Catchment Area and Runoff

Catchment runoff was simulated using the AWBM. The model represents the catchment using three surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each surface stores and evapotranspiration is subtracted from each. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the baseflow store if there is a baseflow component to the stream flow.

AWBM natural land use catchment runoff parameters for the model were adopted from parameters calibrated to the Blackwater Streamflow Gauging Station operated by the DNRME. This calibration was undertaken as part of the streamflow calibration for the Yarrabee Mine GoldSim model and documented in A-Pit Final Void Hydrology Study (Engeny, 2017).

Rehabilitated Spoil AWBM land use catchment runoff parameters were adopted from parameters developed for similar sites within the Bowen Basin. It is assumed for the model that all spoil dumps and disturbed areas have been rehabilitated. The adopted AWBM parameters are presented in Table 6-43.

Table 6-43: Australian Water Balance Model Parameters

Parameter	Natural	Rehabilitated Spoil
C1 (mm)	25	10
C2 (mm)	95	120
C3 (mm)	230	180
A1	0.134	0.134
A2	0.433	0.433
A3	0.433	0.433
BFI	0.03	0.35
Kb	0.98	0.6
KS	0.5	0.1

Source: (Appendix P).

Catchments for the residual voids are based on the 3D final landform and recent site Lidar Survey. Catchment areas delineated in the hydrology assessment are shown in Figure 6-59 and summarised in Table 6-44. Storage curves representing volume-area and volume-elevation relationships for each residual void were also determined using the 3D final landform topography of the residual voids.

Table 6-44: Void Catchment Areas

Residual Void	Catchment Area (ha)
A-Pit	197
YES-Pit	334
CE-North	59
DOM2N	378
DOM2S	137
DOM5	235
DOM6	27
YEN-Pit	449 ¹
	1183 ²

Source: (Appendix P).

1 YEN-Pit Direct reporting catchment area.

2 YEN-Pit Direct plus External reporting catchment area.



Source: Appendix P, Residual Void Hydrology Assessment — Engen Australia Pty Ltd



YARRABEE COAL MINE

Final Landform Catchment Overview

Figure 6-59

6.7.4.3 Groundwater Interactions

Numerical groundwater modelling undertaken by SLR (Appendix G) interfaces the surface water with the forecast void waterbody water level from the surface water model applied as a fixed head boundary in the groundwater model and forecast groundwater fluxes from the groundwater model applied as inflow/outflows to the surface water model.

The two models were iterated several times until a suitable level of convergence in model results was achieved. While the surface water balance model is best suited to forecast void water body levels and water quality trends, the groundwater model is the best tool for assessing groundwater fluxes to the voids and potential for void water body to act as a sink (e.g. net groundwater flow into the void water body) or a source (e.g. net flow from the void water body into regional groundwater). A summary of the relationship between the two models is as follows:

- Forecast void water body levels are well below pre-mining groundwater levels (with the exception of CE-North). Consequently, hydraulic gradients are expected to result in net flows into the nearby residual voids.
- Particle tracking confirmed that there is no off-site migration of groundwater. Even where particles are observed to migrate away from CE-North and DOM6, these particles are captured by nearby residual voids that act as strong groundwater sinks.
- Groundwater fluxes into or out of the void waterbodies were applied to the surface water balance model using the relationship between the void water level and the net groundwater flux.
- The groundwater recovery curves have been applied to the residual void hydrology model with negative net groundwater flows defined as a seepage loss from the void water body, and positive flows defined as inflows into the void waterbody. The residual void hydrology model applies groundwater fluxes for the following void and groundwater interactions:
 - Geology to Void: Groundwater flowing directly between the void water body to/from the surrounding regional groundwater
 - Spoil to Void: Combined volume of groundwater flowing directly between the void water body to/from the backfilled spoil within the as mined extents (inclusive of any rainfall infiltration on the surface spoil).
- As part of the Groundwater Assessment, SLR identified that the regional groundwater table level was below the base of the CE-North residual void and determined that there would be a seepage connection from the CE-North residual void to nearby residual voids. The residual void model applies a constant seepage rate of 0.6 litres per second (L/s) for CE-North, consistent with SLR's "loss to groundwater" assumption.

6.7.4.4 Groundwater Quality

The groundwater quality used was adopted from available samples from the groundwater monitoring program undertaken at Yarrabee. A constant groundwater TDS value of 39,500 mg/L was adopted based on the median of the available lab samples.

6.7.4.5 Residual Void Water Quality

The water balance model calculates TDS for each residual void using a salt mass balance approach. As monitoring is measured in EC, a conversion has been applied. A standard TDS–EC conversion factor of 0.67 has been adopted for the hydrology assessment, which was validated against the early months of monitoring bore data.

Salinity of runoff generated in the water balance was determined by a salt mass input based on land uses. Table 6-45 outlines the adopted TDS runoff parameters for the land-uses applied in the AWBM, based on the water source. Constant TDS values for each land use were adopted based on calibrated values for similar coal mines in the Bowen Basin.

Table 6-45: Water Source Total Dissolved Solids Concentration

Source	Salinity (mg/L)
Natural Catchment	300
Rehabilitated Spoil	700
Rainfall	30

Source: (Appendix P).

The water quality of runoff from rehabilitated spoil would be expected to improve over time, as salts leach out of the surface spoil layers. A constant rehabilitated spoil runoff TDS value was conservatively adopted for the post-closure void hydrology predictions. The runoff entering the residual voids was assumed to be completely mixed with the existing stored water, however, does not account for the potential stratification of water quality within voids.

6.7.4.6 Void Reference Levels

Reference levels were utilised to assess the behaviour of voids including the potential for each void water body to act as a sink or source. References levels are summaries in Table 6-46 and defined as follows:

- Bottom of void: The base of the void used to assess the depth of the resulting void water body and determine whether the void water body periodically dries out.
- Void spill elevation: The level above which water in the void would start to spill over the crest of the void into the receiving environment. This level has also been used as the datum for each void to calculate the depth below surface (mbgl).
- Twelve Mile Creek Invert Level: The invert of Twelve Mile Creek in the vicinity of a void. This level is indicative of the potential for seepage through shallow alluvial materials to express in the creek. For voids that are not in proximity to Twelve Mile Creek this level is not relevant (i.e. YES-Pit and YEN-Pit) and has subsequently been excluded.

Table 6-46: Reference Levels

Residual Void	Base of void (mAHD)	Twelve Mile Creek Invert Level (mAHD)	Void Spill Elevation (mAHD)
A-Pit	62.2	123.55	129.8
YES-Pit	-30.3	-1	145.3
CE-North	110.4	121.45	129.2
DOM2N	-22.9	125.85	139.7
DOM2S	68.8	130.15	141.6
DOM5	64.6	120.05	134.4
DOM6	83.9	125.85	133.6
YEN-Pit (Direct Only)	-50.8	-1	138.8
YEN-Pit (Direct & External)	-50.8	-1	138.8

Source: (Appendix P).

1 Not relevant for YES-Pit and YEN-Pit, which are not in proximity to Twelve Mile Creek.

6.7.4.7 Model Assumptions

The following key assumptions have been adopted for the purpose of the water balance modelling:

- No allowance for flood ingress from Twelve Mile Creek was included in the model and all residual voids lie outside the 0.1% (1:1,000) AEP flood extent (Engeny, 2024).
- Water losses associated with the saturation of the spoil in the backfilled voids (typically during first filling conditions) were excluded from the surface water balance model. However, through the iterative model approach undertaken with SLR, this process of saturating in-pit spoil material is now effectively accounted for in the model outcomes.
- The void water bodies are fully mixed (i.e. no stratification) and quality results indicated the average salt concentration of the entire void water body.
- The salinity of rehabilitated spoil runoff was set as constant values based on the expected quality of runoff immediately after rehabilitation. Improved runoff quality over time was not simulated and accordingly the predicted long-term salinities of the void water bodies were likely to be conservative values.
- All spoil stockpiles, backfilled areas and regraded void walls were assumed to be rehabilitated.
- Adopted groundwater quality parameters were based on the available data to date and as more groundwater monitoring data is collected, the adopted groundwater quality value for the voids at Yarrabee Mine may be subject to change.

6.7.4.8 Goldsim Model Approach

The GoldSim model was simulated by repeating the Data Drill climate data for a 200-year continuous period to ensure equilibrium conditions were reached. To enable the extraction of probabilistic results (e.g. median), 134 realisations of the model were simulated (based on the number of years of historical climate data). Equilibrium values were defined as the median and maximum water surface level reached by the void water body during the last 134 years of the simulation (i.e. the last complete cycle of the available 134 years of historical climate data).

Time to fill is defined as the time until the median water body level reaches the median equilibrium level described above. Median EC values were extracted at 10, 50 and 100 years after closure as an indication of long-term water quality trends. The key residual void water body outcomes are summarised in Table 6-47. Time series plots of the forecast void water body level and EC results are presented in Appendix A of Appendix P.

Multiple catchment scenarios have been identified for YEN-Pit. The “Direct Only” scenario represents the minimum catchment that freely drains into YEN-Pit, whilst the “Direct and External” scenario conservatively includes the catchment areas that pond adjacent to YEN-Pit and could contribute to void water body levels under very wet conditions.

6.7.4.9 Void Outcomes

A summary of the key residual void water body outcomes is provided in Table 6-47 with time series plots of the forecast void water body level and EC results presented in Appendix C. Results were interpreted as follows:

- Equilibrium values were defined as the median water surface level of the void water body during the last 250 years of the simulation (i.e. the second half of the 500-year simulation duration, allowing at least one cycle of the full historical climate record). In addition to the equilibrium value, a maximum water level over the simulation has been extracted to capture the range of fluctuations above the equilibrium level.
- The time to fill has been defined as the time until the water body level reaches the equilibrium level described above.
- Median EC values have been extracted at 10, 50 and 100 years after closure as an indication of long-term water quality trends. The freeboard to either the Spill Level or Twelve Mile Creek Invert level is defined as the difference between these levels and the maximum void water body level.

A Pit

A-Pit is forecast to form a permanent water body that is forecast to act as a groundwater sink, with no discharge and significant freeboard (minimum of 33.75 m to the nearby invert of Twelve Mile Creek or 40 m surface spill level). The median EC 100 years after closure is forecast to be approximately 293,000 $\mu\text{S}/\text{cm}$.

YES-Pit

YES-Pit is forecast to form a permanent water body, forecast to act as a groundwater sink with significant freeboard (minimum of 90.5 m to the surface spill level). The median EC at 100 years after closure is forecast to be approximately 186,000 $\mu\text{S}/\text{cm}$ and no discharge is forecast.

DOM2N

DOM2N is forecast to form a permanent water body and is forecast to act as a groundwater sink. DOM2N is forecast with significant freeboard (a minimum of 53.45 m and 67.3 m to the nearby invert of Twelve Mile Creek or surface spill level respectively). The median EC 100 years after closure is forecast to be approximately 182,000 $\mu\text{S}/\text{cm}$. As DOM2N is a groundwater sink, no discharge is forecast.

DOM2S

DOM2S is forecast to form a permanent water body, that will act as a groundwater sink with significant freeboard (minimum of 28.05 m and 39.5 m to the nearby invert of Twelve Mile Creek or surface spill level respectively). The median EC 100 years after closure is forecast to reach the adopted solubility limit of 300,000 $\mu\text{S}/\text{cm}$. This EC is a result of the very flat configuration of the void invert maximising evaporation from a large shallow water body surface to quickly concentrate salts. In reality, as EC increases towards $>300,000 \mu\text{S}/\text{cm}$, the actual EC value may become limited by the solubility limit of the constituent salts. In reality, as EC increases towards $>300,000 \mu\text{S}/\text{cm}$, the actual EC value may become limited by the solubility limit of the constituent salts.

DOM5

DOM5 is forecast to form a permanent water body. The water body is forecast to have significant freeboard (a minimum of 38.25 m and 52.6 m to the nearby invert of Twelve Mile Creek or surface spill level respectively) and consequently no discharge to surface waters is forecast. The median EC at 100 years after closure is forecast to reach the adopted solubility limit (300,000 $\mu\text{S}/\text{cm}$). This EC is a result of the very flat configuration of the void invert maximising evaporation from a large shallow water body surface to quickly concentrate salts. In reality, as EC increases towards $>300,000 \mu\text{S}/\text{cm}$, the actual EC value may become limited by the solubility limit of the constituent salts. No discharge forecast as DOM5 is a sink.

DOM6

DOM6 is forecast to form a permanent water body. The water body is forecast to have significant freeboard (a minimum of 22.15 m and 29.9 m to the nearby invert of Twelve Mile Creek or surface spill level respectively) and consequently no discharge to surface waters is forecast. The median EC at 100 years after closure is forecast to be approximately 220,000 $\mu\text{S}/\text{cm}$.

CE-North

CE-North is forecast to form a temporary water body that fluctuates between dry conditions and a maximum depth of 8.7 m with a median water depth of 3.1 m. The application of a seepage outflow to groundwater (in accordance with the Groundwater Assessment, Appendix G and Appendix H) contributes to a lower lake level as well as a fresher water quality (median EC after 100 years of 1,700 $\mu\text{S}/\text{cm}$). The water body has the lowest freeboard of the Yarrabee Voids (a minimum of 2.35 m and 10.1 m to the nearby invert of Twelve Mile Creek or surface spill level respectively) but remains significantly below surface spill level with no discharge to surface waters forecast.

YEN-Pit

YEN-Pit is forecast to form a permanent water body that is forecast to act as a groundwater sink with significant freeboard (minimum of 87.1 m and 57.7 m to the surface spill level in the direct catchment only and direct plus external catchment scenarios respectively). The median EC 100 years after closure is forecast to be approximately 178,000 $\mu\text{S}/\text{cm}$ with only the direct catchment modelled or 103,900 $\mu\text{S}/\text{cm}$ with the direct and external catchment considered. As a groundwater sink, no discharge is forecast from YEN-Pit.

With all residual void water bodies forecast to have significant freeboard to spill and no interaction with surrounding surface waters, the residual void hydrology assessment did not result in any alterations to the Yarrabee Mine Final Landform or the proposed rehabilitation techniques detailed throughout this report.

Table 6-47: Residual Void Water Body Results Summary

Residual Void	Catchment Area (ha)	Equilibrium Water Level (mAHD)	Equilibrium Water Level (mbgl)	Maximum Water Level (mAHD)	Maximum Water Level (mbgl)	Freeboard to Creek Invert (m)	Freeboard to Spill Level (m)	Time to Fill (years)	Median EC after 10 Years (µS/cm)	Median EC after 50 Years (µS/cm)	Median EC after 100 Years (µS/cm)
A-Pit	197	86.2	43.6	89.8	40	33.75	40	235	79,600	178,400	293,100
YES-Pit	334	52	94.3	55.8	90.5	- ²	90.5	368	67,700	115,700	186,000
CE-North	59	113.5	15.7	119.1	10.1	2.35	10.1	3	1,700	1,700	1,700
DOM2N	378	68.4	71.3	72.4	67.3	53.45	67.3	367	68,600	117,000	182,200
DOM2S	137	99.4	42.2	102.1	39.5	28.05	39.5	144	87,900	201,200	>300,000 ¹
DOM5	235	79.5	54.9	81.8	52.6	38.25	52.6	129	112,200	264,600	>300,000 ¹
DOM6	27	100.6	33	103.7	29.9	22.15	29.9	23	106,500	198,500	220,300
YEN-Pit (Direct Only)	449	48.1	90.7	51.7	87.1	- ²	87.1	367	68,500	113,400	178,400
YEN-Pit (Direct & External)	1,183	70.7	68.1	81.1	57.7	- ²	57.7	374	56,700	56,700	103,900

Source: (Appendix P).

¹ Elevated EC levels become governed by solubility limit of constituent salts.

² Not relevant for YES-Pit and YEN-Pit, which are not in proximity to Twelve Mile Creek.

6.8 TAILINGS STORAGE FACILITIES

6.8.1 Yarrabee Tailings Storage Facilities

Two TSFs are present at Yarrabee Mine, DE-Pit and DOM1. Coarse, fine and ultra fine rejects (tailings) are produced at the CHPP. Coarse and fine rejects are co-disposed and relocated via truck haulage to pits or stored in dumps. Tailings are pumped as slurry from the CHPP to the TSFs.

DE-Pit is an out-of-pit TSF, composed of an above-ground tailings cell within a storage embankment, in the inactive DE-Pit. Tailings deposition in the DE-Pit TSF ceased in 2014 when it reached capacity. Tailings are now deposited into the DOM1 in-pit TSF which has sufficient capacity to accommodate the tailings generation expected for the remainder of mine life. DOM1 TSF is managed in accordance with the Yarrabee Tailings Management Plan.

The DE-Pit TSF will be rehabilitated to PMLUs of grazing and Native Ecosystem and the DOM1 TSF will be rehabilitated to a PMLU of grazing. The rehabilitation strategy for each TSF is described in detail in Section 6.8.2 and 6.8.3.

6.8.2 DE-Pit Out-of-Pit TSF Design

To maximise the area available for the storage of tailings within DE-Pit, a wall was constructed around the designated tailings area and drains installed to minimise the water catchment. The wall was constructed to Reporting Level (RL) 142 m, with a setback of 10 m from the edge of the open pit wall to account for the safety and the stability of the edge of the pit wall. The wall was constructed from impermeable material and keyed into the existing ground. Access to the top of the wall is available from both ends. A rock-armoured spillway is located on the north-eastern end of the wall, designed per the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* (DESI, 2024e). Cut-off drains allow water to drain away from the tailings dam, reducing the catchment that drains to the tailings dam, thereby minimising the impact of rainfall and storm events.

Based on the 'as constructed' information, the storage capacity of the dam is 919,130 m³. The catchment area of the dam is 137,900 m², resulting in a design storage allowance (DSA) of 83,400 m³. The design, methodology and performance of the DE-Pit TSF are detailed in the *As Constructed Report for Tailings Storage Dam* (Fraser Osborn, 2013) (Appendix Q).

A make-up dam is also present to the west of the DE-Pit TSF. The make-up dam stores water which is supplied to the wash-plant. The dam is filled by approximately 20% decanted water from the DE-Pit TSF, with the balance from other sources across the mine site. The make-up dam has a capacity of approximately 30,000 m³. The top of the bank is at RL 141.6 m. The Mandatory Reporting Level (MRL) is at RL 140.93 m and the design storage allowance is 9,600 m³.

6.8.3 DOM1 In-Pit TSF Design

Tailings are disposed directly into the DOM1 Pit, the fines removed from the product coal by the wash plant are removed as slurry and pumped to the tailings dam. The available storage capacity in DOM1 is estimated at over 20 million m³ and, based on these estimated figures, it will take approximately 36 years to reach 50% capacity and 70 years to reach full capacity. The MRL is set at the level in which only the Extreme Storm Storage allowance is available. It therefore is 0.24 m below the spillway crest level. For the purposes of the design, this then is set at 148.76 m.

To determine the suitability of the mined out inactive DOM1 pit for the storage of tailings, a number of assessments were undertaken to consider the environmental aspects and safety of the proposed facility.

Geotechnical Stability and Surroundings

A geotechnical assessment was undertaken on four sections through the pit walls using GALENA analysis. The highwalls, being the south and east walls achieved FoS between 2.69 and 9.93, indicating that the pit walls will remain stable during the life of the TSF. The northern section received lower FoS, between 1.79 and 2.53. The lowest are small failures in edges of dumped layers. These failures, if they were to occur, would not be critical to the overall operation, function, and safety of the pit.

An assessment of the general geotechnical conditions was also undertaken to assess soil conditions, layering and the potential for leakage of tailings water into the surrounding soils.

The soils surrounding DOM1 consist of topsoil layers which are predominantly clays. Below this is an array of mudstones, siltstones, sandstones, and coal layers. The clays are described as extremely weathered, soft and sticky, the rock layers are all described as fresh, moderate rock and the coal layers are also described as fresh and dark. The descriptions of the materials are typical of low permeable materials. There are no signs of sands, sandy type materials or gravel layers being encountered, which are typical of areas where water movement through the soils can occur. The assessment indicated favourable conditions for a TSF with a low possibility of seepage due to the low permeability of all layers and well compacted conditions.

Flooding

An assessment of the surrounding area was undertaken to determine the effects of flood events on DOM1. The assessment was considered necessary as there is a large catchment to the east of Yarrabee Mine that drains south of DOM1. The flooding assessment indicated that a maximum water level against the waste dumps, on the southern side of the pit is 146 m. The dumps and embankments surrounding the southern side of the pit were subsequently checked and filled to ensure all levels are in excess of 150 m. The dumps are greater than 40 m wide at the top and compacted during the dumping process by mine haul trucks. The majority of these dumps have been in place since the pit was mined and are considered stable.

In accordance with the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* (DESI, 2024e), the DSA is required to be accommodate a 1:20 AEP, 4-month wet season. This results in approximately 605 mm of rainfall and approximately 401,360 m³ of water which is 0.85 m in depth at full. In the bottom of the pit, during the first years of operation, it would be approximately 1.5 to 2 m of water. The pit is approximately 60 m deep.

In accordance with the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* (DESI, 2024e), a spillway design was undertaken. The spillway level was designed at 149 m and a general embankment minimum level of 150 m. The freeboard at spillway level would therefore be 1 m if water was at the spillway level. This level is also above the maximum flood level as modelled. It should be noted that the spillway would not be expected to be operational in the first 10 years of the TSF being operational because of the large capacity available.

Groundwater

There has been little indication of groundwater in the area. Some groundwater has been encountered during normal geotechnical drilling generally at depths varying between 30 and 60 m. The water is detected within layers of either mudstone or sandstone, where it is difficult for water to have any significant movement. There are no layers of sand or silt that would indicate an aquifer or possible source of water.

6.8.4 TSF Decommissioning

DE-Pit TSF is currently in the drying phase of decommissioning. The TSF is subject to drying and surface/crust consolidation before being capped and subsequently rehabilitated to a PMLU of native vegetation and grazing.

The DOM1 TSF will continue to be operational for the remainder of mine life at which point it will be rehabilitated following the criteria outlined in the PRCP Schedule to a PMLU of grazing.

Several years of active and passive management is required to dry the upper layers of deposited tailings. Evaporation of water from the surface within the tailings matrix (under capillary action) facilitates settlement and consolidation of the drying tailings under self-weight. This settlement and consolidation process increases the density of the tailings matrix, which in turn increases its capability of bearing weight, including ground pressure. Drying, consolidation and settlement of the tailings will create a thickened higher density crust (relative to 'wet' tailings). If required, drying may be enhanced by constructing dewatering sumps in opportunistic locations across the surface of the TSF, reducing the time required to dry deposited tailings.

Once the tailings are sufficiently dry, a capping layer will be installed per the design described in Section 6.8.5 and revegetation (where required) as per Section 6.12.

6.8.5 TSF Cover Design

ATC Williams Pty Ltd developed TSF Cover System Design for the DE-Pit Out-of-Pit TSF and the DOM1 in-pit TSF (Appendix R). The TSF cover design, and associated reporting is detailed in Section 6.8.5.1 to 6.8.5.5 and includes:

- A detailed cover design including the recommended minimum thickness of each layer of the cover.
- A detailed description of construction methodology including any proposed staging of the cover system.
- A quantitative assessment that identifies the location and quantity of proposed capping material available on site.
- Proposed quality assurance/quality control for the construction of the cover system including the timely implementation of corrective actions where deviations from the design are identified.

6.8.5.1 Cover System Objectives

The Yarrabee Mine EA EPML00844613, outlines requirements for the rehabilitation and closure of TSFs. When tailings deposition ceases and tailings are allowed to sufficiently dry, a final cover system is to be applied to DE-Pit, so that it is safe, stable, non-polluting, and able to sustain the PMLUs of grazing and native vegetation. A final cover system will be applied to the in pit TSF (DOM1), so that safe, stable, and able to sustain a PMLU of grazing. Cover system objectives were identified for the TSFs as summarised in Table 6-48.

Table 6-48: Cover System Objectives

Landform	Final Land Use	Cover System Objectives
DE- Pit	Native vegetation on slopes > 12.5% Grazing on slopes < 12.5%	• Minimise infiltration of water into the tailings structure. • Minimise moisture content of the disposed tailings to facilitate safe entry of heavy equipment onto the surface of the tailing's disposal structure. • The cover system material should be inert and capable of sustaining plant growth to support the PMLUs.
DOM1	Grazing	• Minimise the likelihood of any erosion occurring to either the final cover system, dumped spoil material or deposited tailings. • Ensure that run off into receiving waters does not exceed limits for water quality.

Source: (Appendix R).

In addition to the objectives detailed in Table 6-48, the final landforms will have the following objectives:

- DE-Pit: A free draining final landform surface to avoid erosion and surface water ponding (i.e., prevent water accumulation on the surface, which can lead to erosion and instability).
- DOM1: A free draining final landform surface to avoid erosion and surface water ponding (i.e., prevent water accumulation on the surface, which can lead to erosion and instability).

6.8.5.2 Cover System Configuration

The EA requires capping layers for each TSF include at least 4 m of NAF earthen material (e.g. spoil) with the top 200 mm of the surface ameliorated. The Yarrabee RMP includes guidance for TSF rehabilitation and suggests that topsoil is applied to DE-Pit at a minimum thickness of 200 mm along with amelioration. It is noted that topsoiling is not recommended on sandstone spoil due to the high salinity.

Based on the desktop review and EA requirements, two conceptual cover system types were selected to assess and compare predicted performance, summarised in Table 6-49.

Table 6-49: Conceptual Cover System Types

Type	Configuration	Comments
Type 1 – Bulk Rock Fill (Spoil)	4 m of spoil	Minimum depth to be applied to the DOM1 and DE-Pit TSFs in accordance with the EA.
Type 2 – Bulk Rock Fill (Spoil) overlain by Topsoil	0.2 m of topsoil 4 m of spoil (mudstone only)	Topsoil may be applied to support PMLUs of grazing and native vegetation.

Source: (Appendix R).

6.8.5.3 Cover System Modelling

Modelling was undertaken using SEEP/W, a finite element package software used in the numerical modelling of saturated and unsaturated flow within soils. Modelling was undertaken using a one-dimensional column through the profile of the proposed cover system, extending 10 m into the tailings profile. The cover systems modelled are presented in Table 6-50. Specific depths shown in each cross-section refer to modelling nodes utilised for model reporting.

The cover system model was developed using empirical formulas and material parameters obtained in laboratory testing and has not been calibrated against field data. An uncalibrated model can have an error margin up to an order of magnitude as a result of the variability between laboratory and longer-term field obtained values. The primary function of the current, uncalibrated cover system model was to compare relative performance of cover system options and configurations, the model was not intended to definitively assess the performance of each cover system.

Table 6-50: Conceptual Cover System Design

Type 1	Type 2
4 m Spoil	0.2 m Topsoil 4 m Spoil

Source: (Appendix R).

The geometric configuration of the model represented the conceptual cover system types. A sensitivity analysis was undertaken on the material parameters to take into consideration the variability of material characterisation data. Estimated SWCCs were generated from laboratory PSD testing of the spoil material. To capture variance in the behaviour of the spoil material under matric suction, a fine and coarse fraction was adopted for each scenario. Model boundary conditions are outlined as follows:

Climatic Conditions

- A daily time step was modelled for a timeframe of 50-years with climatic data sourced from SILO Data Drill. A 50-year period was deemed sufficient, noting that the timeframe adopted incorporates prolonged wet and dry sequences, accounting for multi-year variability in rainfall.

Initial Gradient (Free Drainage)

- Applied 10 m into the tailings profile (the base of the model) to allow seepage from the model. Seepage rates were calculated assuming the downward flux was equal to the hydraulic conductivity at that point.

Initial moisture content and pore water pressures were defined as an initial water head located at the base of the tailings model and running all models for 1,000 days to reach a point of equilibrium throughout the modelled profile. The initial 1,000 days are not presented, recognising these results are influenced by the initial water head input by the user.

Material Properties

SWCCs were available for the tailings which were estimated based on the textural class and using empirical formulas. The adopted SWCCs are shown in Figure 6-60 and detailed in Table 6-51.

The adopted saturated hydraulic conductivity curves are based on the estimated textural class and values and summarised in Table 6-51. The hydraulic conductivity curves were estimated using SEEP/w in-built Fredlund-Xing-Huang model and are presented in Figure 6-61.

To present a realistic initial condition prior to the establishment of sustainable vegetation, the models developed do not account for vegetation. This also accounts for vegetation die-back during drought period, considered a “worst-case” scenario.

Table 6-51: Adopted Saturated Hydraulic Conductivity

Layer	Saturated hydraulic conductivity (m/s)
Topsoil	1×10^{-5}
Spoil (fine)	2×10^{-7}
Spoil (coarse)	1×10^{-6}
Tailings	1×10^{-6}

Source: (Appendix R).

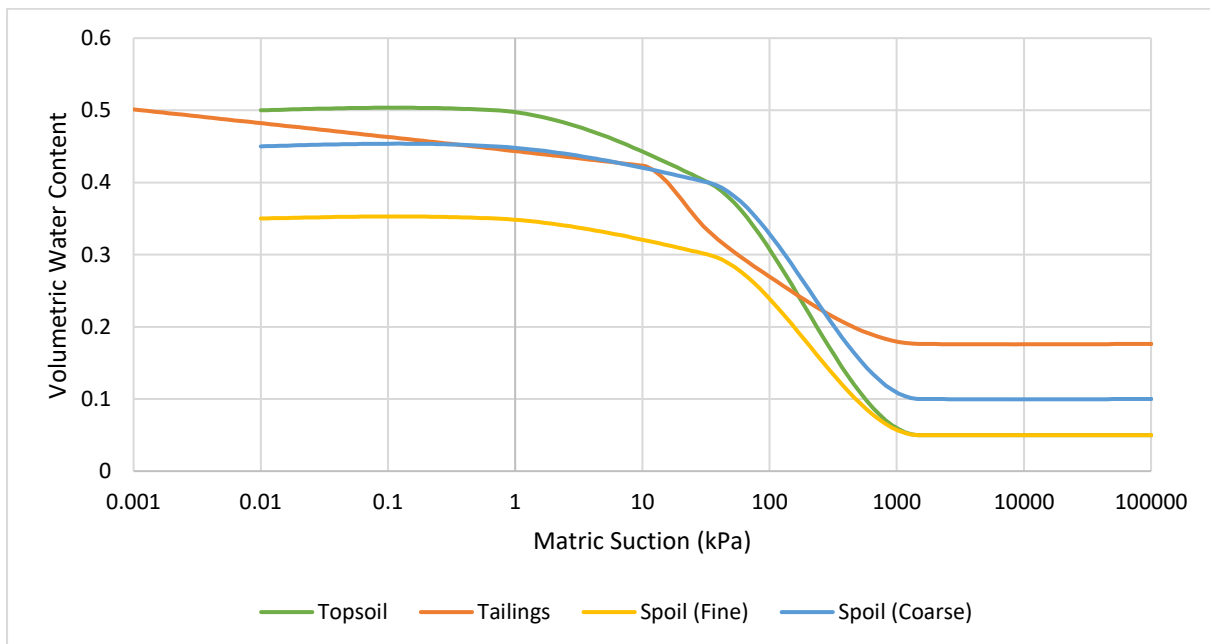


Figure 6-60: Adopted SWCCs (Appendix R)

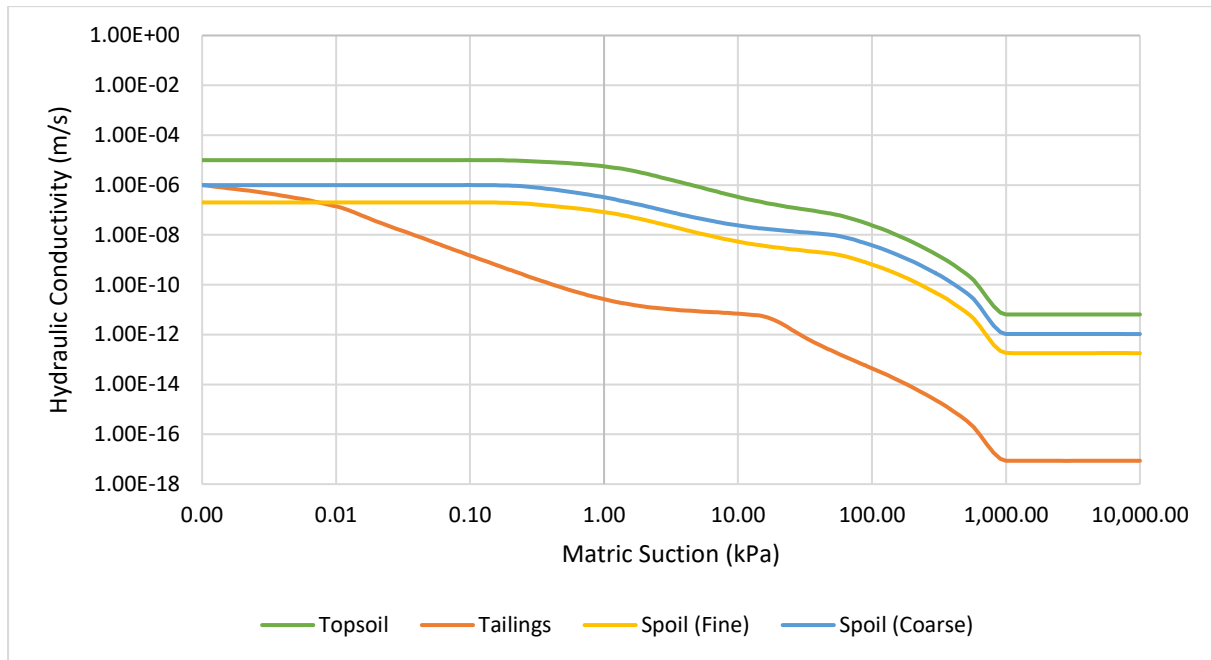


Figure 6-61: Hydraulic Conductivity Curves (Appendix R)

6.8.5.4 Cover System Modelling Results

Water Balance

In natural environments, rainfall will report as run off (RO), or infiltrate into the surface. A portion of the water that infiltrates will be stored in the active zone (change in stored moisture (ΔS)) and subsequently exfiltrate to the surface and evaporate. A percentage of the infiltrating water may migrate beyond the active zone due to gravity overcoming the influence of atmospheric forcing (i.e., evaporation) and result in net percolation (NP) into the underlying tailings.

The water balance presents the balance of moisture within the modelled profile. Results that form part of the water balance are:

- Rainfall: depth of rainfall occurring for the modelled period.
- Run Off: rainfall that does not infiltrate into the cover system and reports as surface runoff off to the TSF. As the model is one-dimensional, no run on is considered, with rainfall reporting as runoff leaving the model domain.
- Stored Moisture: the volume of water stored in the cover system profile at a given time. This water is available for transpiration and evaporation. As evaporation and transpiration dry the soil out, the stored moisture decreases.
- Evaporation: losses from the cover profile.
- Net Percolation: the volume of water moving out of the cover system profile, into the underlying tailings.

Volumetric Water Content and Degree of Saturation

The volumetric water content and degree of saturation are calculated daily. The Plant Available Water Capacity (PAWC) is calculated as the difference between field capacity (nominally 33 kPa matric suction) and permanent wilting point (nominally 1,500 kPa matric suction). When the matric suction is higher than this wilting point, matric suction no longer allows for the uptake of moisture by plants.

Degree of Saturation provides the same chart to the volumetric water content (VWC) with the difference of the Y axis displaying the ratio of saturation from the residual moisture content (0.05 to 0.2) to saturated (1). The degree of saturation for a given VWC is dependent upon material texture.

Flux

Moisture flux provides an indication of the direction and rate of movement of moisture within and through the cover system profile. Negative flux rates indicate the downward movement of moisture (e.g., rainfall infiltrating into the soil or percolation out of the soil and into the tailings) whilst positive flux rates indicate the upward movement (e.g., evaporation or evapotranspiration to the atmosphere or capillary rise).

The water balance was calculated on annual basis starting in the dry season (i.e., August) and the mean annual water balance is summarised in Table 6-52.

Table 6-52: Tailings Storage Facility Cover System Water Balance

Scenario	Mean annual rainfall (mm)	Ro (% cumulative rainfall)	Δsi (% cumulative rainfall)	Np (% cumulative rainfall)	Evap (% cumulative rainfall)
Type 1 (fine)	589	8.4	4.3	0	87.3
Type 1 (coarse)	589	5.3	5.7	0	89.0
Type 2 (fine)	589	6.4	4.5	0	89.1
Type 2 (coarse)	589	5.0	6.4	0	88.5

Source: (Appendix R).

A significant amount of annual rainfall was lost to evaporation, accounting for 87.3% to 89.5% of the cumulative annual rainfall, indicating the dominance of evaporative losses. Runoff was low, ranging from 5.0% to 8.4%. No net percolation was observed, indicating that the cover systems were effective in preventing water from infiltrating into underlying tailings.

The addition of a topsoil layer had minimal impact on the overall balance, due to the 4 m thickness of the spoil. While the topsoil layer may enhance plant growth and increase evapotranspiration, it had limited influence on the water balance. The water balance results demonstrated that 4 m of spoil is effective in managing net percolation into the underlying tailings material. The upper layers of the spoil should be placed loosely to facilitate additional water infiltration to assist with plant growth.

Saturation in the topsoil and upper layers of the spoil was highly variable, showing an increased degree of saturation after rainfall events, followed by periods of drying due to evaporation (Figure 6-62 and Figure 6-63). At greater depths within the spoil material, increases in saturation were only observed following large rainfall events.

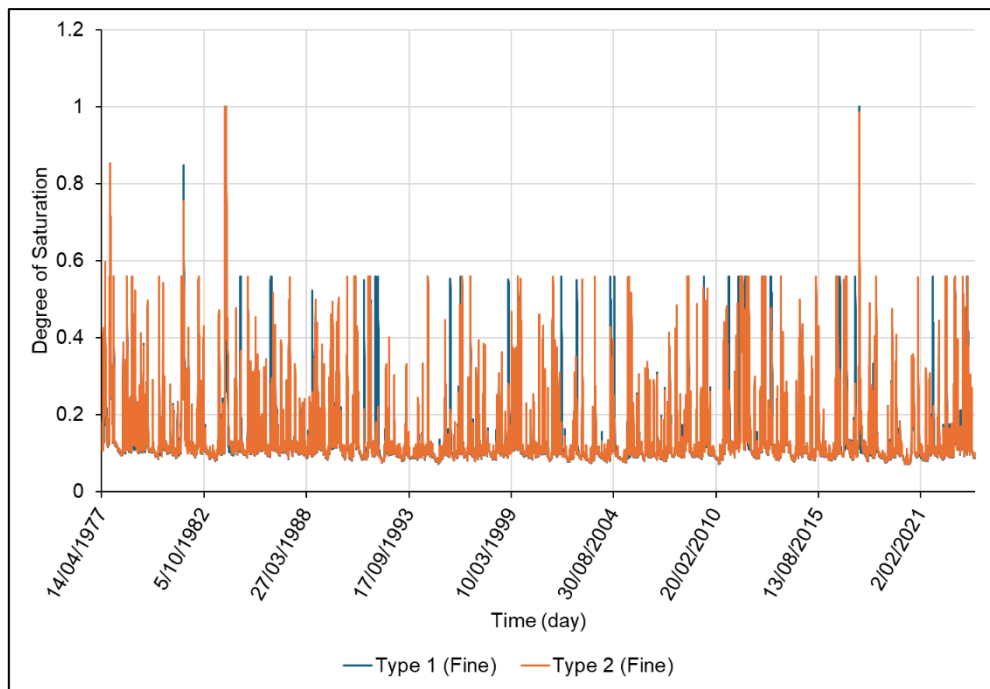


Figure 6-62: Spoil Degree of Saturation (0.3 m below surface) – Fine Spoil (Appendix R)

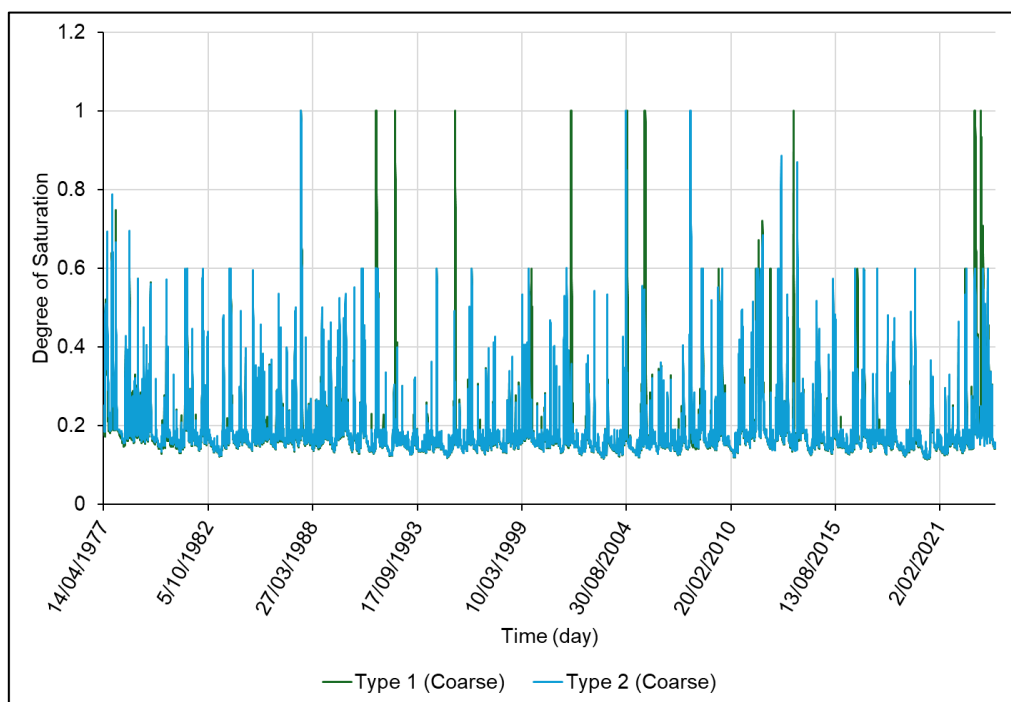


Figure 6-63: Spoil Degree of Saturation (0.3 m below surface) – Coarse Spoil (Appendix R)

The degree of saturation in the spoil material at a depth of 2.2 m below the surface varied over time, with the fine spoil typically exhibiting higher saturation levels than coarse spoil. This variation may have been influenced by rainfall events and water holding capacity. The higher saturation levels at the beginning of the model period may have been due to high initial moisture conditions.

Saturation of the tailings remained low throughout the model duration, where NP was approximately 0 mm (0 % of cumulative rainfall). Species selected for revegetation will need to be drought-tolerant to survive, particularly during dry seasons and years with below-average rainfall. The use of endemic native species would improve the potential for successful vegetation establishment.

For all cover systems, flux near the surface (0.3 mbgl) was highly variable and controlled by climatic conditions (Figure 6-64). Negative flux rates (indicating infiltration) were observed following rainfall events, followed by minor periods of positive flux rates caused by evaporation.

Flux rates in the tailings (0.01 m below the interface of the cover system) over the modelled period were close to 0 mm/day indicating that moisture from the cover system profile was not infiltrating into the underlying tailings material (Figure 6-65).

Table 6-53 outlines the maximum flux rate at 0.01 m below the cover profile/tailings interface. As shown in Figure 6-65, the maximum daily flux rate was low, with positive flux spikes decreasing over approximately a three-year period.

Table 6-53: Maximum Flux (mm/Day) 0.01 m Below Cover/Tailings Interface

Flux Rate	Type 1: 4 m Spoil (fine)	Type 2: 0.2 m topsoil 4 m Spoil (fine)	Type 1: 4 m Spoil (coarse)	Type 2: 0.2 m topsoil 4 m Spoil (coarse)
Maximum Flux (mm/day)	0.19	0.16	0.36	0.45

Source: (Appendix R).

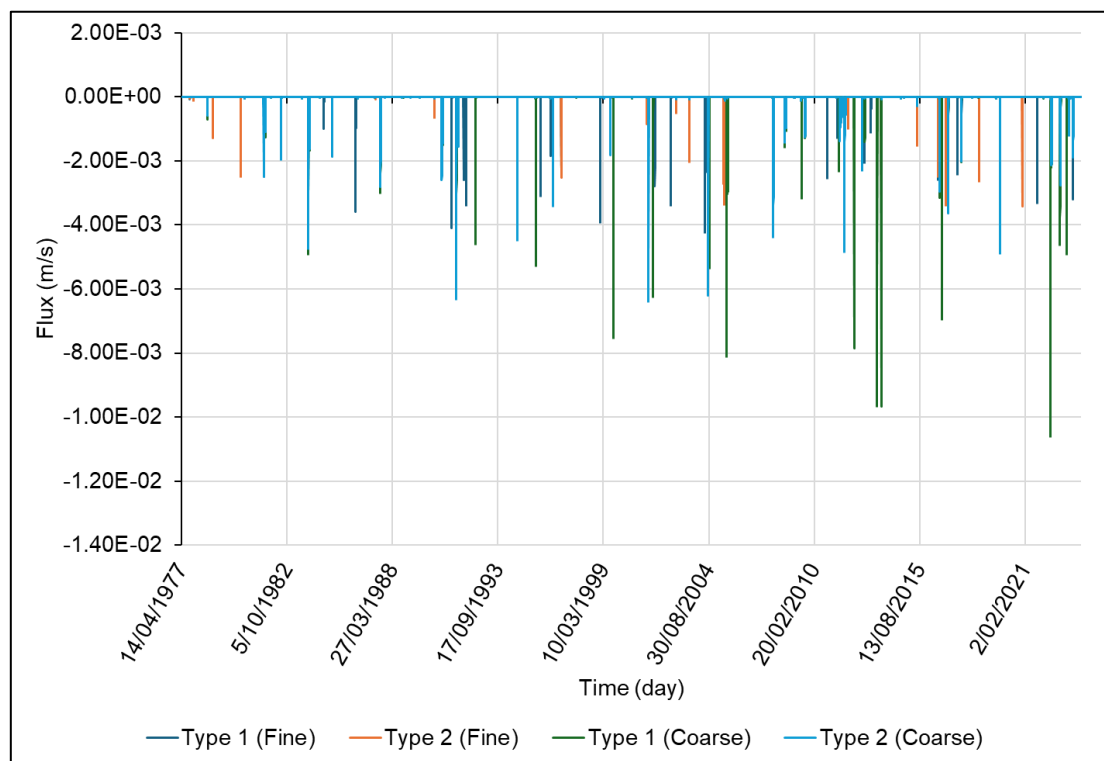


Figure 6-64: Flux - Top of Spoil (0.3 m Below Surface) (Appendix R)

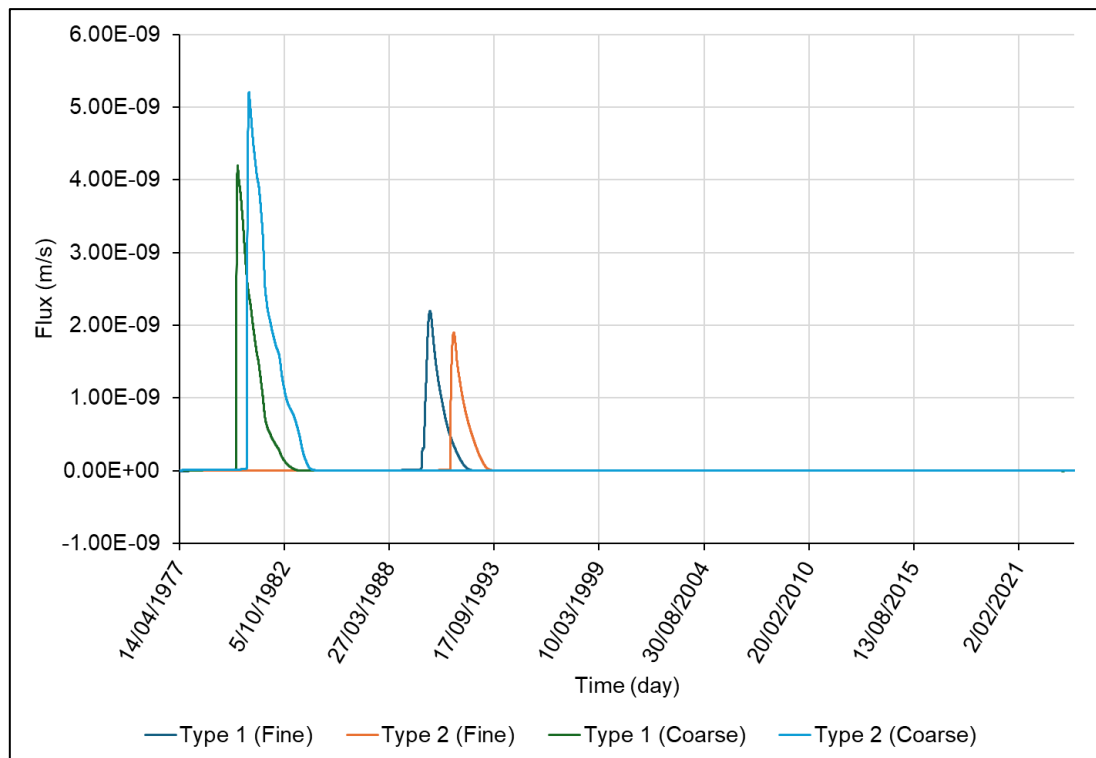


Figure 6-65: Flux – Top of Tailings (0.01 m Below Cover/Tailings Interface) (Appendix R)

6.8.5.5 Cover System Construction

Construction aspects including a high-level construction methodology, material requirements and QA/QC are discussed in the following sections. The concept drawings are provided in Drawing 1 and 2 of Appendix R, which show the surface in October 2023 and the final landform, and the cover system profile:

- DRAWING 1240540-01-000-001: Sections of DOM1, which show a minimum of 4 m of spoil over the tailings extent, due to rehabilitation activities pushing overburden material over the area.
- DRAWING 124054-01-001-002: Sections of DE-Pit, which show a minimum of 4 m of spoil over the tailings extent, due to rehabilitation activities pushing overburden material over the area.

Construction Preparation

Construction preparation works for the cover systems may include but not limited to:

- Decommissioning and removal of all pipework and associated infrastructure unless required to assist with dewatering of the tailings.
- Allow drying of the upper tailings layers to facilitate settlement and consolidation, which will increase bearing capacity for construction by increasing density. Drying may be enhanced, if necessary, by planting the surface of the tailings, or constructing dewatering sumps across the tailings surface. Additional techniques for cover construction also include mud farming, the use of geo-grids or placement of a traffic layer prior to placement of the cover material.
- If required, in situ treatment of unsuitable material to remove soft and compressible material to form a competent surface to construct the cover system on.
- Earthworks to shape landform to achieve slopes in accordance with the landform design criteria, with the final surface of DE-Pit to be free draining.
- As required, construct, install and/or establish water management and erosion infrastructure.

Construction of the Cover System

Construction of the cover system may include but not limited to:

- Material source testing to determine required treatments.
- The DE-pit and DOM1 TSF are covered as part of final landform construction.
- Ameliorate spoil to a minimum depth of 200 mm, as required.
- Undertake seeding and revegetation works in accordance with the revegetation plan.

The material requirements to apply a minimum of 4 m of spoil to DOM1 is estimated in Table 6-54. DE-Pit does not require additional cover, as soil placement over its extent occurs as part of final landform development. There is sufficient spoil material available to achieve a minimum 4 m thickness on DOM1.

Table 6-54: Material Quantities Required

Landform	Cover system type	Material	Layer thickness (m)	Volume estimate (m ³)
DOM1	Type 1	Spoil	4 (minimum)	2,080,000 (minimum)
DE-Pit	Type 1	Spoil	4 (minimum)	N/A

Source: (Appendix R).

Note: The volume estimate makes the following assumptions: DOM1 is 52 ha. All quantities are in BCM. No bulking factors have been included.

QA/QC will form a key component of construction to ensure design standards are met and the cover system and final landform performs in accordance with the design intent. Generally, QA/QC would be undertaken as follows:

- Survey control would be required for the duration of works, to ensure construction tolerances specified are met. This would include the thickness of the cover system as well as achieving final levels.
- Material characterisation to be undertaken prior to, and during construction works. Material characterisation would be undertaken to confirm material used in construction was in accordance with the specification, and treatment required.
- Construction Quality Assurance information would be complied with engineering certification provided, demonstrating works were completed in accordance with the design, at the completion of construction.

6.9 WATER MANAGEMENT

6.9.1 Twelve Mile Creek Diversion

Engeny developed a conceptual design for the Twelve Mile Creek diversion (Appendix S). The overall goal was to prepare a concept level diversion design that fits with the final landform and meets the stability objectives for watercourse diversions in the Bowen Basin. The design and associated reporting are detailed in Section 6.9.1.1 to 6.9.1.6 and include the following:

- hydraulic compliance modelling of the concept design;
- diversion rehabilitation plan; and
- concept drawings for the closure concept.

6.9.1.1 Twelve Mile Creek

As discussed in Section 2.4, Twelve Mile Creek is an ephemeral tributary of the Mackenzie River that occurs within the Yarrabee Mine ML areas (ML 1770 and ML 80197). Twelve Mile Creek is a second order ephemeral creek with head waters approximately 40 km upstream of the Yarrabee Mine. Twelve Mile Creek drains in a north-easterly direction through the Yarrabee Mine, with open cut pits located on both sides of the creek. A narrow riparian margin (less than 20 m wide) has been left along much of the banks of Twelve Mile Creek.

Twelve Mile Creek was originally diverted in the mid 1980's to allow access to coal deposits beneath the original creek alignment (Engeny, 2023). The diversion commences near the western mining lease boundary and runs between A-Pit and D-Pit before transitioning into the existing channel near C-Pit.

In 2020 Engeny completed an options assessment of the Twelve Mile Creek Corridor assessing design options for the realignment of the Twelve Mile Creek diversion (the diversion). The design selected featured a re-alignment of the diversion to enable the construction of a flood protection landform on the southern side of A-Pit to prevent flood ingress. This design was identified as the preferred configuration as it provided the best outcome for long-term environmental performance and risk.

Monitoring of the diversion has been undertaken since 2015, with the last major monitoring event completed following the 2022/2023 wet season. As part of the major monitoring, the latest condition of the diversion was assessed.

The upstream control reach of the diversion has a small meandering channel, an undulating bed floor and gentle longitudinal gradient. The channel typically features a small active channel with wide floodplains. No control structures are present within the upstream control reach. The reach features consistent vegetated benches along the length with no spoil piles or constructed structures in the immediate vicinity. Overstorey vegetation is patchy, understorey vegetation is continuous and ground cover vegetation is patchy, with little variation along the length of the reach.

The upstream control reach is in good condition with generally limited erosion noted. The existing upstream reference reach of the diversion has a small active channel with a wide floodplain area. The longitudinal grade of the channel is very flat which has caused regular pools of ponded water to form in the channel bed.

Upstream of the Haul Road crossing, erosion from rehabilitation of the surrounding landform has resulted in a large side inflow gully forming, adjacent to the former DOM2 Levee. The inflow gully appears to have further progressed since 2022. Erosion has produced a large amount of sediment which continues to be deposited within the channel and downstream.

The vegetation cover throughout the reach is significant, consisting primarily of grass and canopy cover, providing stabilisation to most of the channel banks and floodplain areas. The ground cover is consistent with 2022 inspections. There are still some locations where the ground vegetation cover is sparse and minor erosion gullies have formed from lateral inflow to the creek.

The diversion reach has a deep active channel with a constricted floodplain as a result of the construction of the A Pit levee, C Pit embankment and D Pit embankments. The main channel banks have been historically subjected to erosion and steepening, with evidence of historical cattle tracks down the steep sections of the embankments.

Grazing has not occurred within the diversion or its vicinity for several years, which appears to be contributing to its stability, with most of the diversion reaches steep batter slopes remaining unchanged. The lack of major flow events in the diversion in recent times has also likely contributed to the ongoing stability.

Vegetation within the diversion reach is typically less dense than the upstream and downstream reaches. It has remained mostly stable, with vegetation primarily consisting of a single species mid canopy nature, primarily located on the floodplain with sparse vegetation establishment on the channel banks. Some larger canopy species have established on the diversion channel batter, which has promoted the deposition of sediment forming benches in the channel bed.

For much of the diversion reach, no significant change in condition has been identified since diversion monitoring commenced in 2015.

6.9.1.2 Diversion Design Closure Objectives

The long-term performance of the diversion under both operating and closure scenarios is assessed against the following objectives, based on requirements from relevant licences, guidelines, and approvals:

- To be in a safe, stable, non-polluting, and self-sustaining state, as per PRCP Closure Criteria and Environmental Authority requirements.
- Rehabilitation requirements and acceptance criteria include goals, objectives, and acceptance criteria for the Watercourse PMLU which is applicable for the diversion.
- Achieves the key outcomes identified in the DNRME Guideline: *Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000* (DNRME, 2019).
- Existing water licence diversion objectives generally align with the objectives under the DNRME Guidelines (2019).

A further discussion of legislative requirements and guidelines considered in the development of the Twelve Mile Creek Conceptual Diversion Design is provided in Appendix S.

6.9.1.3 Basis for Concept Design

The two recognised guidelines for the design of watercourse diversions within Queensland are as follows:

- Guideline: *Works that interfere with water in a watercourse for a resource activity - watercourse diversions authorised under the Water Act 2000* (DNRME, 2019).
- Criteria for functioning river landscape units in mining and post-mining landscapes (Australian Coal Association Research Program [ACARP], 2014).

Both the DNRME and ACARP Guidelines were developed based on research completed by ACARP in the early 2000's which included an assessment of existing diversion performance, as well as the development of design and rehabilitation criteria for watercourse diversions. The DNRME and ACARP Guidelines were both utilised to inform the basis of design for the Twelve Mile Creek conceptual diversion design.

DNRME

The following design criteria are recommended by DNRME in the development of permanent watercourse diversions and were considered in the development of the Twelve Mile Diversion:

- The watercourse diversion should tie-in with the existing or receiving watercourse within the resource tenure boundary.
- The stability and performance of a watercourse diversion is assisted by vegetation within the watercourse diversion and adjoining floodplain and does not include artificial structures for grade control that requires ongoing maintenance.
- The channel capacity must be at least equivalent to the natural stream channel capacity existing in that vicinity.
- The length of the channel should be equivalent to the length of the watercourse it replaces.
- Bed grade/slope should be equivalent to the existing watercourse.
- Batter slopes should be designed to maintain stability through different substrates.

The DNRME Guideline also nominates a set of hydraulic design criteria which have been adapted from the original ACARP research. These criteria were developed based on assessment of existing Bowen Basin streams and watercourse diversions and are considered reflective of stable hydraulic conditions for ephemeral systems in central Queensland.

The criteria are summarised in Table 6-55 and include:

- Shear stress – a function of discharge, flow depth and hydraulic gradient, which represents the tractive force acting on sediment particles and is used to determine the threshold of sediment motion. High shear stress provides an indication of potential erosion in cohesive sediments or movement of non-cohesive sediments. It also provides a measure of the ability of vegetation to withstand flow.
- Stream power – a function of hydraulic gradient, flow width and flow rate. It represents the energy available to do work on the channel. High stream power values generally result in elevated erosion potential.
- Velocity – a function of flow rate and cross-sectional area. A simplified measure of erosion potential. Generally higher velocities result in higher erosion potential; however, stream power and shear stress tend to be more reliable indicators of erosion and sediment transport potential.

Table 6-55: Hydraulic Design Criteria (DNRME, 2019)

Design Flow Event	Stream Power (W/m ²)	Velocity (m/s)	Shear Stress (N/m ²)
39% AEP (Previously 2-year ARI) – No Vegetation	<83	<1.0	<40
39% AEP (Previously 2-year ARI) – Vegetated	<60	<1.5	<40
2% AEP (Previously 50-year ARI)	<150	<2.5	<80 ¹

Source: (Appendix S).

1DNRME values are extracted from ACARP (2002), however the value reported for the 2% AEP shear stress (<50 N/m²) in the DNRME 2014 is incorrect. The ACARP value of <80 N/m² has been adopted.

The DNRME hydraulic design criteria summarised in Table 6-55 were adopted as the basis for the concept design. The ACARP values were referenced when considering stable stream powers and shear stresses during the vegetation establishment phase of the construction.

ACARP Guidelines

ACARP (2014) outlined multiple approaches to the diversion channel dimensions, including:

- The analogous approach, where channel dimensions are chosen from a reference reach.
- The hydraulic geometry approach, where dimensions are selected from regression relationships.
- The analytical approach, where equations are utilised to calculate continuity, hydraulic resistance, and sediment transport and channel characteristics are determined from field inspection of a reference reach.

In addition to the analogous approach, ACARP (2014) also provides guidance on alluvial channel design parameters (adapted from ACARP (2002)). These parameters are intended to be representative of stable watercourses within the Bowen Basin (Table 6-56). ACARP (2014) also provides recommendations on shear stress thresholds for vegetation used in rehabilitation activities. These thresholds are summarised in Table 6-57.

Table 6-56: Alluvial Channel Design Parameters (ACARP, 2014)

Stream Type	Sediment Scenario	Stream Power 39% AEP (W/m ²)	Stream Power 2% (W/m ²)
Alluvial	Supply Limited	13 to 35	50 to 100
	Transport Limited	35 to 60	80 to 150
Bedrock Controlled	N/A	50 to 100	100 to 350

Source: (Appendix S).

Table 6-57: Recommended Vegetation Shear Stress Thresholds (ACARP, 2014)

Vegetation Type	Design Shear Stress (N/m ²)
Buffel Grass (Cenchrus Ciliaris)	40
Structurally diverse suite of established native vegetation	120

Source: (Appendix S).

6.9.1.4 Concept Design Parameters

Table 6-58 details the parameters for the design plan for a permanent diversion, aligning with DNRME and ACARP Guideline requirements, from which a suitable level of detail for has been undertaken for a concept design. Only benchmark values for shear stress and velocity were adopted from DNRME (2019). Stream power benchmark values were adopted from ACARP (2014) due to it being a more contemporary standard that considers impacts of sediment transport.

Table 6-58: Adopted DNRME and ACARP Parameters

Outcome	DNRME Parameters (DNRME, 2019)	Equivalent ACARP Parameters (ACARP, 2014)
1	The design plan should include a detailed description of: a) the location, function, and description of geomorphic features within the proposed watercourse diversion as well as a revegetation and vegetation management plan.	Geomorphic and riparian vegetation features of the diverted watercourse and connecting reaches (minimum of 1 km upstream and downstream of proposed tie ins). Vegetation characteristics along the proposed optional watercourse diversions should also be noted.
2	The design plan should include a detailed description of: a) the development and calibration, or sensitivity analysis, of the hydrologic model, including the referencing of methodologies used to generate flood frequency analysis. b) any design implications and construction processes that necessitate a lateral disconnectivity of sub-surface flow between the watercourse and an adjacent final void (if proposed).	Summary of hydrological characteristics including surface water groundwater interactions and water use. Flow changes along the reach should also be clearly noted.
3	The design plan should include hydraulic modelling results (benchmarked against guideline values for stream power, shear stress and velocity adopted from ACARP, 2002) and analysis identifying depth of inundation. The design plan should include a floodplain of sufficient capacity.	Summary of hydraulic characteristics along the waterway length. Longitudinal section of stream power with standard cross section increments. A higher frequency of cross sections is required at stream junctions and bifurcations. A table summarising stream powers (in channel and floodplain) at each cross section is also required, along with statistics for the reach. This specifically includes the reach minimum, low quartile, median, mean, upper quartile and maximum values.
4	The design plan should include a sediment transport analysis that identifies how the watercourse diversion will manage erosion or deposition events such that they are consistent with the existing sediment regime.	Sedimentation characteristics. Where the existing reach is aggrading, degrading, or is in equilibrium. Note presence of sediment sources (e.g., main channel bed or bank instabilities, floodplain contributions) and sinks (e.g., flood outs or sediment plays along low gradient sections of the reach, and infilling pools).
5	The design plan should include the specification of spoil placement and sequencing and the settlement process and timing of operation that will ensure the watercourse diversion, once constructed, operates in a stable manner.	Interaction between watercourse diversion options and mine infrastructure (pipes, pits, culverts, access, etc.) and planning over the life of mine.

Source: (Appendix S).

Diversion Alignment and Channel Geometry

Typical upstream and downstream channel cross sections of Twelve Mile Creek are shown in Figure 6-66 and Figure 6-67. The section for the concept diversion was developed to align with the configuration of natural upstream and downstream channel geometry. The location of the reference cross sections is presented in Figure 6-68. Table 6-59 summarises the selected typical channel cross section for the concept design. The full concept drawings for the Twelve Mile Creek Diversion are presented in Appendix A of Appendix S.

Table 6-59: Detailed Channel Cross Section Geometry for Concept Design

Channel Geometry	Quantity	Comments
Channel Bed Width	5 m	Typical reference reach.
Channel Depth	5 m	Minimum 5m channel, with flood plain that batters out to tie-in to adjacent landforms.
Batter Slope	1V:4H	Typical reference reach.

Source: (Appendix S).

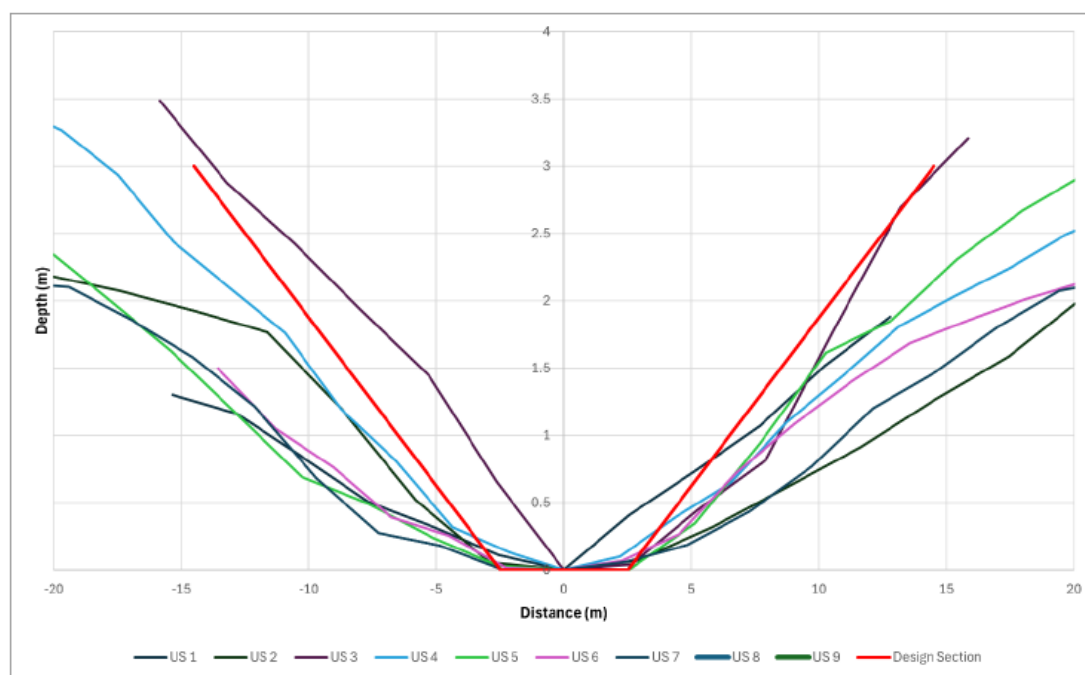


Figure 6-66: Typical Upstream Channel Cross Section of Twelve Mile Creek (Appendix S)

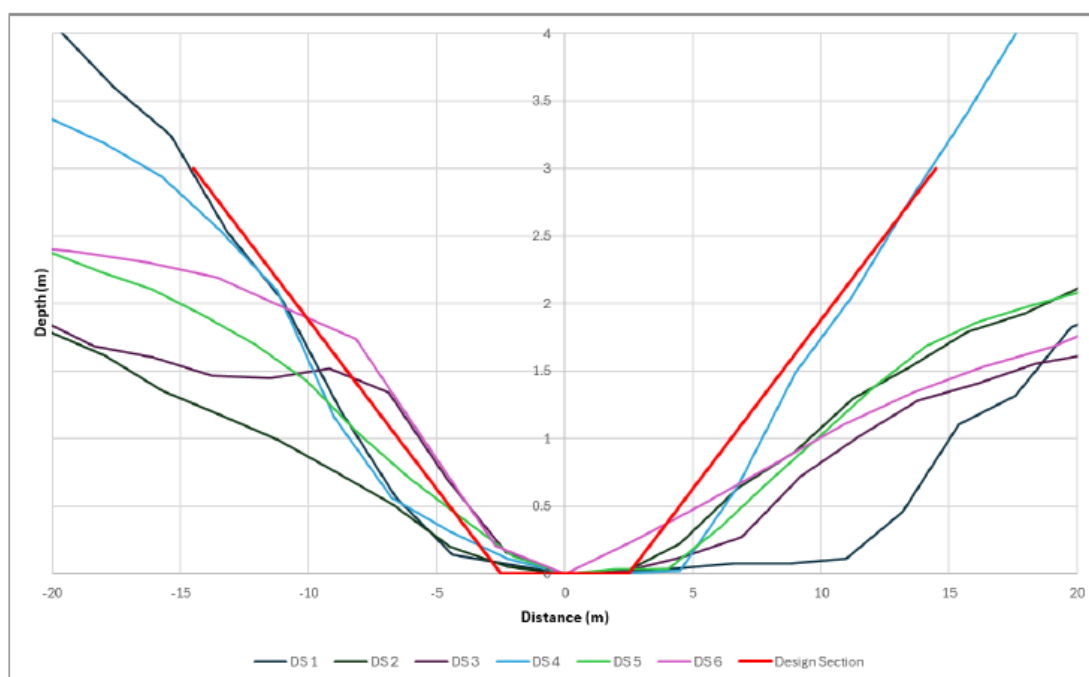
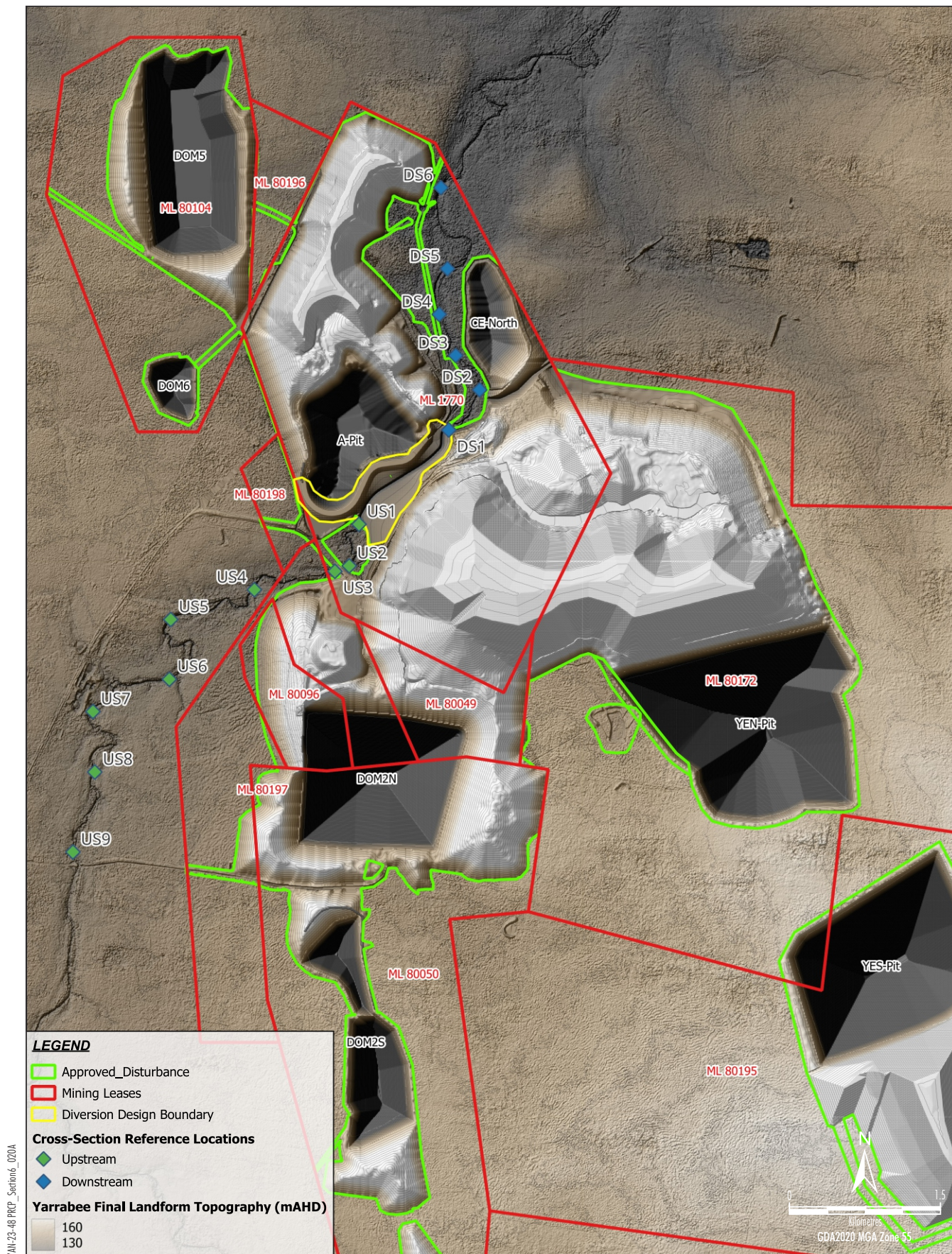


Figure 6-67: Typical Downstream Cross Section of Twelve Mile Creek (Appendix S)



Frequent Events

Twelve Mile Creek is a very flat system, with an average longitudinal gradient of approximately 0.067%. As such, there is little available space or requirement to incorporate sinuosity into the design and therefore the concept design does not seek to change the vertical grade. The design maintains a relatively straight alignment to achieve a gradient as close as possible to natural. The resulting longitudinal gradient for the concept diversion reach is 0.05%, with a length of approximately 1.35 km.

Hydrology

A hydrologic model of Twelve Mile Creek was developed by Engeny to inform the Final Landform Flood Assessment. The model was used to estimate flows for a range of flood events including the 50%, 10%, 2%, 1%, 0.1% AEP and PMF events. Further details of this assessment are provided in Section 6.3.

The interaction of a 0.1% AEP and PMF flood event and the PRCP landform has been assessed as part of the final landform flood modelling completed for the PRCP. This informs the interaction between the diversion and final voids, landform, and potential impacts to downstream infrastructure.

Hydraulics

A one-dimensional HEC RAS hydraulic model of the diversion concept was developed to assess compliance with the DNRME and ACARP hydraulic performance criteria for the 39% and 2% AEP (2-year and 50-year ARI) events.

Impacts to the flooding regime in rare events (0.1% AEP and PMF) and the risk of void flood inundation were assessed through the PRCP Flood Assessment using a two-dimensional TUFLOW hydraulic model (Engeny, 2024) (Appendix I). A flood map showing the flood immunity of the final landform and diversion concept design for the rare flood events is provided in Appendix B of Appendix S.

Average values were derived for stream power, stream velocity and shear stress in the 39% and 2% AEP event are presented in Table 6-60. The proposed diversion values are compared to the DNRME (2019) diversion channel design parameters.

Table 6-60: Diversion Design Criteria Compared to DNRME (2019) Guideline Parameters

Design Criteria	2% AEP (50 Year ARI)		39% AEP (2 Year ARI)	
	Diversion	DNRME Design Parameter (2019)	Diversion	DNRME Design Parameter (2019)
Stream Power (W/m ²)	109	150	22	60
Stream Velocity (m/s)	5.6	2.5	1.5	1.5
Shear Stress (N/m ²)	41	80 ¹	15	40

Source: (Appendix S).

¹ DNRME values are extracted from ACARP 2002, however the value reported for the 2% AEP shear stress (<50 N/m²) in the DNRME 2019 is incorrect. The ACARP value of <80 N/m² has been adopted.

As shown in Table 6-60, all the hydraulic results for the diversion were on average below the recommended DNRME design parameters except for the 2% AEP stream velocity, which was slightly elevated. This small exceedance is not of concern and could be refined through future Functional Design optimisation.

It is noted that the 39% AEP velocity only met the DNRME and ACARP design criteria for stability of the channel for vegetated conditions. Consequently, construction timing and vegetation development will be important to be taken into consideration during future Functional and Detailed Design stages.

Stream power was investigated as a proxy for sediment transport capacity. A comparison of stream power in the diversion reach compared to the reference reach (upstream and downstream) is presented in Figure 6-69 and Figure 6-70, with the ACARP guideline values for transport limited reaches provided for comparison.

The ACARP guideline recommends that the 25th to the 75th percentile of stream powers in the proposed stream lie within the typical guideline value range and no stream power value should be more than 30% greater than the maximum value. From the results presented in Figure 6-69 and Figure 6-70, it is evident that the background for Twelve Mile Creek (upstream and downstream) reaches are naturally lower than the ACARP guideline value range. Figure 6-69 and Figure 6-70 indicate that comparable or slightly elevated stream power results can be achieved for the diversion reach relative to the comparison reaches, or within the ACARP guideline values.

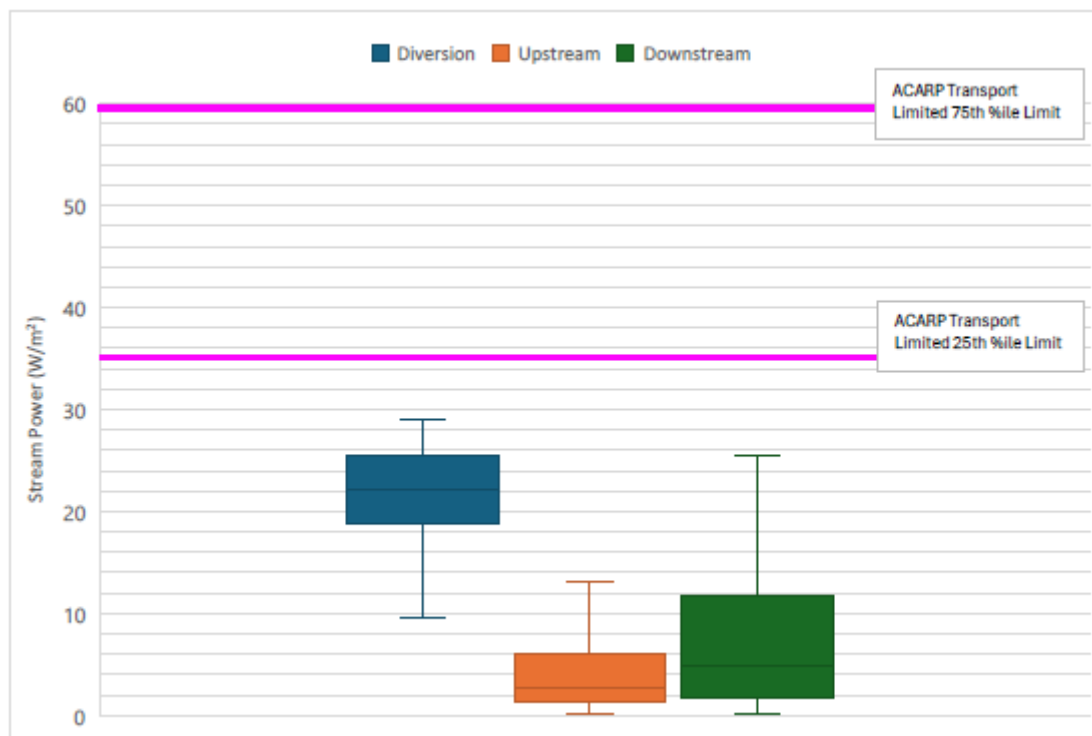


Figure 6-69: 39% AEP Concept Design Stream Power Assessment (Appendix S)

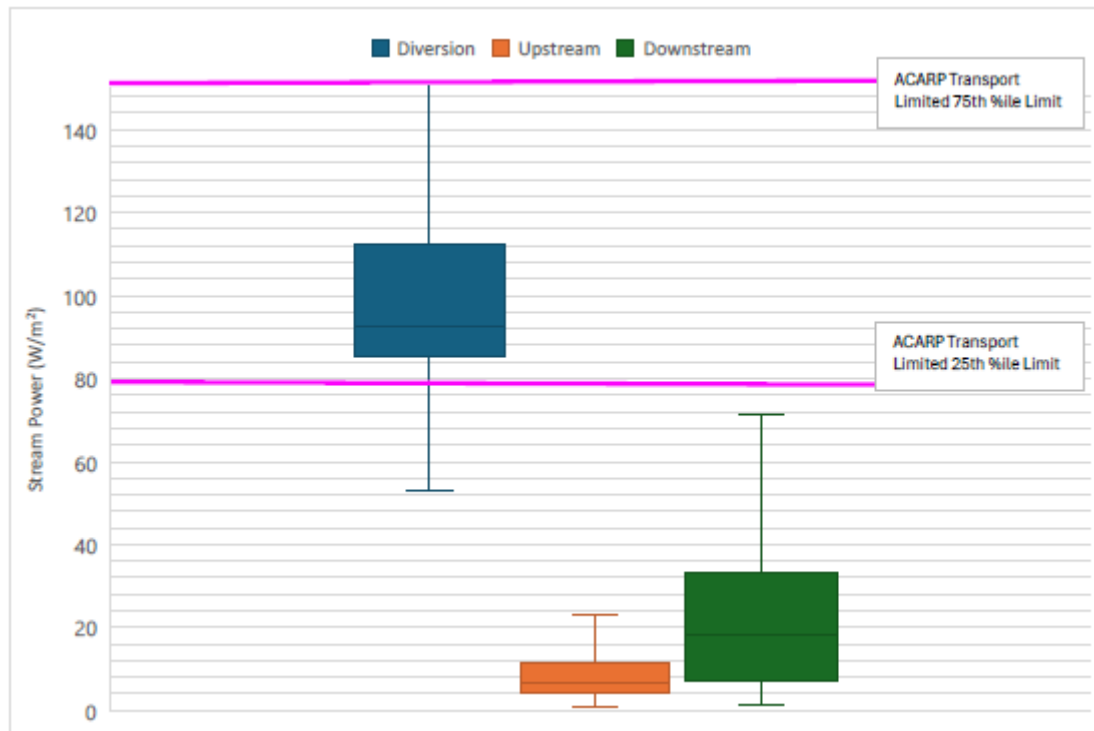


Figure 6-70: 2% AEP Concept Design Stream Power Assessment (Appendix S)

6.9.1.5 Diversion Design Risks and Proposed Mitigation Measures

The Concept Design assessment identified a range of risks to the successful implementation of the Twelve Mile Creek Diversion. Potential controls and mitigation measures have been identified and a summary of the key identified risks and associated mitigation measures:

- Construction of a portion of a diversion channel through a back-filled pit (i.e. C-Pit) is an accepted approach across the Queensland coal industry. However, this configuration does introduce the risk of settlement and/or differential settlement of back-filled material. The timeframe for settlement to occur is influenced strongly by the recovery of potential groundwater and is currently poorly understood. To reduce risk, the diversion channel avoids D-Pit but cannot avoid C-Pit. The mined depth of C-Pit is relatively shallow, which will assist in reducing potential settlement.
- The potential presence of a historical paleo channel through D-Pit and A-Pit was previously identified based on seepage expression observed at A-Pit. Hydraulic connection between Truckfill Dam, D-Pit and A-Pit could cause stability risk because of the seepage expression in A-Pit. This risk would be managed through a combination of select engineered controls (e.g. material placement, compaction, liner) and undertaking a geotechnical assessment of A-Pit highwall.
- The concept design flood assessment (Engeny, 2024, Appendix I) indicates potential for elevated velocities within the Twelve Mile Creek Diversion corridor, particularly at the downstream where the diversion is most constricted by the landform. Whilst the above assessment indicates that the Concept Design could achieve the 39% and 2% AEP ACARP criteria for frequent flows, further refinement of the floodplain configuration may be required to optimise velocities in more rare flood events at future Functional and Detailed Design stages.
- The final landform and diversion concept achieve flood protection for the A-Pit void that exceeds the 0.1% AEP immunity criteria required by the EA. The Landform Feature and diversion concept also achieve PMF immunity which further supports the outcomes of minimising flood risk.
- The risk of failure of A-Pit Landform Feature under a closure scenario has been managed by adopting a A-Pit landform design of sufficient geometry to achieve no practical dam failure mechanism. Further geotechnical assessment of A-Pit highwall should be undertaken at future design stages.
- Establishment of self-sustaining vegetation will be critical for the ongoing stability of the diversion. Particular care should be undertaken during the early establishment period. Potential controls include construction during appropriate climatic conditions (i.e. during the dry season) and development of a detailed revegetation plan to be implemented to promote rapid establishment.

6.9.1.6 Key Findings

The Twelve Mile Creek diversion concept design was developed to meet achieve a state of dynamic equilibrium enabling its relinquishment in the post closure landform of Yarrabee Mine. The concept design report demonstrates that the watercourse diversion will satisfy the closure objectives identified in the PRCP guidelines and ACARP and DNRME criteria. In particular, this assessment concluded that:

- The diversion has been designed in accordance with the DNRME hydraulic design criteria for permanent diversions (DNRME, 2019) and presents hydraulic parameters within threshold values for 2% AEP and 39% AEP events (excluding stream velocity as discussed above).
- The geomorphic features, including stream length and grade are similar to the natural upstream and pre-mining channel, including vegetation of the natural surrounding ecosystem to meet the DNRME (2019) guideline objectives for permanent diversions.
- The post-mining land use for surrounding land will be potentially used for grazing and native vegetation purposes.
- The concept design will mimic the hydraulic performance, water quality and sediment transport regime within the diversion representative of the natural watercourse reaches.
- Programs for monitoring and revegetation/rehabilitation of the diversion will continue to be maintained throughout the operational phase of the mine.

6.9.2 Contaminants that Pose a Risk to Environmental Values

The final landform of Yarrabee Mine includes large areas of reshaped spoil and two TSFs. Depending on the chemical nature of the spoil, when exposed it can oxidise and result in the formation of acid which may leach metals and other contaminants from the spoil.

The following potential contaminants have been identified as posing a potential risk to environmental values of the receiving environment:

- carbonaceous materials;
- major ions, including sodium, chloride, sulphate, and bicarbonate; and
- trace metals/metalloids.

The key potential sources of contaminants (post-rehabilitation) are:

- in-pit waste rock emplacements (including IWL cells and Central Void);
- out-of-pit rejects emplacements; and
- final voids.

Pathways for the potential contaminants to reach the receiving environment (e.g. watercourses or the groundwater table) includes overland flow (e.g. overtopping of the final voids) or infiltration/seepage (e.g. from out-of-pit rejects emplacements).

With regards to overland flow, once rehabilitation is completed, all runoff will be clean water as it will be from rehabilitated surfaces. Runoff within the final void catchments will be directed into the final voids by the safety bund and will not flow to the receiving environment.

While DOM6, DOM2S and CE-North act as local sources, the remaining voids act as strong groundwater sinks capturing seepage from spoil emplacements or water seeping from the source voids. The final landform has been designed to minimise contamination potential, however, if seepage were to occur it would be drawn to the final voids which act as groundwater sinks, thereby preventing any potential exposure to the environment.

RGS concluded that dissolved metal/metalloid concentrations in surface runoff and seepage from the coal, coarse reject, fine reject, and tailings materials are unlikely to present a significant risk to surface and groundwater resources with the expectation that the material will be handled according to standard industry mine waste management practices (Appendix J). Based on RGS' findings presented in Appendix J, SLR considered that Yarrabee Mine waste does not pose a significant risk to groundwater quality.

6.9.3 On-going Water Management and Reduction Requirements

As detailed in Attachment 1 and 2, water management infrastructure including dams will be retained post-mining. As grazing and native vegetation are the approved PMLUs, most water management structures (i.e. dams) shall be retained due to their direct benefit to the PMLU. If specific water management structures are not required to be retained, they would be decommissioned and rehabilitated in consultation with relevant stakeholders and with the approval of DETSI.

Once rehabilitation is completed, no ongoing water management would be required for the remainder of the site, including the residual voids.

6.10 UNDERGROUND MINING

No underground mining is undertaken at the Yarrabee Mine, therefore this Section is not applicable.

6.11 BUILT INFRASTRUCTURE DECOMMISSIONING

Infrastructure areas that service the operations of Yarrabee Mine include buildings, roads, laydown areas and services (e.g. pipelines). Where an agreement with the post-mining landholder and relevant agencies is not in place to retain infrastructure, it will be decommissioned and rehabilitated when no longer required. Infrastructure on site includes but is not limited to:

- CHPP;
- workshops and administration buildings;
- refuelling facilities;
- hydrocarbon and chemical storages;
- electrical transformers and powerlines/power poles;
- equipment/vehicle wash pads;
- warehouses;
- sewage treatment plant and associated sub-surface irrigation systems;
- pipelines and pumps;
- dams;
- ROM and coal stockpile pads;
- fences;
- hardstands and laydown pads; and
- roads and access tracks.

The specific decommissioning process for the different forms of infrastructure is described in Section 6.11.1 to Section 6.11.5.

Throughout the decommissioning process, all retained infrastructure would be assessed by an AQP to ensure it is safe, stable and will not cause environmental harm. All retained infrastructure would be subject to ongoing maintenance to ensure the area is suitable to sustain its approved PMLU and would be managed in accordance with the Rehabilitation requirements and completion criteria detailed in the PRCP Schedule. Any maintenance requirements would be detailed in the report provided by the AQP and provided to the future landowner.

A summary of infrastructure to be retained along with the specific post closure maintenance requirements is outlined in Table 6-61 and Attachment 2.

Table 6-61: Retained Infrastructure and Associated Maintenance Requirements

Infrastructure	Ongoing Maintenance Requirements	Agreement in Place
Eight water storages	Regular monitoring of water quality would be conducted. Maintenance would be undertaken as required.	A landholder agreement for the retention of infrastructure post closure is provided in Attachment 2.
Two access roads	Regular monitoring of road condition would be conducted and maintenance undertaken as required.	
A workshop and administration building	Regular monitoring of building condition would be conducted and maintenance undertaken as required.	
A powerline owned by Ergon Energy	N/A – powerlines would be managed by Ergon Energy.	

6.11.1 Remediation of Contaminated Land

Investigations will be undertaken at mine closure and prior to rehabilitation to identify and remediate any contaminated materials (i.e. soil, water, construction materials) that may exist in accordance with the requirements described in Part 8 of Chapter 7 of the EP Act or equivalent statutory provision in force at the time. All activities may require a contaminated land assessment; however, this will be decided on a case-by-case basis. Where areas of potential land contamination are identified during rehabilitation activities, YCC will undertake:

- Detailed site investigation report, as required under the EP Act.
- Removal or on-site treatment of contaminated water (e.g., affected by hydrocarbons, metals, etc.).
- Removal and appropriate disposal/remediation of contaminated materials (e.g., Polychlorinated biphenyls [PCBs], Dioxins, Mercury, hydrocarbon contaminated soils etc.).
- All wastes removed from site and lawfully disposed.
- Validation testing to confirm that contaminated soils have been removed/remediated.

6.11.2 CHPP, Workshops and Other Fixed Infrastructure

The general steps required to decommission fixed infrastructure (e.g. CHPP, workshops and buildings) and their related facilities and services, where not retained via an agreement with the post-mining landholder and relevant agencies, include the following:

- All reusable and/or resalable components to be salvaged/sold and transported from site.
- All recoverable scrap steel to be sold or recycled where possible.
- Removal and/or demolition of all plant, infrastructure, services and associated components.
- Dewatering of dams and water storages via controlled releases (in compliance with the relevant environmental licence) or by dewatering to a residual void.
- Removal of compacted coal either to be recovered and transported off-site where saleable or disposed of in-pit (such as in the DOM1 TSF).
- Concrete pads and footings to be removed to a depth of at least 1.5 m below the final landform elevation before being backfilled to ground level.
- Waste concrete (if not holding contaminated material) will be crushed and re-used in rehabilitating the site, potentially sold as aggregate, or otherwise suitably buried within a mining void/spoil dump in accordance with the EA.
- Removal, treatment and/or encapsulation of identified contaminated materials and areas (see Section 6.11.1).
- Placement of fill and/or recontouring and shaping to be consistent with the surrounding landscape where required.

Once the infrastructure components are removed, the area will be rehabilitated as per the surface preparation and revegetation methods outlined in Section 6.12.

6.11.3 ROM and Coal Stockpile Pads

ROM and coal stockpile pads are composed of compacted ROM or washed coal material that is extracted from the mine workings or CHPP processing. Where possible, these layers will be removed and sold as coal, or otherwise buried as backfill in an available void and covered with benign material. Alternatively, these areas may be capped with benign material where removal of contaminated material is not required.

The DOM1 TSF will provide the most appropriate disposal solution for salvaged material as it will be undergoing drying during the decommissioning and rehabilitation of the ROM and coal stockpile pads. Once the coal and any other sources of contamination have been removed (or remediated in situ), the area will be rehabilitated as per the surface preparation and revegetation methods described in Section 6.12.

6.11.4 Hardstands and Laydown Pads

Hardstands and laydown pads generally consist of benign compacted earth or gravel material that is used to create a stable working surface. Depending on the items stored and/or activities carried out over the life of the mine, parts of the surface and underlying materials (soil, regolith, or overburden) may have been contaminated by chemicals, including hydrocarbons. Any identified contaminated material will either be remediated in situ or removed as per the process outlined in Section 6.11.5. Once any sources of contamination have been removed (or remediated in situ), the area will be rehabilitated in line with the surface preparation and revegetation methods described in Section 6.12.

6.11.5 Haul Roads and Access Tracks

For all roads not retained via a post-mining landholder agreement (as approved by relevant agencies), any hard or contaminated materials (such as bitumen or road base) will be removed and buried as backfill in an available void (such as the DOM1 TSF). The area will then be rehabilitated per the surface preparation and revegetation methods described in Section 6.12.

6.12 REVEGETATION

The primary objective of revegetation is to reinstate self-sustaining vegetation communities suitable for the target PMLU of grazing and native vegetation. Section 6.12.1 to 6.12.6 describe the soil preparation process, species selection methodology and planting techniques to achieve this objective.

6.12.1 Surface Preparation Timing

Surface preparation will be targeted to occur at the end of the wet season (April/May). For newly recontoured and/or rehabilitated areas, the short-term priority is to establish a suitable level of groundcover so that there is sufficient erosion protection against rainfall impact damage and/or surface water run-off. This can be achieved by (for example):

- establishing vegetative cover (ground and/or canopy);
- generating (through application or growth) organic mulch/cover; and/or
- improving the physical/chemical properties of the upper surfaces through the application of soil ameliorants.

The greatest erosion risk occurs in late spring/early summer. This risk can be managed through establishment of sufficient ground cover prior to this time. However, the benefits of increased moisture levels associated with the wet season (April/May) offer advantages in both vegetative establishment and amelioration of reinstated landforms.

As far as practical, final shaping of reinstated landforms will be minimised during this period, particularly on the steeper slopes of waste rock emplacements. Where feasible, completing the final trim, soil spreading, incorporating any required amelioration, and seeding/planting will occur outside of the wet season. This timing will maximise the chances for successful land outcomes through:

- completing 'on design' landform creation at the end of the wet season (reducing erosional risks to the landform);
- maximising naturally occurring potential soil moisture levels (for both vegetative establishment and facilitating any intended chemical reaction associated with amelioration);
- maximising the length of time between landform creation completion and the next wet season (for vegetative establishment/ground cover and amelioration to be effective); and
- maximising exposure of the revegetated landform to more consistent and gentler weather and rainfall events through the autumn, winter, and spring.

6.12.2 Soil Spreading and Seedbed Preparation

Where available and utilised, topsoil will be spread on reshaped and contoured rehabilitation areas typically to depths of 200 mm (+/- 50 mm). Ameliorants (e.g. gypsum, fertiliser, organics) will be applied (where necessary) at the recommended rate per hectare (refer Section 6.6.5) and the area then ripped on the contour to incorporate the ameliorants.

Light-ripping or harrowing will be undertaken for grazing rehabilitation areas, and deep-ripping undertaken for native vegetation rehabilitation areas, as appropriate. Ripping creates a roughened, friable surface which encourages rainfall infiltration, reduces run-off, and optimises soil/seed contact, enhancing vegetation establishment and persistence. This is particularly beneficial in periods of low rainfall.

6.12.3 Species Selection and Seeding Rates

The rehabilitation objective of the grazing PMLU is to establish self-sustaining pasture capable of supporting light grazing with a minimum land suitability Class 4. Areas to be rehabilitated to a grazing PMLU will be spread with a mix of grasses, legumes, salt bush and wooded species to maximise establishment in variable site conditions. Species should have the following characteristics:

- some degree of salinity tolerance;
- adapted to light clay soils; and
- the potential to increase basal area cover by being either stoloniferous or tending to develop dense swards of tussocks smaller than Buffel grass.

Species suitable for grazing and native vegetation rehabilitation are listed in Table 6-62 and Table 6-63. These tables should be used as a guide only, the species used for each rehabilitation will be dependent upon seed and tubestock availability and the outcomes of additional research. Other species will be considered on the advice of rehabilitation and/or agronomy specialists, and in response to ongoing monitoring, including the following species present in undisturbed areas. As far as practical, Buffel grass would be avoided during seeding.

The rehabilitation objective of native vegetation PMLU is to establish a self-sustaining ecosystem of native species suitable for the landform and substrate that are representative of local RE species or that provide beneficial uses.

A review of the characteristics of the local REs and the Yarrabee Mine soil/waste rock was undertaken in 2020 (Landloch, 2020) to identify the REs most suited to the various soil and waste materials available for rehabilitation. The review identified that the available waste rock and soils materials limit plant selection to those adapted to alkaline, strongly sodic, and mostly saline soils with low to moderately low plant-available water capacity. The anticipated hard-setting soil surfaces also limit seed germination and seedling establishment. Growth rates can be expected to be suppressed due to low nutrients, low soil biological activity, low plant-available water capacity, poor soil structure, potential chloride toxicity, and high salinity affecting plant water extraction. Slope position and aspect may also affect plant establishment due to exposure to sun and drying winds.

It was determined that no REs were entirely suitable for the rehabilitated landform (Landloch, 2020). However, several REs were identified as having species with the potential to establish. Subsequently, the native vegetation PMLU is considered a *planned novel ecosystem*, which is characterised by being dominated by native species but is not analogous to a single RE (Spain et al., 2023).

Rehabilitation to a native vegetation PMLU will include initial establishment of local pioneer species to condition the soil for successive plant regeneration. Concentrated tree plantings will be incorporated to provide habitat areas, wildlife corridors and livestock shelter belts. Heavy tree establishment both creates canopy cover (overhanging branches/leaves) and ground cover (dead leaves, branches, and organic matter), however also has the potential for reduced grass coverage through suppression.

Although Brigalow (*Acacia harpophylla*) is the dominant species in native undisturbed areas around the Yarrabee Mine, it is not recommended for grazing areas as it can spread quickly and suppress grass growth. This would conflict with the desired end land use of grazing for the majority of the Yarrabee Mine.

Tree species to be considered will be targeted to the landform type with a consideration given to such features as slope, aspect, growth medium (i.e., soil, rock mulch or rocky areas), water availability and vegetation establishment (e.g. habitat areas, riparian protection, stock sheltering). Species that occur locally and may be suitable for revegetation are listed in Table 6-63. Consideration will also be given to species of local and regional REs (such as Brigalow and Brigalow/Dawson gum communities on clay soils – RE 11.4.2, 11.4.8 and 11.4.9) or those that may provide other beneficial post-mining end uses, where applicable. Availability of seed stock will also influence the species mix in any given seeding campaign.

Riparian species suitable for rehabilitation works will include a mix of groundcover and canopy species, such as (but not limited to):

- Groundcover:
 - *Panicum decompositum*; and
 - *Katambora rhodes*.
- Canopy cover:
 - *Acacia harpophylla*;
 - *Casuarina cristata*;
 - *Eucalyptus tereticornus*; and
 - *Lysiphyllum carronii*.

Consideration will also be given to species consistent with and representative of RE 11.3.3 – *mixed riverine vegetation on sandy clay soils along watercourses*.

Table 6-62: Grazing Post-Mining Land Use Species List

Scientific Name	Common Name	Plant Type	Application Rate (kg/ha)
<i>Barrel Medic</i>	<i>Medicago truncatula</i>	Legume	1
<i>Bermuda couch</i>	<i>Cynodon dactylon</i>	Grass	2
<i>Black Speargrass</i>	<i>Heteropogon contortus</i>	Grass	0.2
<i>Butterfly pea</i>	<i>Clitoria ternatea</i>	Legume	2
<i>Caatinga stylo</i>	<i>Stylosanthes seabrana</i>	Legume	1
<i>Creeping Bluegrass</i>	<i>Bothriochloa insculpta</i>	Grass	2.5
<i>Desmanthus</i>	<i>Desmanthus virgatus</i>	Legume	1
<i>Forest Bluegrass</i>	<i>Bothriochloa bladhii</i>	Grass	2.5
<i>Indian Bluegrass</i>	<i>Bothriochloa pertusa</i>	Grass	2.5
<i>Lemon Scented-Gum</i>	<i>Corymbia citriodora</i>	Tree	0.03
<i>Old Man Saltbush</i>	<i>Atriplex nummularia</i>	Shrub	0.3
<i>Purple Pigeon Grass</i>	<i>Setaria incrassata</i>	Grass	2
<i>Queensland Bluegrass</i>	<i>Dicanthium sericeum</i>	Grass	3
<i>Rhodes grass</i>	<i>Chloris gayana</i>	Grass	3.5
<i>Round-leafed cassia</i>	<i>Chamaecrista rotundifolia</i>	Legume	0.5
<i>Ruby Saltbush</i>	<i>Enchylaena tomentosa</i>	Shrub	0.3
<i>Sabi Grass</i>	<i>Urochloa mosambicensis</i>	Grass	3.5
<i>Shrubby stylo</i>	<i>Stylosanthes scabra</i>	Legume	1
<i>Tall Finger Grass</i>	<i>Digitaria milanjiana</i>	Grass	1
Total			29.8

Table 6-63: Native Vegetation Post-Mining Land Use Species List

Scientific Name	Common Name	Application Rate (kg/ha)
<i>Eucalyptus crebra</i>	Narrow Leaved Ironbark	0.2
<i>Eucalyptus melanophloia</i>	Silver Leaved Ironbark	0.2
<i>Corymbia tessellaris</i>	Moreton Bay Ash	0.2
<i>Corymbia clarksoniana</i>	Bloodwood	0.1
<i>Corymbia gummifera</i>	Red Bloodwood	0.1
<i>Acacia victoriae</i>	Bardi Bush	0.2
<i>Atriplex nummularia</i>	Old Man Saltbush	0.2
<i>Enchylaena tomentosa</i>	Ruby Saltbush	0.2
<i>Bothriochloa insculpta</i>	Creeping Bluegrass (cultivas Hatch or Bisset)	2.5
<i>Bothriochloa bladhii</i>	Forest Bluegrass (cultivas Swann)	2.5
<i>Digitaria eriantha</i>	Digit Grass (cultivas Premier)	2
<i>Bothriochloa pertusa</i>	Indian Bluegrass (cultivas Keppel or Bowen)	1
<i>Urochloa mosambicensis</i>	Sabi Grass (cultivas Saraji)	2
<i>Melinis repens</i>	Red Natal Grass	1
<i>Cynodon dactylon</i>	Greencouch	2
<i>Bothriochloa ewartiana</i>	Desert Bluegrass	1
<i>Dichanthium sericeum</i>	Queensland Bluegrass	1
<i>Heteropogon contortus</i>	Black Speargrass	0.2
<i>Themeda triandra</i>	Kangaroo Grass	0.2
<i>Cymbopogon refractus</i>	Barbed Wire Grass	0.2
<i>Bothriochloa decipiens</i>	Pitted Bluegrass	0.2
<i>Chloris gayana</i>	Rhodes Grass	1
<i>Wynn cassia</i>	Round Leaf Cassia	1
<i>Clitoria ternatea</i>	Butterfly Pea	1
Total		20.2

6.12.4 Tubestock Planting

Native vegetation establishment in rehabilitation areas revegetated through seeding may be supplemented with tubestock. Tubestock planting of long-lived trees may be the most efficient method to ensure adequate establishment and to control density (which can be difficult to achieve with direct seeding).

Tubestock improves establishment of species in saline soil typically found in Bowen Basin mine soils, as salinity particularly impacts seed germination (Madsen and Mulligan, 2006). Tubestock may need to be introduced a number of times during rehabilitation, particularly if unfavourable weather impacts plant survival during the first few years. Examples of species more amenable to use of tubestock for vegetation establishment include *Acacia harpophylla*, *Casuarina cristata*, *Eucalyptus cambageana*, *E. ochrophloia* and *E. argophloia* (Emmertson and Elsol, 2006). Where practical, tubestock will be propagated in a local or commercial scale nursery from locally sourced seed, subject to availability.

Species suitable for native vegetation tubestock rehabilitation are listed in Table 6-64.

Table 6-64: Native Vegetation Post-Mining Land Use Species List (Tubestock)

Scientific Name	Common Name	Application Rate (stems/ha)
<i>Eucalyptus ochrophloia</i>	Yapunyah	100
<i>Acacia harpophylla</i>	Brigalow	120
<i>Corymbia citriodora</i>	Spotted Gum	100
<i>Eucalyptus argophloia</i>	Chinchilla White Gum	100
<i>Casuarina cristata</i>	Belah	100
<i>Cassia brewsteri</i>	Leichardt Bean	100
<i>Eucalyptus molucana</i>	Grey Box	70
<i>Allocasuarina luehmannii</i>	Bulloak	70
<i>Eucalyptus populnea</i>	Poplar Box	30
<i>Eremophila mitchellii</i>	False Sandalwood	45
<i>Owenia acidula</i>	Emu Apple	25
<i>Carissa ovata</i>	Current Bush	30
<i>Brachychiton rupestris</i>	Narrow-leaved Bottle Tree	30
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree	3
<i>Geijera parviflora</i>	Wilga	30
Total		953

6.13 REHABILITATION AND MANAGEMENT MILESTONES

YCC has developed a comprehensive suite of milestones to achieve the PMLU or NUMA designated for each RA or IA, respectively. Table 6-65 and Table 6-66 describe these milestones and the associated completion timeframe. Table 6-67 provides a summary of the rehabilitation requirements provided in Attachment 1 of EA EPML00844613 and how they have been transitioned into this PRCP and the associated PRCP Schedule.

Section 8.1 provides further detail on how YCC will manage the rehabilitation activities to achieve the rehabilitation and improvement milestones. The management measures for the RAs and IAs have been developed in consideration of guidelines and relevant information available at the time of writing, including the:

1. PRCP Guideline (DESI, 2024a).
2. DES (2014) *Guideline: Rehabilitation requirements for mining resource activities (Historical)*.
3. Australian Government (2016a) *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation*.
4. Australian Government (2016b) *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure*.
5. Queensland Mine Rehabilitation Commissioner Reports.

The RA and IA management measures are considered by YCC to be consistent with measures outlined in the LODs. If further information becomes available or these guidelines are revised, the PRCP and PRCP Schedule will be reviewed, and the proposed management measures updated as required in the LODs.

The Rehabilitation Milestone criteria, Management Milestone criteria and timeframes have been developed with consideration for the outcomes of the PRCP Risk Assessment (ESG Consulting, 2024; Appendix T), discussed further in Section 7. A general overview of the rehabilitation methodology is provided in Section 8.1.7.

Table 6-65: Rehabilitation Milestones and Criteria

Milestone Number	Milestone Reference	Milestone Description	Applicable Rehabilitation Areas	Milestone Criteria	Timeframe	Justification for Proposed Timeframe
RM1	Infrastructure Decommissioning and Removal	Removing infrastructure and rendering the area safe.	RA4 RA5 RA6 RA7 RA8 RA9	- All services disconnected and decommissioned, unless agreed in writing by landholders and relevant agencies. - All built infrastructure demolished and removed, unless agreed in writing by landholders and relevant agencies. - All water management infrastructure not required for water management in post-mining landscape decommissioned, unless agreed in writing by landholders and relevant agencies. - All roads and access tracks removed, unless agreed in writing by landholders and relevant agencies. - All wastes and hazardous materials removed from site and lawfully disposed of. - Concrete pads, where not retained by landholder agreement (as approved by relevant agencies), are removed to a depth of 1.5 m below the landform elevation and backfilled to ground level or higher (for settlement).	2 years	Sufficient time to allow for safe removal and disposal of infrastructure, considering potential delays such as weather.
RM2	Remediation of Contaminated Land	Conducting a contaminated land assessment and remediating contaminated land, if required.	RA4 RA5 RA6 RA7 RA8 RA9	- Contaminated water (e.g. affected by hydrocarbons, metals, etc.) is treated. - Contaminated land assessment undertaken by an appropriately qualified person (AQP¹). - Any contaminated material either remediated in situ, encapsulated, or removed/transported to an approved landfill for disposal, and waste tracking information recorded and submitted. - Validation testing confirms that contaminated materials have been removed or remediated. - Evidence that all measures required in contaminated land assessments have been implemented. - If required, a site investigation report including a site suitability statement prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act. Additional PMLU Criteria for RA6 (Grazing): - Contaminated land assessment conducted to verify the proposed use is suitable. - No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion. Additional PMLU Criteria for RA5 (Native Vegetation): - Contaminated land assessment conducted to verify the proposed use is suitable. - No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion. ¹AQP: a person who has professional qualifications, training, skills, or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods, or literature.	2 years	Sufficient time to allow for assessments, safe removal, and disposal of contaminated land, considering potential delays due such as weather.
RM3	Installation of Cover System/Capping	Installing capping over tailings storage facilities.	RA5 RA6	- Certification from an AQP that tailings have dried and settled prior to capping. - Minimum capping layer of 4 m of non-acid forming material. - Certification from appropriately qualified person that surface capped with suitable material that has been certified as complying with design requirements.	5 years	Sufficient time for tailings to dry and settle prior to installation of capping.
RM4	Vegetation Removal	Removal of vegetation and topsoil in preparation for re-rehabilitating.	RA11	- All vegetation is stripped from the landform and lawfully disposed of. - Topsoil stripped at a depth of 200 mm and stockpiled in accordance with the topsoil management plan.	2 years	Sufficient time for vegetation and soil to be removed.
RM5	Landform Development	Shaping unformed rock into desired land surface profile that is stable and non-polluting. Includes earthworks activities such as cut and fill, rock raking, water storage, and drainage construction.	RA1 RA2 RA3 RA4 RA5 RA6 RA7 RA8 RA9 RA11 RA12	- All major earthworks completed to landform design in accordance with Condition F20 of the EA EPML00844613. - Final landform provides flood protection to all residual voids up to and including a 0.1% AEP and, where landform is required to function as permanent flood protection for a residual void, achieves a FoS of 1.2 and meets engineering design. - Where required, water management and erosion control structures (e.g. drainage swales and diversion channels) installed per design and certified by an AQP. - Geotechnical stability of built landforms confirmed by AQP. - Voids are backfilled to ground level or higher (for settlement) and self-draining, according to criteria in Condition F20 of the EA. - Spoil is shaped to be sympathetic to and consistent with the surrounding unmined areas, in accordance with Condition F20 of the EA. - Records retained of as built drawings to completely backfill void to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA. - Records retained of reshaping of out-of-pit waste emplacement to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA. - Water management infrastructure and erosion control structures installed as required.	2 years	Sufficient time for landform construction and sign off.

Table 6-65 (Continued): Rehabilitation Milestones and Criteria

Milestone Number	Milestone Reference	Milestone Description	Applicable Rehabilitation Areas	Milestone Criteria	Timeframe	Justification for Proposed Timeframe
RM5 (Continued)	Landform Development	Shaping unformed rock into desired land surface profile that is stable and non-polluting. Includes earthworks activities such as cut and fill, rock raking, water storage, and drainage construction.	RA1 RA2 RA3 RA4 RA5 RA6 RA7 RA8 RA9 RA11 RA12	Additional PMLU Criteria for RA1, RA8, RA12 and RA13 (Grazing): - Slopes are no greater than 12.5%. - Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 0.4 m to minimise erosion. Additional PMLU Criteria for RA2, RA9, RA 10 and RA11 (Native Vegetation): - Slopes are no greater than 27%. - Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 1 m to minimise erosion. Additional PMLU Criteria for RA3 (Native Vegetation [Riparian]): - Slopes are consistent with Twelve Mile Creek Diversion Functional Design. - Certification from an AQP that the diversion is constructed to design. Additional PMLU Criteria for RA4 (Water Storage): - Geotechnical stability confirmed by appropriately qualified hydro-geotechnical engineer. - Bywash/spillway structures confirmed to have adequate capacity. Additional PMLU Criteria for RA6 (Grazing): - Slopes are no greater than 12.5%. - Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 0.4 m to minimise erosion. - A suitability qualified geotechnical engineer certifies that batters are safe and achieves a minimum factor of safety of 2. Additional PMLU Criteria for RA5 (Native Vegetation): - Slopes are no greater than 25%. - Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 1 m to minimise erosion. - A suitability qualified geotechnical engineer certifies that batters are safe and achieves a minimum factor of safety of 2.	2 years	Sufficient time for landform construction and sign off.
RM6	Surface Preparation	Establishing and enhancing the physical and chemical properties of topsoil and substrate medium for plant growth. This includes spreading topsoil and applying ameliorants, as required.	RA1 RA2 RA3 RA4 RA5 RA6 RA7 RA8 RA9 RA11 RA12	- Certification that the growth medium has physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate to sustain vegetation growth and chemical properties do not limit its suitability for vegetation growth. - Topsoil, or other growth medium such as benign waste rock or subsoil, is spread to a depth of 200 mm (+/- 50 mm). - Ameliorate spoil as required to a depth of a minimum of 200 mm to suitably stabilise the landform and promote vegetative establishment. - Ameliorants, where required, applied by an appropriately qualified person to achieve the PMLU at the following rates: - 5 t/ha of gypsum; - 50 kg/ha DAP with added zinc; - 100 kg/ha of urea; and - 100 kg/ha of coated (slow release) urea. Additional PMLU Criteria for RA1, RA6, RA8, RA12 and RA13 (Grazing): - Soil ripped on the contour.	1 year	Sufficient time for topsoil spreading and application of ameliorants.
RM7	Revegetation	Seeding and/or planting species appropriate for the intended PMLU.	RA1 RA2 RA3 RA4 RA5 RA6 RA8 RA9 RA11 RA12	- Water management and erosion control structures, where required, are vegetated with stoloniferous grasses or other suitable ground cover. - Vegetated with a mix of perennial pasture species (grasses and legumes) and low-density wooded vegetation (for livestock shelter) suited to the reinstated soils, capable of sustaining grazing activities and providing stabilising groundcover. Additional PMLU Criteria for RA1, RA6, RA8, RA12 and RA13 (Grazing): - Direct seeding of palatable perennial pasture species seed mix at 1-4 kg/ha. Additional PMLU Criteria for RA2, RA5, RA9, RA 10 and RA11 (Native Vegetation): - Seeding of native species at 1-4 kg/ha for grasses, 1-2 kg/ha for legumes, 0.2-1 kg/ha for shrubs and 0.2-1 kg/ha for trees. - Planting of native species and/or tubestock at 350 stems per hectare, where required. Additional PMLU Criteria for RA3 (Native Vegetation [Riparian]): - Planting of native species and/or tubestock at 350 stems per hectare, where required. - Seeding with riparian and riverine vegetation at 1-4 kg/ha for grasses, 1-2 kg/ha for legumes, 0.2-1 kg/ha for shrubs and 0.2-1 kg/ha for trees.	1 year	Sufficient time for seeding and planting of tubestock.
RM8	Surface Conditions – Grazing	Vegetation has established, landform is stable, and drainage follows appropriate pathways.	RA1 RA6 RA8 RA12	- No active rill, piping, or gully erosion. - Certification by an AQP that drainage follows appropriate pathways. - Vegetation dominated by pasture grass and legume species. - Vegetation dominated by >70% palatable perennial pasture cover.	5 years	Sufficient time for vegetation to establish and provide erosion control.

Table 6-65 (Continued): Rehabilitation Milestones and Criteria

Milestone Number	Milestone Reference	Milestone Description	Applicable Rehabilitation Areas	Milestone Criteria	Timeframe	Justification for Proposed Timeframe
RM9	Safe, Stable and Sustainable Condition – Grazing	Vegetation is self-sustaining, the land is non-polluting and can support the PMLU.	RA1 RA6 RA8 RA12 RA13	- Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. - Erosion rates comparable to reference sites as determined by Condition F15 of the EA. - Soil nutrient concentrations and nutrient cycling comparable to reference sites as determined by Condition F15 of the EA. - Annual monitoring indicates an absence of declared pest and weed species. - Evidence of natural recruitment (flowering, germination, viable seed and emergence) of palatable perennial pasture species. - Groundcover comprises >70% palatable perennial pasture cover. - Water quality in receiving waters does not exceed the limits in EA Table C5. - Run-off into receiving waters does not exceed the limits in EA Table C2. - Land suitability assessment by an AQP certifies that land has achieved a minimum post-mine land suitability Class of 4, and land is capable of supporting light intensity grazing. - Evidence that measures required in site contaminated land investigation report have been implemented. Additional PMLU Criteria for RA6 (Grazing): - Final surface is free-draining and includes drainage structures to channel run-off and to minimise erosion and surface water ponding.	5 years	Sufficient time for vegetation to mature and groundcover to meet required coverage.
RM10	Surface Conditions – Native Vegetation	Vegetation has established, landform is stable, and drainage follows appropriate pathways.	RA2 RA5 RA9 RA10 RA11	- No active rill, piping or gully erosion. - Certification by an AQP that drainage follows appropriate pathways. - Wooded vegetation density achieves a minimum of 350 stems per hectare. - Tree, shrub, and grass diversity and cover % are on a demonstrated trajectory towards being comparable to reference sites described in Condition F15 of the EA. - A minimum of eight target species per hectare established.	5 years	Sufficient time for vegetation to establish and provide erosion control.
RM11	Safe, Stable and Sustainable Condition – Native Vegetation	Vegetation is self-sustaining, the land is non-polluting, and land can support the PMLU.	RA2 RA5 RA9 RA10 RA11	- Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. - Erosion rates comparable to reference sites as determined by Condition F15 of the EA. - Soil nutrient concentrations and nutrient cycling comparable to reference sites as determined by Condition F15 of the EA. - Annual monitoring indicates an absence of declared pest and weed species. - Evidence of natural recruitment (flowering, germination, viable seed, and emergence) of native trees and shrubs. - Pest and weed density comparable to reference site determined by Condition F15 of the EA. - Water quality in receiving waters does not exceed the limits in EA Table C5. - Run-off into receiving waters does not exceed the limits in EA Table C2. - Ground cover comprises >30% living ground cover and >70% overall groundcover (includes live, dead, and non-vegetative). - Evidence that measures required in site contaminated land investigation report have been implemented. Additional PMLU Criteria for RA5 (Native Vegetation): - Final surface is free-draining and includes drainage structures to channel run-off and to minimise erosion and surface water ponding.	15 years	Sufficient time for vegetation to mature and groundcover to meet required coverage.
RM12	Surface Conditions – Native Vegetation (Riparian)	Vegetation has established, landform is stable, and drainage follows appropriate pathways.	RA3	- No active rill, piping, or gully erosion. - Certification by an appropriately qualified person that drainage follows appropriate pathways. - Vegetation dominated by native riparian species. - Similar geomorphology to regional ephemeral drainage lines as part of design plan in Condition F20 of the EA.	5 years	Sufficient time for vegetation to establish and provide erosion control.

Table 6-65 (Continued): Rehabilitation Milestones and Criteria

Milestone Number	Milestone Reference	Milestone Description	Applicable Rehabilitation Areas	Milestone Criteria	Timeframe	Justification for Proposed Timeframe
RM13	Safe, Stable and Sustainable Condition – Native Vegetation (Riparian)	Vegetation is self-sustaining, the land is non-polluting, and land can support the PMLU.	RA3	1. Hazard and Safety Assessment completed by an appropriately qualified person demonstrates hazards are consistent with the type and severity of hazards typical of the creek system in unmined landscape. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2. Certification by an AQP that the creek diversion functions as designed, and that the integrity of Twelve Mile Creek and adjoining watercourses will be maintained long-term. 3. Certification by an AQP that the creek diversion and associated structures will maintain equilibrium and functionality and will not require ongoing maintenance. 4. Vegetation dominated by mixed riverine vegetation suitable for sandy clay soils along watercourses. 5. Evidence of natural recruitment. 6. Ground cover comprises >30% living ground cover and >70% overall groundcover (includes live, dead, and non-vegetative). 7. Water quality in receiving waters does not exceed the limits in EA Table C5. 8. Run-off into receiving waters does not exceed the limits in EA Table C2.	15 years	Sufficient time for vegetation to mature and groundcover to meet required coverage.
RM14	Safe, Stable and Sustainable Condition – Water Storage	Water quality can support the PMLU.	RA4	1. Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2. Records of retained of structural integrity of permanent retention of water storage structures, and certification that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA EPML00844613. 3. Removal of any contaminated sediments identified by site contaminated land investigation. 4. Water quality in receiving waters does not exceed the limits in EA Table C5. 5. Run-off into receiving waters does not exceed the limits in EA Table C2. 6. Management inputs required to sustain aquatic habitat are comparable to selected reference sites determined by Condition F15. 7. Retained water storage water quality parameters are below the trigger values for livestock drinking water defined in ANZECC and ARMCANZ 2000.	2 Years	Sufficient time ensure water storages are safe, stable and sustainable.
RM15	Safe, Stable and Sustainable Condition – Retained Infrastructure	Land and infrastructure are safe and can support the PMLU.	RA7	1. Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2. All built structures form part of a landholder agreement (as approved by relevant agencies). 3. Audit records demonstrate that areas subject to AS1940:2004 (The Storage and Handling of Flammable and Combustible Liquids) that are retained for use by the post-mining landholder comply with the standard. 4. Where required, diversion drains designed and built to have similar morphology and functionality to regional ephemeral drainage lines. 5. Evidence from an AQP the retained infrastructure is structurally and functionally sound before providing/selling such infrastructure to a future landholder.	2 Years	Sufficient time to ensure land and infrastructure are safe and can support the associated retained infrastructure.

Table 6-66: Management Milestones and Criteria

Milestone Number	Milestone Description	Applicable Improvement Areas	Milestone Criteria	Timeframe	Justification For Proposed Timeframe																																				
MM1	High Wall and Low Wall Treatment	IA1	1. Highwall slope in competent rock is <70 degrees. 2. Highwall slope in incompetent rock is <45 degrees. 3. Low wall slope is <37 degrees. 4. Battering back, partial backfilling, regrading, and reshaping completed according to table F1 and Condition F20 of the EA. 5. Records retained of as built drawings to completely backfill void to certify that it is operating in accordance with Condition F20 of the EA. <table><tr><th>Void</th><th>Depth (m)</th><th>Area (ha)</th><th>Volume (Mm³)</th></tr><tr><td>A-Pit</td><td>113</td><td>126</td><td>40</td></tr><tr><td>CE-North</td><td>40</td><td>53</td><td>8</td></tr><tr><td>DOM2N</td><td>100</td><td>103</td><td>41</td></tr><tr><td>DOM2S</td><td>59</td><td>45</td><td>7</td></tr><tr><td>DOM5</td><td>50</td><td>133</td><td>41</td></tr><tr><td>DOM6</td><td>54</td><td>25</td><td>10</td></tr><tr><td>YEN-Pit</td><td>129</td><td>223</td><td>121</td></tr><tr><td>YES-Pit</td><td>129</td><td>174</td><td>87</td></tr></table>	Void	Depth (m)	Area (ha)	Volume (Mm³)	A-Pit	113	126	40	CE-North	40	53	8	DOM2N	100	103	41	DOM2S	59	45	7	DOM5	50	133	41	DOM6	54	25	10	YEN-Pit	129	223	121	YES-Pit	129	174	87	5 years	Sufficient time to ensure all high and low walls are developed with the required slopes, depth, area, and volume.
Void	Depth (m)	Area (ha)	Volume (Mm³)																																						
A-Pit	113	126	40																																						
CE-North	40	53	8																																						
DOM2N	100	103	41																																						
DOM2S	59	45	7																																						
DOM5	50	133	41																																						
DOM6	54	25	10																																						
YEN-Pit	129	223	121																																						
YES-Pit	129	174	87																																						
MM2	Surface Conditions	IA1	1. Bund wall installed with a minimum height of 2 m, a minimum base of 4 m, and be located at least 10 m beyond the area potentially affected by instability of the pit edge or a fence. 2. Security fencing installed around entire perimeter and up to the highwall. 3. Appropriate signage placed to clearly identify and convey the purpose (e.g. EP Act 1994 Non-Use Management Area No Entry). 4. Any contaminated material either remediated in situ or removed/transported to an approved landfill for disposal, and waste tracking information recorded and submitted. 5. Validation testing confirms that contaminate materials (e.g. PCBs, dioxins, mercury, hydrocarbon contaminate soils) have been removed or remediated. 6. If required, a site investigation report including a site suitability statement prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act.	2 years	Sufficient time for construction of bund and installation of fencing and safety signage.																																				
MM3	Achievement of Sufficient Improvement	IA1	1. Certification from an AQP that the residual void low walls, highwalls and end walls are safe and achieve a minimum FoS of 2.0. 2. Certification from an AQP that residual voids are internally draining. 3. Certification from an AQP that the residual void is safe to humans and livestock. 4. No exposed hazardous materials at surface determined by the results of site contaminated land investigation including exposure due to erosion. 5. Residual void acts as a groundwater sink in perpetuity. 6. Water balance modelling demonstrates that residual void water is contained with no potential for overflow events. 7. If required, evidence that measures required in site contaminated land investigation report have been implemented.	15 years	Sufficient time allowed for vegetation to establish.																																				

Table 6-67: Completion Criteria Transitioned from EA EPML00844613

Post-Mining Land Use	Completion Criteria from EPML00844613 Attachment 1	Transitioned Milestone
Grazing Native Vegetation	No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion.	RM2
Native Vegetation (Riparian) Water Storage	Evidence that measures required in site contaminated land investigation report have been implemented.	RM2
Grazing Native Vegetation Native Vegetation (Riparian)	Geotechnical stability confirmed by suitably qualified geotechnical engineer for landform.	RM5
Grazing Native Vegetation Water Storage Native Vegetation (Riparian)	All major earthworks are completed in accordance with design plan in Condition F20.	RM5
Grazing Native Vegetation	Receiving water quality indicators do not exceed limits specified in Table C5.	RM9
Native Vegetation Water Storage Retained Infrastructure	Run-off into receiving waters not to exceed limits for release water quality indicators specified in Table C2.	RM9
Grazing Native Vegetation Water Storage	No active rill, piping or gully erosion.	RM8
Grazing Native Vegetation Native Vegetation (Riparian) Water Storage	Pest and weed density comparable to reference sites determined by Condition F15.	RM11
Grazing Native Vegetation	Ameliorate spoil as required to a depth of a minimum of 200 mm to suitably stabilise the landform and promote vegetative establishment.	RM6
Native Vegetation	Evidence of natural recruitment (flowering, viable seed, germination and emergence) and evidence of generational succession of trees and shrubs.	RM11
Grazing Native Vegetation (Riparian)	Certification that the growth medium has physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate to sustain vegetation growth and chemical properties do not limit its suitability for vegetation growth.	RM6
Grazing Native Vegetation Water Storage	Spoil shaped to be sympathetic to and consistent with the surrounding unmined areas and in accordance with design plan in Condition F20.	RM5
Grazing Native Vegetation	Erosion rates comparable to reference sites as determined by Condition F15.	RM9 RM11
Native Vegetation Native Vegetation (Riparian) Water Storage	Trees, shrubs and grass diversity and cover % are, or are on a demonstrated trajectory towards being, comparable to reference sites described in Condition F15, on similar landform/slope and substrate of rehabilitated areas	RM10
Native Vegetation Water Storage	Slopes no greater than specified in Table F2: Post-mining Land Use Areas and Non-Use Management Areas based on chemical and physical characteristics of local site.	RM5
Water Storage	Water and sediment analysis to confirm water quality from run-off will be suitable and sediments are benign for intended final land use.	RM14
Grazing Native Vegetation (Riparian)	Water management infrastructure and erosion control structures installed as required for flood protection structures.	RM5

Table 6-67 (Continued): Completion Criteria Transitioned from EA EPML00844613

EA Post-Mining Land Use	Completion Criteria from EPML00844613 Attachment 1	Transitioned Milestone
NUMA	Suitable bunding, security fencing and signage installed around entire perimeter and up to highwall.	MM2
	Access is prohibited to final voids by bund wall with a minimum height of 2 m, a minimum base width of 4 m and be located at least 10 m beyond the area potentially affected by any instability of the pit edge or a fence.	MM2
Native Vegetation Native Vegetation (Riparian)	>30% living ground cover and >70% overall ground cover (including live, dead and non-vegetative).	RM11 RM13
Grazing Native Vegetation	Soil nutrient concentrations and nutrient cycling comparable to reference sites determine by Condition F15.	RM9 RM11
	Records retained of 'as built' drawings to completely backfill void to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5 MM1
	Voids will be backfilled to ground level or higher (for settlement) and self-draining, according to design plan in Condition F20.	RM5
	Water management infrastructure and erosion control structures installed as required, such as sediment dams, contour banks, drop structures, drainage swales and diversion channels.	
	Records retained of 'as built' drawings for reshaping out-of-pit waste emplacement to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	
Native Vegetation Grazing	Surface capped with suitable material that has been certified as complying with design requirements in Condition F20.	RM3
	Engineering and capping designs ensures structure is geotechnically stable, accordingly, to design plan in Condition F20.	
Water Storage Native Vegetation	Removal of any contaminated sediments identified by site contaminated land investigation.	RM2 RM14
	Sediment dams to be backfilled to ground level or higher (for settlement), according to design plan in Condition F20.	RM5
Native Vegetation	Final top surface is to be free-draining and include drainage structures to channel run-off and to avoid erosion and surface water ponding.	RM9
Water Storage	The hazards in the water storage must have no significant difference to hazards in water storage in surrounding unmined landscape.	RM14
	Structural and geotechnical stability confirmed by suitably qualified hydro-geotechnical engineer for water storage structures.	RM5
	Bywash/spillway structures with adequate capacity.	
Native Vegetation Grazing Retained Infrastructure	The hazards in the diversion drains must have no significant difference to hazards in drainage lines in surrounding unmined landscape.	RM9
	Meets earthworks and engineering design as part of design plan in Condition F20.	RM5
	Similar geomorphology to regional ephemeral drainage lines in reference sites determined by Condition F15.	RM15
Native Vegetation Native Vegetation (Riparian) Grazing	Regrading/reshaping of the low walls and highwall completed as required, according to Table F1 and design plan in Condition F20.	RM3
	Placement of at least 4m of NAF earthen material on top of the final deposited tailings layer.	
	Certification from an appropriately qualified person that the residual void is safe to humans and livestock.	RM5

Table 6-67 (Continued): Completion Criteria Transitioned from EA EPML00844613

EA Post-Mining Land Use	Completion Criteria from EPML00844613 Attachment 1	Transitioned Milestone
Grazing Native Vegetation	Records retained of 'as built' drawings for flood protection structures to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F21.	RM5
	Records retained of 'as built' drawings for Flood Protection Structures to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	
	Removal of temporary levee/other structures (decommissioning), according to design plan in Condition F21.	RM1
	Meets engineering design as part of design plan in Condition F20 including functioning as a permanent flood protection landform.	RM5
	Increase size of levee to create permanent flood protection structure as part of the final landform, according to design plan in Condition C21.	
	Records retained of 'as built' drawings for filling in quarries/borrow pits to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5 MM1
	Quarries/Borrow pits backfilled to ground level or higher (for settlement), according to design plan in Condition F20.	RM5
	Hard surface materials removed) and landform shaped, in accordance with design plan in Condition F20.	RM1
Water Storage	Records retained of structural integrity of permanent retention of water storage structures and certification that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM14
	Preservation of existing beneficial use of water resources.	
	Management inputs required to sustain aquatic habitat are comparable to selected reference sites determined by Condition F15	
	Water storages contain water of a suitable quality for native wildlife and/or livestock ingestion.	
Native Vegetation	The hazards in the native vegetation must have no significant difference to hazards in local regional ecosystems in surrounding unmined landscape.	RM11
	Records retained of 'as built' drawings for filling in each water storage structure to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5
	Water storage structure backfilled to ground level or higher (for settlement), according to design plan in Condition F20.	
	All major earthworks completed in accordance with design plan in Condition F20.	
	Minimum of 4 meters of NAF earthen material placed on top of the tailings.	RM3
Native Vegetation (Riparian)	The watercourse diversion and associated structures are certified as maintaining equilibrium and functionality and do not require ongoing maintenance, according to design plan in Condition F20.	RM13
	Develop features by vegetating mixed riverine vegetation on sandy clay soils along watercourses, which provide for groundcover, canopy habitat and aquatic habitat.	
Native Vegetation (Riparian)	Records retained of 'as built' drawings for permanent creek diversion to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5
Retained Infrastructure	Encapsulation or removal of contaminated materials/areas identified by site contaminated land investigation.	RM2 RM14

Table 6-67 (Continued): Completion Criteria Transitioned from EA EPML00844613

EA Post-Mining Land Use	Completion Criteria from EPML00844613 Attachment 1	Transitioned Milestone
Grazing	Plant, infrastructure, services and associated components removed and/or demolished, and landform reshaped in accordance with design plan in Condition F20.	RM1
	Concrete pads and footings removed to a depth of 1.5 m below the landform elevation and backfilled to ground level or higher (for settlement) and shaped, in accordance with design plan in Condition F20.	
	The hazards in the grazing land must have no significant difference to hazards in grazing land in surrounding unmined landscapes.	RM9
	Slopes no greater than 12.5% based on chemical and physical characteristics of local site.	RM5
	Vegetated with a mix of perennial pasture species (grasses and legumes) and low-density wooded vegetation (for livestock shelter) suited to the reinstated soils, capable of sustaining grazing activities and suitable for providing stabilising groundcover.	RM7
	Vegetation dominated by pasture grass and legume species.	RM8
	>70% palatable perennial pasture cover.	
	Class 4 or improved land suitability outcomes ¹ .	RM9
	Capable of supporting sustainable (light intensity) grazing, with stocking rates comparable to reference sites determined by Condition F15.	
	Diversion drains backfilled to ground level or higher (for settlement), according to design plan in Condition F20.	
	Design of A-Pit Twelve Mile Creek permanent Flood Protection structure is in accordance with the design plan in Condition F20	RM5
	Contour ripping and seeding undertaken in accordance with the Revegetation Strategy in the Rehabilitation Management Plan.	RM6
Native Vegetation Native Vegetation (Riparian) Grazing	Records retained of 'as built' drawings for permanent retention of diversion drains to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5 RM6
	Diversion drains functioning to move water, according to design plan in Condition F20.	RM5
	Water management infrastructure and erosion control structures installed as required for functioning of a non-polluting diversion drain.	
	Preservation of existing beneficial use of water resources.	
	Management inputs required to sustain diversion drain are comparable to selected reference sites determined by Condition F15.	
	Slopes no greater than specified in Table F2: Post-mining Land Use Areas and Non-Use Management Areas based on chemical and physical characteristics of local site.	
Native Vegetation (Riparian)	Records retained of 'as built' drawings for permanent creek diversion to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	RM5
	The hazards in the permanent diversion must have no significant difference to hazards in creek system in surrounding unmined landscape.	RM13
	The hazards in the creek diversions have no significant difference to hazards in creeks in surrounding unmined landscape.	
	An assessment demonstrates that the creek diversion is functioning as designed in Condition F20 and the integrity of the watercourse diversion and/or adjoining watercourses is not threatened.	

Table 6-67 (Continued): Completion Criteria Transitioned from EA EPML00844613

EA Post-Mining Land Use	Completion Criteria from EPML00844613 Attachment 1	Transitioned Milestone
Retained Infrastructure	Contaminated land assessment conducted to verify the proposed use is suitable.	RM2
	Evidence from suitability qualified person the retained infrastructure is structurally and functionally sound before providing/selling such infrastructure to a future landholder.	RM15
	Audit results showing that any applicable areas subject to AS1940:2004 (The storage and handling of flammable and combustible liquids) that are left for the landowner after mining are in compliance with the standard.	RM15
	No infrastructure with structural or geotechnical instability retained.	RM15
	Design according to design plan in Condition F20 ensures no serious environmental harm from retained infrastructure.	RM5
	Surface infrastructure and services signed landholder agreement to indicate acceptance of any associated risks of all retained infrastructure after closure.	RM1
	Signed landholder agreement to indicate acceptance of any associated risks of all retained infrastructure after closure.	RM1
NUMA	A suitability qualified geotechnical engineer certifies that low walls, highwalls and end wall slopes are safe and achieve a minimum factor of safety of 2.	MM3
	Backfilling and regrading/reshaping of the low walls and highwall completed, according to Table F1 and design plan in Condition F20.	MM1
	Partial backfilling undertaken to ensure it is internally draining, avoids water related interaction with the surrounding landscape/naturally occurring environment and creates any required flood immunity and low wall has native vegetation, in accordance with design plan in Condition F20.	MM1
	Evidence that final void water is contained with no potential for overflow events as predicted by water balance modelling.	MM3
	Battering back of the low walls and highwall completed, according to Table F1 and design plan in Condition F20.	MM1
	Stabilisation works undertaken so void is internally draining and avoids water related interaction with the surrounding landscape/naturally occurring environment and low wall having native vegetation, in accordance with design plan in Condition F20.	MM3
	Records retained of 'as built' drawings to ensure each void has stabilised walls to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20.	MM1

¹ (Department of Natural Resources and Mines and the Department of Science, Information Technology, Innovation and the Arts, 2013).

6.14 REHABILITATION AREA COMMENCEMENT DATES

YCC is committed to undertaking progressive rehabilitation as land becomes available. The anticipated commencement dates, and justification of these dates, is provided in Table 6-68. Rehabilitation Areas are shown in Figure 2-13.

Table 6-68: Rehabilitation Area Commencement Dates and Justification

RA	Relevant Activity	PMLU/NUMA	Commencement Date	Completion Date	Progressive Rehabilitation Availability
RA1	In-pit and Out-of-pit Waste Emplacement (less than [$<$] 12.5% Slopes)	Grazing	2025	2073	When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA1 will become available progressively.
RA2	In-pit and Out-of-Pit Waste Emplacement (Slopes 0 to $<$ 27%)	Native Vegetation	2024	2082	When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA2 will become available progressively.
RA3	Twelve Mile Creek Diversion	Native Vegetation (Riparian)	2035	2059	When landform development of Twelve Mile Creek Diversion is complete, and the landform stability will not be affected by adjacent mining activities.
RA4	Water Management Infrastructure (Water Storage)	Water Storage	2056	2066	When water management infrastructure is no longer needed for mining or rehabilitation activities, and the landform stability and/or water quality will not be impacted by adjacent mining activities.
RA5	DE-Pit TSF	Native Vegetation	2037	2070	When landform development surrounding the TSF is complete.
RA6	DE-Pit TSF and DOM1 TSF	Grazing	2037	2076	When landform development surrounding the TSF is complete.
RA7	Infrastructure Areas (Retained Infrastructure)	Retained Infrastructure	2057	2068	When infrastructure is no longer needed for mining or to support rehabilitation activities.
RA8	Infrastructure Areas (Grazing)	Grazing	2043	2075	When infrastructure is no longer needed for mining or to support rehabilitation activities.
RA9	Infrastructure Areas (Native Vegetation)	Native Vegetation	2042	2082	When infrastructure is no longer needed for mining or to support rehabilitation activities.
RA10	Existing Rehabilitation	Native Vegetation	2024	2044	NA, rehabilitated to native vegetation PMLU.
RA11	Existing Rehabilitation to be re-disturbed (Native Vegetation)	Native Vegetation	2031	2081	Rehabilitation to be re-disturbed due to an updated dumping schedule. When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA11 will become available progressively.

Table 6-68 (Continued): Rehabilitation Area Commencement Dates and Justification

RA	Relevant Activity	PMLU/NUMA	Commencement Date	Completion Date	Progressive Rehabilitation Availability
RA12	Existing Rehabilitation to be re-disturbed (Grazing)	Grazing	2034	2074	Rehabilitation to be re-disturbed due to an updated dumping schedule. When an area is no longer used for dumping, and the landform stability will not be affected by adjacent mining activities. Areas of RA12 will become available progressively.
RA13	Undisturbed Land	Grazing	2024	2029	When an area is not to be used for any mining or future exploration activities. Areas previously used for exploration will become available progressively.
IA1	Residual Voids	NUMA	2048	2070	When mining of the pit has ceased, or, if being backfilled or partially backfilled, when backfilling is complete.

7 RISK ASSESSMENT

A risk assessment was undertaken as part of this PRCP to identify the risks of the post-mining landform not being achieved, the risks of the NUMAs causing environmental harm and not being safe and structurally stable, and how the risks will be managed or minimised (Appendix T).

The risk assessment was facilitated at Yarrabee Mine and involved a site tour, enabling the team to inspect various landforms (established and forming) and existing rehabilitation areas to visualise and identify constraints to achieving successful PMLUs.

7.1 RISK IDENTIFICATION

For each domain, a list of risks and unwanted events was identified, including the cause/s of the event and potential maximum consequences with current controls in place. Risks that were considered to be a result of controls failing could not be ranked (on the basis that a failed control has an indeterminant outcome) and are recorded in Appendix T.

7.2 RISK EVALUATION AND TREATMENT

The risk analysis step involved exploring an understanding of the risks identified and determining risk causes and sources. The risk analysis process utilises the Yancoal Risk Matrix (Table 7-1) to determine:

- the potential consequence (of the event) of all risk issues, given the existing risk controls in place;
- the likelihood that the assessed consequence will occur with those controls in place; and
- the potential risk score (based on identified consequence/likelihood ratings).

The appropriate risk treatment options were identified and assessed after considering cost-benefit, regulatory obligations, social responsibility, and protection of the surrounding environment.

Table 7-1: Risk Matrix

YANCOAL RISK MATRIX						
Loss Type		Consequence				
		1 - Insignificant	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
(P) Harm to People		Slight injury or health effects – report only (RO) or first aid injury (FAI)	Minor injury or health effects – medical treatment injury (MTI) or restricted work injury (RWI)	Serious bodily injury or health effects – lost time injury (LTI)	Single fatality	Multiple fatalities
(E) Environmental Impact		Environmental nuisance – trivial or negligible, short term impact to area of low significance, minimal or no physical remediation required No regulation. Cost < \$1K	Minor environmental harm – short term impact to area of limited local significance, limited physical remediation Reportable Breach /Minor Non-Compliance, potential warning notice, other notices (infringement / prosecution) unlikely. Costs \$1K - \$10K	Serious environmental harm – long term impact to area of local conservation value, medium term physical remediation, actual community health impacts or significance or pollution or contamination Infringement Notice but Prosecution unlikely Costs \$10k - \$100k	Major environmental harm – long term reversible impacts to area of regional conservation significance, health statistics in community alter as a result of this incident or pollution or contamination Prosecution Costs \$100k - \$1M	Extreme environmental harm – irreversible impacts on environmental values of extreme & widespread areas, or those of national conservation significance, community fatalities or pollution or contamination Prosecution, License revoked Costs > \$1M
(O) Asset Damage and Other Consequential Losses		Slight damage < \$1M or < 1 day disruption to operation	Minor damage \$1M - \$5M. Or < 1 week disruption to operation	Local damage \$5M - \$20M or < 1 month disruption to operation	Major damage \$20M - \$100M or < 6 Months Partial loss of operation	Extreme damage > \$100M or > 6 months substantial or total loss of operation
(R) Impact on Reputation		Slight impact – Public awareness may exist but no public concern Isolated compliance failure – no brand damage	Limited impact – Some local public concern Intervention of regulating authority – minimal brand damage	Considerable impact - Regional public concern Major compliance failure involving fines – medium brand damage	National impact – National public concern Temporary withdrawal of license to operate – significant brand damage	International impact - International public attention Loss of shareholder confidence – irreparable brand damage
Likelihood		Likelihood Guide		Level of Risk		
A (Almost Certain)	Likely that the unwanted event could occur several times per year at this location	11 (Moderate)	16 (High)	20 (High)	23 (Extreme)	25 (Extreme)
B (Likely)	Likely that the unwanted event could occur several times per year in the Australian mining industry; or could happen annually	7 (Moderate)	12 (Moderate)	17 (High)	21 (Extreme)	24 (Extreme)
C (Possible)	The unwanted event could well have occurred in the Australian mining industry at some time in the past 10 years	4 (Low)	8 (Moderate)	13 (High)	18 (High)	22 (Extreme)
D (Unlikely)	The unwanted event has happened in the Australian mining industry at some time; or could happen in 50 years	2 (Low)	5 (Low)	9 (Moderate)	14 (High)	19 (High)
E (Rare)	The unwanted event has never been known to occur in the Australian mining industry; or is highly unlikely that it could ever occur	1 (Low)	3 (Low)	6 (Moderate)	10 (Moderate)	15 (High)

7.2.1 Risk Assessment Workshop

The rehabilitation risk assessment workshop was held on 7 March 2024. It involved a team of multidisciplinary technical specialists and operational personnel responsible for advising, planning, and implementing rehabilitation activities for Yarrabee Mine. The key steps followed included:

1. Desktop review of available technical and monitoring reports to identify potential rehabilitation risks.
2. Establish the project context to support the PRCP risk assessment.
3. A site inspection of current landforms at the Yarrabee Mine, and existing rehabilitation with members of the risk assessment team.
4. Facilitated rehabilitation risk assessment workshop to:
 - Agree on rehabilitation domains.
 - Based on the site inspection and visual tools, such as aerial photos and drone footage, identify key risks for each domain using pre-populated risk statements that were informed by the desktop review.
 - Assess the consequences for each risk and evaluate the likelihood.
 - Detail existing controls and identify additional risk treatments to reduce or eliminate identified risks.
5. Where additional risk treatments were proposed, the following considerations were documented:
 - The reasons for selecting the treatment option.
 - Those responsible for the approval and implementation of the plan.
 - Proposed actions.
 - Resource requirements.
 - Performance measures and constraints.
 - Reporting and monitoring requirements.
 - Timing and scheduling.
6. A report was developed to document all findings, including identified risks, assessment methodologies, and mitigation strategies and provided to workshop participants for review and approval.

Members of the risk assessment team had extensive industry experience across multiple disciplines required for rehabilitation planning and implementation. This experience enabled a high level of confidence in ensuring the key risks were identified. The attendees present are listed in Table 7-2.

Table 7-2: Risk Assessment Attendees

Name	Company	Role
Jamie Lees	ESG Consulting	Facilitator
Michael Moore	Yancoal	Manager - Approvals
Megan Dawson	Yancoal	Superintendent - Approvals
Jeff Hansen	Yancoal	Queensland Technical Manager
Andrew Lau	Yancoal	Mine Closure Manager
Michael Priestly	YCC	SSE/Operations Manager
Charmain Grouch	YCC	Commercial Manager
Godfrey Banda	YCC	Technical Services Manager
Jazmin Byles	YCC	Senior Process Engineer
Lee James	YCC	Mining Manager
Sloane Hobbs	YCC	Snr HST Advisor
Troy King	YCC	CHPP Superintendent
David Drew	Minserve	Mining Engineer
Kirsten Gollogly	Resource Strategies	Approvals Consultant
Josh Peters	Resource Strategies	Approvals Consultant
Phoebe French	Resource Strategies	Approvals Consultant

Note: SSE = Site Senior Executive; Snr = Senior; HST = Health and Safety.

7.2.2 Summary of Closure Risks

45 residual risks were identified that could prevent the nominated PMLU from achieving a stable condition for land. Eight of these risks are repeated as they apply to multiple domains, leaving 37 distinct residual risks. The 37 residual risks include two high, 14 moderate, and 21 low risks. No extreme risks were identified. The two identified high risks include:

- Insufficient technical and operational resources to plan and implement the rehabilitation plan. This risk is influenced by the loss of or inability to attract the required technical and operational skills due to industry skills shortages and market competition. This risk is compounded by the need for additional skilled resources to manage the increased complexity of complying with the PRCP Scheduling and reporting obligations.
- Inadequate growth medium (topsoil) to support rehabilitation (applicable to two domains). Seed germination and plant growth may be compromised due to insufficient topsoil volumes, poor soil structure and fertility characteristics consistent with local topsoil resources. Note: This is consistent with the findings detailed in Section 6.6.4.

Six risks were identified for the NUMAs, including two moderate and four low residual risks, that could cause environmental harm and make them unsafe and structurally stable. No extreme or high risks were identified (Appendix T).

8 MONITORING AND MAINTENANCE METHODOLOGY

8.1 MILESTONE MONITORING

Progressive rehabilitation by definition means rehabilitation is completed at different times across a landform. As a result, rehabilitation areas will vary in age and potentially in condition and progress along the completion criteria trajectory to a 'satisfactory' outcome.

Rehabilitation is monitored at Yarrabee Mine according to the Annual Rehabilitation Monitoring Program. The monitoring program is based on the Landscape Function Analysis methodology and includes the following:

- measure the progress and success of the rehabilitation program against performance indicators and Rehabilitation Success Criteria for the applicable targeted PMLU;
- inform the continuous improvement process and refine rehabilitation methodologies and success criteria; and
- identify when rehabilitation is not trending toward success criteria in an appropriate timeframe, triggering adaptive management.

8.1.1 Ongoing Inspection and Surveillance

The inspection and surveillance components of the monitoring program are to be completed by Yarrabee Mine environmental personnel. Inspection and surveillance are intended to be completed year round with a focus upon younger, newer rehabilitation areas and after periods of heavy rainfall. These inspections are intended to be carried out at least annually and should generally cover all assessable and visible areas. Efforts should be made to ensure all areas are generally assessable or visible for inspection and surveillance.

The intent in carrying out inspection and surveillance is to identify issues or localised areas of failure and implement corrective actions early and quickly. This ensures the overall rehabilitation landscape remains on track in its progression towards achieving success criteria and ultimately a satisfactory outcome. Inspections and surveillance are intended to be primarily visual, however may be supported by drone surveillance and/or site survey data. The inspections and surveillance will primarily examine areas of failed vegetative establishment and/or erosion wash outs, rills etc.

8.1.2 Formal Monitoring and Reporting Schedule

The formal monitoring program is completed at approximately the same time each year, post wet season during the cooler winter months, to standardise timing and remove seasonal variation from the monitoring results (Note: year to year variation in conditions will be expressed in monitoring results). These aspects of the monitoring program will be completed using Yarrabee Mine environmental personnel or otherwise contracted out to a suitably qualified consultancy.

The formal monitoring and reporting of rehabilitated areas will take place annually using an appropriately defined schedule (Table 8-1). Individual locations will be revisited at regular intervals to monitor the performance of rehabilitated areas and progression against the success criteria. Monitoring outcomes will also inform whether any remediation works are required. The schedule based on the number of years since the rehabilitation was completed (seeding/planting), will define which areas are formally monitored and reported upon in any particular year.

Formal monitoring and reporting will utilise fixed monitoring locations in each rehabilitation area, based upon each geographic location and year of completion. One fixed monitoring transect location will be established per rehabilitation area (by geographic area and year of completion) up to 40 ha. Above this size additional fixed monitoring transects/locations will be established in increments of 40 ha. This will ensure results between monitoring periods can be directly compared and assessed against progression and trajectory for achieving completion criteria. These fixed monitoring transects will be comprised of both analogue/reference sites for each post-mining land use and those established within each rehabilitation area.

The utilisation of analogue and reference monitoring sites in addition to those in each rehabilitation area will allow for comparison against the targeted outcome benchmark whilst considering year to year variation in conditions. This removes any performance bias based upon naturally occurring conditions fluctuation.

Formal monitoring and reporting will also aim to identify and inform whether any remedial works are required that haven't already been identified/able to be corrected through inspection and surveillance activities. A discussion of monitoring methodologies is provided in Section 8.2. The 2022 and 2023 annual rehabilitation monitoring report is provided in Appendix D and Appendix E respectively.

Table 8-1: Rehabilitation Monitoring Schedule

Age of Rehabilitation	Frequency of Monitoring
1 to 5 years	Annual Formal Monitoring and Reporting.
5 to 10 years	Formal Monitoring and Reporting at years 7 and 10.
Greater than 10 years	Formal Monitoring and Reporting at 5 yearly increments (e.g. years 15, 20, 25, 30 etc.).

Source: (Appendix D).

8.1.3 Monitoring Performance Indicators

Rehabilitation performance will be based on seven major indicators:

1. progress along anticipated trajectory for achieving targeted Rehabilitation Objectives and associated PMLU success criteria;
2. compliance to targeted PMLU landform design/profile;
3. landform stability and erosion;
4. land suitability, capability and/or configuration to targeted PMLU;
5. vegetation percentage cover (live and dead) and total ground cover;
6. species diversity and density (including relative to that seeded/planted and natural recruits);
7. nutrient cycling and potential areas/sources of contamination; and
8. natural recruitment and reproduction.

Table 8-2 describes the outcome success criteria for the Yarrabee Mine rehabilitation monitoring.

Table 8-2: Success Criteria for Rehabilitation Monitoring

Grazing	Native Vegetation
Vegetation dominated by pasture grass and legume species.	Vegetation dominated by local pioneer species.
>30% living ground cover, >70% overall ground cover (including live, dead, and non-vegetative).	>30% living ground cover, >70% overall ground cover (including live, dead, and non-vegetative).
Evidence of natural recruitment (flowering, seeding).	Evidence of natural recruitment (flowering, seeding).
Soil nutrient concentrations comparable to reference sites.	Soil nutrient concentrations comparable to reference sites.
Pest and weed density comparable to reference sites.	Pest and weed density comparable to reference sites.
	>8 species/ha established across areas.
Erosion rates comparable to reference sites.	Erosion rates comparable to reference sites.

Source: (Appendix D).

8.1.4 Rehabilitation Monitoring Sites

Rehabilitation monitoring sites will be established following the completion of each rehabilitation area. Sites will be placed at random within newly established rehabilitation polygons, at a density of approximately one site per 40 ha.

Surveys for both native vegetation and grazing utilise a 50 m transect, which is also used in the creation of a 50 m x 20 m plot. The 50 m x 20 m plot is used to measure species diversity, dominant species, search for evidence of recruitment and count stem density. Five 1 m x 1 m quadrats are also run out along 10 m intervals along the main transect to measure weed density, vegetative cover, and bare ground. Quadrats are established at 9 m to 10 m, 19 m to 20 m, 29 m to 30 m, 39 m to 40 m, and 49 m to 50 m along the length of a 50 m transect. Table 8-3 summarises the plot types and associated measures to complete vegetation assessments.

Table 8-3: Plot Types and Associated Measures

Plot Type	Grazing	Native Vegetation
50 m x 20 m	1. Dominant species assessment. 2. Evidence of natural recruitment.	1. Dominant species assessment. 2. Evidence of natural recruitment. 3. Stem density. 4. Species diversity.
1 m x 1 m Quadrats	1. Weed density. 2. Ground cover.	1. Weed density. 2. Ground cover.

Source: (Appendix D).

8.1.5 Reference Sites

Reference sites are located outside the disturbance areas to offer useful comparison to the surrounding landscape. Reference sites have been selected to represent each targeted PMLU with application to similar conditions/circumstances. Where possible, reference sites have been selected as close as possible to the mine disturbances and associated rehabilitation areas, whilst ensuring they will not be impacted by future mining activities. This will ensure issues such as weather, rainfall, climate, and year to year condition differences are minimised. The selection of reference sites also considered physical attributes including gradient to ensure any comparison between it and rehabilitation areas was as representative as practically achievable.

8.1.6 Data Collection

The Rehabilitation Monitoring Program will collect relevant and sufficient spatial/temporal data to statistically validate any conclusions of the monitoring program. Data collection will occur across all final land use domains and PMLUs.

8.2 MONITORING METHODOLOGY

8.2.1 Methodology Overview

Monitoring is conducted along fixed transects, following the Landscape Functional Analysis methodology described by Tongway & Hindley (2004). Vegetation monitoring of rehabilitation sites is undertaken using various modified techniques from the *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual* (Eyre et al., 2015). Techniques for both grazing and native vegetation utilise most of the same techniques with only minor differences.

The following sections describe the existing survey methodology used at Yarrabee Mine to assess vegetation rehabilitation on site. This methodology will continue to be utilised where appropriate, however, Yarrabee Mine will also implement contemporised survey techniques as they are developed.

8.2.2 Soil

Soil monitoring will be carried out to achieve one of two main objectives:

1. **diagnostic:** determine the cause of poor performance or failure to achieve required surface cover levels; and
2. **sustainability:** compare nutrient status to reference sites as an indicator of sustainability of vegetation growth (both groundcover and pasture productivity).

Persistent bare areas identified in ground-based monitoring or aerial survey will be sampled to diagnose the constraints limiting vegetation growth.

Routine rehabilitation monitoring will also include a soil testing program to gain an understanding of the soil's ability to sustain levels of cover necessary for long-term stability. The key nutrients measured are nitrogen, phosphorus, potassium, and organic carbon.

Soil nutrient concentrations at reference sites provide a benchmark against which rehabilitation sites can be measured. Comparison of nutrient concentrations in the upper 600 mm of the soil profile to those measured at reference sites provides an indication of the soil's capacity to sustain the requisite vegetation community and cover level.

Soil samples are collected and submitted to a suitable laboratory accredited by the National Association of Testing Authorities and the Australasian Soil and Plant Analysis Council. Soil samples are not collected from locations that are considered to be practically the same as an adjacent soil sample. Samples of approximately 500 grams each are collected and given a project name and given a unique profile number. The following measures are tested for:

1. pH (1:5 H₂O), EC (1:5 H₂O), Chloride, and KCL extractable sulphur;
2. Cation exchange capacity (CEC) and Exchangeable sodium percentage (ESP); and
3. Emerson Aggregate Test (EAT) (an indicator of dispersion).

Results are assessed against the ratings of Hazelton and Murphy (2016) and the DME (1995) as outlined in Table 8-4.

Table 8-4: Soil Testing Measures

Analysis	Not Limiting	Possibly Limiting	Limiting
pH	5.5 to 9	<5.2 to 5.4 and >9 to 9.5	>9.5, <5.2
EC 1:5 H ₂ O	-	1 dS/m	2dS/m
Chloride mg/kg	<600	600	1200
CEC cmol/kg	>12	<12	-
ESP	<6	>6 to 15	>1
Ca:Mg	>=2	1 to 1.9	<1
EAT	>2	<=2	-
SO ₄ *	-	-	-

Source: (Appendix D).

Note: ≥ = greater than or equal to; ≤ = less than or equal to; * SO₄ has no clear rating system

8.2.3 Erosion

Rehabilitation areas will be inspected for erosion rills, erosion gullies, signs of slumping or failure and topsoil depth to determine their erosion rating as shown in Table 8-5.

Table 8-5: Erosion Rating System Used in Rehabilitation Monitoring

Erosion Rating	Rills	Average Depth of Rills	Topsoil Depth	General Observations
0	0-3	<100 mm	>90% of original depth.	Generally little erosion. The majority of rills are only <10 cm depth.
1	2-6	100 mm to 200 mm	>75% of original depth.	Minimal instances of sheet-wash and gully erosion.
2	3-8	200 mm to 500 mm	>50% of original depth.	Minimal-moderate erosion occurring but limited to localised areas.
3	4+	500 mm to 800 mm	>40% of original depth.	Moderate erosion occurring.
4	4+	>800 mm	>30% of original depth.	Heavy erosion occurring.

Source: (Appendix D).

Erosion assessments are conducted at each rehabilitation monitoring site, using Table 8-5. Assessments are taken from a general point within the 50 m x 20 m plot and completed after a meander search, rather than from one fixed point. Where a site has scores from differing erosion rating categories as per Table 8-5, the average score from 0 to 4 is taken. Erosion rates are compared directly to reference sites given an identical assessment is undertaken at each established reference site.

A drone is flown to identify any major erosion features on a broader scale than could be observed from the ground. Note that drone flights are substantially larger than the existing 50 m x 20 m plots and are typically conducted between 200 m x 200 m wide to capture sufficient images to be rendered together. This is ultimately beneficial as it provides a much broader analysis to determine if the raw data collected in the physical plots is representative. Erosion features less than 500 mm wide, and 200 mm deep cannot be reliably identified on drone imagery.

8.2.4 Dominant Species Assessment

A meander search through the 50 m x 20 m plot is completed to determine the dominant species. This assessment differentiates between grazing and native vegetation sites where the criteria for success are unique (pasture and legume species required for grazing and local pioneer species required for native vegetation).

8.2.5 Evidence of Natural Recruitment

A meander search through the 50 m x 20 m plot is completed and any evidence of recruitment such as flowering, seed heads, and saplings is recorded. The species name is recorded along with abundance, recruitment features noted, and photographic evidence taken.

8.2.6 Stem Density

The total number of wooded stems in the 50 m x 20 m plot is recorded. The total number of stems in the plot is then multiplied by 10 to get a per ha rate. Drones are flown across a broader area to determine visually if this extrapolation appears to be reasonable (i.e., is the stems count in the subplot a reasonable indication of the distribution and abundance of stems in the general area).

8.2.7 Species Richness

To determine the species richness, a random meander search is undertaken through the 50 m x 20 m plot, and all species are recorded until over eight species have been recorded (if present).

8.2.8 Weed Density

Weed density is assessed using the 1 m x 1 m quadrats. Using the quadrat method (Eyre et al., 2015), weed density (coverage percentage) is calculated by combining the total for non-native forbs, grasses, and shrubs and dividing by the five quadrats for the mean. Large infestations of weeds identifiable aerially are also collected and mapped through the use of drone flight.

8.2.9 Ground Cover

Ground cover is assessed using the 1 m x 1 m quadrats. Ground cover is calculated by categorising all data into three categories:

1. Living ground cover (all shrubs, forbs, grass and cryptograms).
2. Overall ground cover (as above with the addition of leaf litter, including sticks and other fallen tree matter).
3. Bare ground and rock.

Drones are also flown during the assessment to analyse the overall ground cover and determine whether the data collected during the quadrat surveys is representative of the landscape in general. The drones also assist in locating any abnormalities in ground cover and bare patches that are not representative of the general landscape.

8.2.10 Biomass Assessment

A measurement of biomass is recorded at one location most representative of the surrounding landscape within the 50 m x 20 m plot following the Brigalow Belt pasture photo standards (Future Beef, 2011). To undertake these assessments, star pickets are positioned in a representative location within the 50 m x 20 m plot. Care is taken to position the star picket with a view of something easily recognisable such as a tree or other landmark so that changes over time can be easily observed. The correct photo standard is selected based on the vegetation type (e.g., Buffel grass is standard if in a Buffel grass paddock). The total t/ha is then recorded along with the photo standard used.

When using Biomass in the overall score and standardised scoring, a specific t/ha measure cannot be used as each type of vegetation has different measures. However, each vegetation type has six example photos overall, and these are used to determine an appropriate scoring system.

8.2.11 Use of Drones and Aerial Surveys

Remotely sensed data such as drones are used for multiple purposes throughout Yarrabee Mine as discussed above. For clarity, the full list of drone flights that are used opportunistically include but is not limited to:

1. Aerial survey of stems per hectare to validate ground truthed plot data.
2. Aerial survey identifying areas of erosion and key erosion features.
3. Aerial survey to validate data collected on ground cover.
4. Mapping the extent of large weed infestations where identified.

8.2.12 Rehabilitation Trajectory and Scoring

All of the data collected in the rehabilitation monitoring program is used to determine overall rehabilitation progress. Each site is given an outcome category that indicates its progress towards meeting the minimum success criteria (Table 8-6). The overall outcome is then mapped across the entire Yarrabee mine so that the overall progress can be viewed in a quick snapshot via a traffic light system.

Table 8-6: Overall Monitoring Site Scoring System

Rehabilitation Status	Criteria	Rehabilitation Score Range (%)
Acceptable	Meets all completion criteria and ready for sign off by stakeholders. Continue to manage and monitor to maintain status until relinquishment is sought.	>0.80
Monitor	Progressing towards completion criteria but does not meet all criteria. No intervention required but continue to monitor (e.g. ecologically young areas, variable results).	0.55 to 0.80
Maintenance	Does not meet completion criteria. Routine rehabilitation maintenance works required (e.g. weed control, infill seeding/plantings, repair of minor erosion, fertiliser application).	0.30 to 0.55
Rework	Does not meet completion criteria. Extensive rework required that would not typically form part of a rehabilitation program (e.g. insufficient stems per hectare, high bare ground cover, heavy erosion).	0.00 to 0.30

Source: (Appendix D).

8.3 REHABILITATION MAINTENANCE/CONTINGENCY

Triggers for investigation and possible remediation works are:

1. not achieving targeted PMLU landform design/profile;
2. landform stability and erosion not achieving or on trajectory to achieve completion criteria requirements. Active erosion (erosion rating of 2 or greater);
3. revegetated area dominated by weed species;
4. persistent bare areas (vegetation either dead or failed to establish) visible from aerial imagery; and
5. vegetation and fauna species (where applicable) not consistent with, or on trajectory to achieve targeted PMLU outcome completion criteria.

Appropriate information available for each area will be reviewed to determine whether the cause of the poor performance can be clearly identified, and to aid decisions whether targeted remedial works should be implemented. In some cases, additional investigations may be required to fully establish the causes of poor performance. Mitigation measures to improve rehabilitation performance include:

1. supplementary/re-seeding;
2. application of fertiliser and/or ameliorants;
3. replacement of surface materials; and
4. re-shaping of surface contours to modify overland flow paths.

8.4 ADDITIONAL MONITORING

8.4.1 Dam and Water Storage Monitoring

All water storages will be periodically monitored for water quality throughout the life of mine to confirm any trends or long-term trajectories (outside of seasonable variability) relating to water quality over time. Once identified, appropriate management techniques will be implemented to ensure YCC is capable of achieving the rehabilitation criteria and progressive rehabilitation and closure planning commitments and requirements.

Prior to relinquishment, water contained within all dams, water storages, and final voids will be tested to confirm it is generally consistent with non-mine impacted areas and not harmful/toxic to livestock, terrestrial wildlife, or aquatic life within the Twelve Mile Creek catchment area. This monitoring and testing will apply irrespective of whether or not these landform features will be retained within the PMLU landscape.

8.4.2 Mine Void Monitoring

Monitoring of the residual voids will be undertaken prior to and during the mine closure phase. It will involve monitoring the effectiveness of erosion and surface water control measures, surface water run-off volumes, and geotechnical stability. The monitoring program will be undertaken until such time that the completion criteria for the residual voids have been met.

8.5 LEGISLATIVE REPORTING REQUIREMENTS

8.5.1 Annual Return

In accordance with section 316J of the EP Act, YCC's Annual Return must include an evaluation of the effectiveness of:

1. the actions taken in relation to each rehabilitation milestone or management milestone under the PRCP Schedule; and
2. the environmental management carried out under the PRCP Schedule.

The evaluation must state whether any rehabilitation milestones or management milestones to be completed under the PRCP Schedule during the year have been met, and whether YCC has complied with the conditions imposed on the PRCP Schedule.

8.5.2 Estimated Rehabilitation Cost

All mine sites are required to have an Estimated Rehabilitation Cost (ERC), and this can be applied for under section 298 of the EP Act. Therefore, YCC will submit an ERC to the department consistent with this PRCP and PRCP Schedule.

As required, the ERC must (Queensland Government, 2023):

1. Be calculated on a project basis as it relates to the EA (i.e., may cover several activities on one or more resource authorities).
2. Be calculated for the total cost for the ERC period for rehabilitating the land and preventing, or minimising environmental harm, or rehabilitating or restoring the environment in relation to the activity.
3. Be based on the rehabilitation costs for the year in which the maximum liability is incurred within the nominated ERC period.
4. Account for the full extent of work necessary to meet all EA conditions pertaining to rehabilitation and any relevant rehabilitation requirements contained in a related approval, such as the final land use criteria (whether PMLU or NUMA) and any conditions of a PRCP Schedule (where applicable).
5. Include all activities and costs contained in the department's ERC calculator.

8.5.3 Progressive Certification

Under section 318Z of the EP Act, the administering authority may certify that a particular area within a relevant tenure for a resource project has been rehabilitated under all relevant requirements of the EP Act, EA EPML00844613, the PRCP Schedule, and any relevant guidelines or documents made under the EP Act.

As required by section 318ZF of the EP Act:

The progressive certification report must—

- (a) contain the following information—*
 - (i) if a PRCP schedule applies for the relevant activities carried out in the proposed certified area—*
 - (A) information showing how the rehabilitation milestones and management milestones under the PRCP schedule have been achieved; and*
 - (B) information about the extent to which the relevant conditions stated in the PRCP schedule have been complied with;*
 - (ii) otherwise—information required under section 264, as if a reference in the section to land were a reference to the proposed certified area; and*
- (b) include—*
 - (i) a map of an appropriate scale that shows the proposed certified area; and*
 - (ii) relevant information to locate the proposed certified area, including, for example, GPS information or a survey; and*
- (c) if progressive certification has previously been given for a relevant tenure for the environmental authority—*
 - (i) state when the certification was given; and*
 - (ii) identify the certified area the subject of the certification.*

8.5.4 Surrender Application

Under section 257 of the EP Act, YCC may apply to the administering authority to surrender EA EPML00844613 if, under the *Mineral Resources Act 1989*, YCC has sought a conditional surrender for all, or part of, a relevant mining tenure.

The surrender application must be accompanied by a compliance statement for the EA, the PRCP Schedule, and the conditions imposed on the PRCP Schedule. The compliance statement must state:

1. the extent to which relevant activities carried out under the environmental authority have complied with the conditions of the authority;
2. whether the rehabilitation milestones and management milestones under the PRCP Schedule have been met; and
3. the extent to which conditions imposed on the PRCP Schedule have been complied with.

8.6 AUDITING

In accordance with section 285 of the EP Act, YCC must commission an audit of the PRCP Schedule by a rehabilitation auditor for the following periods:

1. the three-year period starting on the day the PRCP Schedule takes effect; and
2. each three-year period starting on the day after the previous audit period ended.

YCC must, within four months of the end of each audit period, provide the administering authority the rehabilitation auditor's report and a declaration for the audit report stating that YCC has not knowingly given false or misleading information to the rehabilitation auditor and has provided all relevant information to the rehabilitation auditor.

In accordance with section 286 of the EP Act:

An audit report for a PRCP schedule must be in the approved form, and include the following—

- (a) a statement about whether the holder has complied with the schedule during the audit period, including—*
 - (i) details of actions the holder has taken, or failed to take, in relation to the rehabilitation milestones and management milestones under the schedule; and*
 - (ii) whether the holder has complied, or failed to comply, with conditions imposed on the schedule; and*
 - (iii) whether information given to the administering authority under this Act about rehabilitation carried out under the schedule is accurate;*
- (b) an assessment of whether the post-mining land use for land the subject of the schedule is likely to be achieved, having regard to the rehabilitation that has been and is to be carried out under the schedule;*
- (c) recommendations about actions the holder should take to ensure rehabilitation milestones and management milestones are achieved or conditions of the schedule are complied with;*
- (d) the other information the administering authority considers necessary to decide whether to take action to amend the schedule under part 6.*

In addition to the mandatory three-yearly audits, the administering authority has the ability (under section 322 of the EP Act) to issue an audit notice, which requires the holder of a PRCP Schedule to commission an audit.

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Attachment 1

Progressive Rehabilitation and Closure Plan Schedule

Progressive Rehabilitation and Closure Plan Schedule template

Instructions

General Instructions:

- This form can be used for completing a PRCP schedule for the submission of a progressive rehabilitation and closure plan (PRC plan).
- See the PRCP schedule section of the PRC plan guideline (ESR/2019/4964) for further information requirements.

- A default value of one (1) Rehabilitation Area (RA) is represented by one RA sheets below (RA1).
- A default value of one (1) Improvement Area (IA) is represented by one IA sheet below (IA1).

- To record additional RAs for your project make a copy of the RA sheet below and update it to the relevant RA number (i.e. RA2).
- To record additional IAs for your project make a copy of the IA sheet below and update it to the relevant IA number (i.e. IA2).
- To remove the IA sheet if there is no IA for your project, delete the IA sheet below.

- Each RA and IA sheet contains **two separate excel tables** (yellow and blue) for recording the time-based rehabilitation milestones.
- Add a new column or row to each table as required for your information requirements.

- Two (2) separate sheets below exist for recording the "Rehabilitation Area Milestones" and "Improvement Area Milestones".
- Delete the Improvement Area Milestone sheet if it does not apply to your project.
- Delete additional rows in either sheet if they do not apply to your project.
- See the PRC plan guideline for a list of reference milestones and further information for developing additional site-specific milestones where appropriate.

Further Instructions when inputting PMLUs

Headings under Rehabilitation Area (RA) sheets

Rehabilitation area - The rehabilitation area must align with the spatial information included in the rehabilitation planning part of the PRC plan. This area must have the same PMLU and same milestones applied to the whole area.

Relevant activities - The relevant activities must align with the activities identified in the rehabilitation planning part of the PRC plan. The relevant activities are those undertaken within the rehabilitation area prior to land becoming available for rehabilitation.

Total size of rehabilitation area (ha) - Total size of rehabilitation area in hectares.

Commencement of first milestone - The applicant must nominate a date for when the first milestone for the rehabilitation area will commence. The milestone reference for the first milestone must be included in the heading.

PMLU - The PMLU must align with those identified in the rehabilitation planning part of the PRC plan and in the proposed final site design.

Date area is available - The PRCP schedule must identify when land within the rehabilitation area becomes available for rehabilitation. If the whole rehabilitation area becomes available at once there should be only one date. If the rehabilitation areas becomes available progressively there should be multiple dates. These dates should reflect the information provided in the rehabilitation planning part of the PRC plan.

Cumulative area available (ha) - The PRCP schedule must identify the area of land within the rehabilitation area that will become available at a given time.

Milestone completed by - The PRCP schedule must identify completion dates for milestones to be completed.

Cumulative area achieved (ha) - The PRCP schedule must show how progressive rehabilitation is being achieved over the life of the mine. This section must reflect the proposed rehabilitation work required for the rehabilitation area to achieve stable condition. The milestone reference to be included refers back to the Rehabilitation Area Milestones sheet with the detailed milestone criteria. The milestones must be achieved consecutively.

Headings under Rehabilitation Area Milestones sheet

Rehabilitation milestone & Milestone criteria - The "rehabilitation milestone" is a short description of the rehabilitation activities. The "milestone criteria" must be able to demonstrate achievement of the milestone.

Further Instructions when inputting NUMAs

Headings under Improvement Area (IA) sheets

Improvement area - The improvement area must align with the spatial information included in the rehabilitation planning part of the PRC plan. This area must have the same NUMA and same milestones applied to the whole area.

Relevant activities - The relevant activities must align with the activities identified in the rehabilitation planning part of the PRC plan. The relevant activities are those undertaken within the improvement area prior to land becoming available for improvement.

Total size (ha) - Total size of improvement area in hectares.

Commencement of first milestone - The applicant must nominate a date for when the first milestone for the improvement area will commence. The milestone reference for the first milestone must be included in the heading.

NUMA - The NUMA must align with those identified in the rehabilitation planning part of the PRC plan and in the proposed final site design.

Date area is available - The PRCP schedule must identify when land within the improvement area becomes available for improvement. If the whole improvement area becomes available at once there should be only one date. If the improvement areas becomes available progressively there should be multiple dates. These dates should reflect the information provided in the rehabilitation planning part of the PRC plan.

Cumulative area available (ha) - The PRCP schedule must identify the area of land within the improvement area that will become available at a given time.

Milestone completed by - The PRCP schedule must identify completion dates for milestones to be completed.

Cumulative area achieved (ha) - The PRCP schedule must show how progressive improvement is being achieved over the life of the mine. This section must reflect the proposed management work required for the improvement area to achieve sufficient improvement. The milestone reference refers back to the Improvement Area Milestones sheet with the detailed milestone criteria. The milestones must be achieved consecutively.

Headings under Improvement Area Milestones sheet

Attachment 1 - Progressive Rehabilitation and Closure Schedule

Post-mining land uses (PMLU)																								
Rehabilitation area		RA1																						
Relevant activities		In-pit and Out-of-pit Waste Emplacement (Slopes <12.5%)																						
Total rehabilitation area size (ha)		944																						
Commencement of first milestone: RM5		10/12/2025																						
PMLU		Grazing																						
Date area is available	10/12/25	10/12/27	10/12/29	10/12/31	10/12/33	10/12/35	10/12/37	10/12/39	10/12/41	10/12/43	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53	10/12/55	10/12/57							
Cumulative area available (ha)	73	114	149	182	194	260	349	480	624	658	701	799	838	887	894	909	944							
Milestone completed by	10/12/27	10/12/29	10/12/31	10/12/33	10/12/35	10/12/37	10/12/39	10/12/41	10/12/43	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53	10/12/55	10/12/57	10/12/59	10/12/61	10/12/63	10/12/65	10/12/67	10/12/69	10/12/71	10/12/73
Milestone Reference	Cumulative area achieved (ha)																							
RM5	73	114	149	182	194	260	349	480	624	658	701	799	838	887	894	909	944							
RM6		73	114	149	182	194	260	349	480	624	658	701	799	838	887	894	909	944						
RM7		73	114	149	182	194	260	349	780	624	658	701	799	838	887	894	909	944						
RM8					73	114	149	182	194	260	349	480	624	658	701	799	838	887	894	909	944			
RM9								73	114	149	182	194	260	349	480	624	658	701	799	838	887	894	909	944

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Attachment 1 - Progressive Rehabilitation and Closure Schedule

Post-mining land uses (PMLU)																											
Rehabilitation area				RA2																							
Relevant activities				In-pit and Out-of-Pit Waste Emplacement (Slopes 0 to <27%)																							
Total rehabilitation area size (ha)				1264																							
Commencement of first milestone: RMS				10/12/2024																							
PMLU				Native Vegetation																							
Date area is available	10/12/24	10/12/30	10/12/32	10/12/34	10/12/36	10/12/38	10/12/40	10/12/42	10/12/44	10/12/46	10/12/48	10/12/50	10/12/52	10/12/54	10/12/56												
Cumulative area available (ha)	56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264												
Milestone completed by	10/12/26	10/12/32	10/12/34	10/12/36	10/12/38	10/12/40	10/12/42	10/12/44	10/12/46	10/12/48	10/12/50	10/12/52	10/12/54	10/12/56	10/12/58	10/12/60	10/12/62	10/12/64	10/12/66	10/12/68	10/12/70	10/12/72	10/12/74	10/12/76	10/12/78	10/12/80	10/12/82
Milestone Reference	Cumulative area achieved (ha)																										
RM5	56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264												
RM6		56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264											
RM7		56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264											
RM10					56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264								
RM11													56	97	148	225	304	338	357	467	580	709	813	911	1099	1213	1264

- 1) Insert new columns to the **yellow table** to include further rehabilitation milestone dates.
2) Insert new columns to the **blue table** to match rehabilitation milestone dates.
3) Insert new rows to the **blue table** to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area		RA3								
Relevant activities		Twelve Mile Creek Diversion								
Total rehabilitation area size (ha)		53								
Commencement of first milestone: RM5		10/12/2035								
PMLU		Native Vegetation (Riparian)								
Date area is available	10/12/35									
Cumulative area available (ha)	53									
Milestone completed by	10/12/37	10/12/38	10/12/39	10/12/44	10/12/59					
Milestone Reference	Cumulative area achieved (ha)									
RM5	53									
RM6		53								
RM7			53							
RM12				53						
RM13					53					

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area		RA4								
Relevant activities		Water Management Infrastructure (Water Storage)								
Total rehabilitation area size (ha)		18								
Commencement of first milestone: RM1		10/12/2056								
PMLU		Water Storages								
Date area is available	10/12/56									
Cumulative area available (ha)	18									
Milestone completed by	10/12/58	10/12/60	10/12/62	10/12/63	10/12/64	10/12/66				
Milestone Reference	Cumulative area achieved (ha)									
RM1	18									
RM2		18								
RM5			18							
RM6				18						
RM7					18					
RM14						18				

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area		RA5								
Relevant activities		DE-Pit TSF								
Total rehabilitation area size (ha)		2								
Commencement of first milestone: RM1		10/12/2037								
PMLU		Native Vegetation								
Date area is available	10/12/37									
Cumulative area available (ha)	2									
Milestone completed by	10/12/39	10/12/41	10/12/46	10/12/48	10/12/49	20/12/50	20/12/55	20/12/70		
Milestone Reference	Cumulative area achieved (ha)									
RM1	2									
RM2		2								
RM3			2							
RM5				2						
RM6					2					
RM7						2				
RM10							2			
RM11								2		

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)															
Rehabilitation area		RA6													
Relevant activities		DE-Pit TSF and DOM1 TSF													
Total rehabilitation area size (ha)		59													
Commencement of first milestone: RM1		10/12/2037													
PMLU		Grazing													
Date area is available	10/12/37	10/12/39	10/12/41	10/12/46	10/12/48	10/12/49	10/12/53								
Cumulative area available (ha)	7	7	7	7	7	7	59								
Milestone completed by	10/12/39	10/12/41	10/12/46	10/12/48	10/12/49	20/12/50	10/12/55	10/12/2057	10/12/60	10/12/62	10/12/64	10/12/65	10/12/66	10/12/71	10/12/76
Milestone Reference	Cumulative area achieved (ha)														
RM1	7	7	7	7	7	7	59								
RM2		7	7	7	7	7	7	59							
RM3			7	7	7	7	7	7	7	59					
RM5				7	7	7	7	7	7	7	59				
RM6					7	7	7	7	7	7	7	59			
RM7						7	7	7	7	7	7	7	59		
RM8							7	7	7	7	7	7	7	59	
RM9								7	7	7	7	7	7	7	59

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area		RA7								
Relevant activities		Infrastructure Areas (Retained Infrastructure)								
Total rehabilitation area size (ha)		12								
Commencement of first milestone: RM1		10/12/2057								
PMLU		Retained Infrastructure								
Date area is available	10/12/57									
Cumulative area available (ha)	12									
Milestone completed by	10/12/59	10/12/61	10/12/63	10/12/64	10/12/68					
Milestone Reference	Cumulative area achieved (ha)									
RM1	12									
RM2		12								
RM5			12							
RM6				12						
RM15					12					

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)																
Rehabilitation area				RA8												
Relevant activities				Infrastructure Areas (Grazing)												
Total rehabilitation area size (ha)				292												
Commencement of first milestone: RM1				10/12/2043												
PMLU				Grazing												
Date area is available	10/12/43	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53	10/12/55									
Cumulative area available (ha)	10	45	92	106	117	135	292									
Milestone completed by	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53	10/12/55	10/12/57	10/12/59	10/12/61	10/12/63	10/12/65	10/12/67	10/12/69	10/12/71	10/12/73	10/12/75
Milestone Reference	Cumulative area achieved (ha)															
RM1	10	45	92	106	117	135	292									
RM2		10	45	92	106	117	135	292								
RM5			10	45	92	106	117	135	292							
RM6				10	45	92	106	117	135	292						
RM7				10	45	92	106	117	135	292						
RM8							10	45	92	106	117	135	292			
RM9										10	45	92	106	117	135	292

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)																		
Rehabilitation area				RA9														
Relevant activities				Infrastructure Areas (Native Vegetation)														
Total rehabilitation area size (ha)				50														
Commencement of first milestone: RM1				10/12/2042														
PMLU				Native Vegetation														
Date area is available	10/12/2042	10/12/2044	10/12/2046	10/12/2048	10/12/2050	10/12/2052	10/12/2054											
Cumulative area available (ha)	1	6	16	18	37	46	50											
Milestone completed by	10/12/2044	10/12/2046	10/12/2048	10/12/2050	10/12/2052	10/12/2054	10/12/2056	10/12/2058	10/12/2060	10/12/2062	10/12/2064	10/12/2070	10/12/2072	10/12/2074	10/12/2076	10/12/2078	10/12/2080	10/12/2082
Milestone Reference	Cumulative area achieved (ha)																	
RM1	1	6	16	18	37	46	50											
RM2		1	6	16	18	37	46	50										
RM5			1	6	16	18	37	46	50									
RM6				1	6	16	18	37	46	50								
RM7				1	6	16	18	37	46	50								
RM10							1	6	16	18	46	50						
RM11													1	6	16	18	46	50

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area			RA10							
Relevant activities			Existing Rehabilitation (Native Vegetation)							
Total rehabilitation area size (ha)			168							
Commencement of first milestone: RM10			10/12/2024							
PMLU			Native Vegetation							
Date area is available	10/12/24									
Cumulative area available (ha)	168									
Milestone completed by	10/12/29	10/12/2044								
Milestone Reference	Cumulative area achieved (ha)									
RM10	168									
RM11		168								

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Attachment 1 - Progressive Rehabilitation and Closure Schedule

Post-mining land uses (PMLU)																									
Rehabilitation area		RA11																							
Relevant activities		Existing Rehabilitation to be re-disturbed (Native Vegetation)																							
Total rehabilitation area size (ha)		149																							
Commencement of first milestone:		10/12/2031																							
PMLU		Native Vegetation																							
Date area is available	10/12/31	10/12/33	10/12/35	10/12/37	10/12/39	10/12/41	10/12/43	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53													
Cumulative area available (ha)	32	35	35	35	40	40	127	127	127	149	149	149													
Milestone completed by	10/12/33	10/12/35	10/12/37	10/12/39	10/12/41	10/12/43	10/12/45	10/12/47	10/12/49	10/12/51	10/12/53	10/12/55	10/12/57	10/12/59	10/12/61	10/12/63	10/12/65	10/12/67	10/12/69	10/12/71	10/12/73	10/12/75	10/12/77	10/12/79	10/12/81
Milestone Reference	Cumulative area achieved (ha)																								
RM4	32	35	35	35	40	40	127	127	127	149	149	149													
RM5		32	35	35	35	40	40	127	127	127	149	149	149												
RM6			32	35	35	35	40	40	127	127	127	149	149	149											
RM7			32	35	35	35	40	40	127	127	127	149	149	149											
RM10						32	35	35	35	40	40	127	127	127	149	149	149								
RM11													32	35	35	35	40	40	127	127	127	149	149	149	

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)																	
Rehabilitation area				RA12													
Relevant activities				Existing Rehabilitation to be re-disturbed (Grazing)													
Total rehabilitation area size (ha)				153													
Commencement of first milestone: RM5				10/12/2034													
PMLU				Grazing													
Date area is available	10/12/34	10/12/36	10/12/38	10/12/40	10/12/42	10/12/48	10/12/50	10/12/2052	10/12/2054	10/12/56							
Cumulative area available (ha)	2	14	55	73	88	129	129	129	129	153							
Milestone completed by	10/12/36	10/12/38	10/12/40	10/12/42	10/12/44	10/12/50	10/12/2052	10/12/2054	10/12/2056	10/12/58	10/12/60	10/12/62	10/12/64	10/12/68	10/12/70	10/12/27	10/12/74
Milestone Reference	Cumulative area achieved (ha)																
RM5	2	14	55	73	88	129	129	129	129	153							
RM6		2	14	55	73	88	129	129	129	129	153						
RM7		2	14	55	73	88	129	129	129	129	153						
RM8					2	14	55	73	88	129	129	129	153				
RM9						2	2	2	14	55	73	88	129	129	129	129	153

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area		RA13								
Relevant activities		Undisturbed Land								
Total rehabilitation area size (ha)		4230								
Commencement of first milestone: RM9		10/12/2024								
PMLU		Grazing								
Date area is available	10/12/24									
Cumulative area available (ha)	4230									
Milestone completed by	10/12/29									
Milestone Reference	Cumulative area achieved (ha)									
RM9	4230									

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
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- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Non-use management area (NUMA)										
Improvement area				IA1						
Relevant activities				Residual Voids						
Total size (ha)				882						
Commencement of first milestone: MM1				10/12/2048						
NUMA				NUMA						
Date area is available	10/12/48	10/12/49	10/12/50	10/12/53	10/12/56	10/12/57				
Cumulative area available (ha)	143	197	239	366	745	882				
Milestone completed by	10/12/53	10/12/54	10/12/55	10/12/58	10/12/61	10/12/62	10/12/66	10/12/69	10/12/70	
Milestone Reference	Cumulative area achieved (ha)									
MM1	143	197	239	366	745	882				
MM2			143	239	366	745	882			
MM3					143	239	366	745	882	

- 1) Insert new columns to the **yellow table** to include further management milestone dates.
- 2) Insert new columns to the **blue table** to match management milestone dates.
- 3) Insert new rows to the blue table to include additional management milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. MM1).

Attachment 1 - Progressive Rehabilitation and Closure Schedule

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure Decommissioning and Removal	1.All services disconnected and decommissioned, unless agreed in writing by landholders and relevant agencies. 2.All built infrastructure demolished and removed, unless agreed in writing by landholders and relevant agencies. 3.All water management infrastructure not required for water management in post-mining landscape decommissioned, unless agreed in writing by landholders and relevant agencies. 4.All roads and access tracks removed, unless agreed in writing by landholders and relevant agencies. 5.All wastes and hazardous materials removed from site and lawfully disposed of. 6.Concrete pads, where not retained by landholder agreement (as approved by relevant agencies), are removed to a depth of 1.5 m below the landform elevation and backfilled to ground level or higher (for settlement).
RM2	Remediation of Contaminated Land	1.Contaminated water (e.g. affected by hydrocarbons, metals, etc.) is treated. 2.Contaminated land assessment undertaken by an appropriately qualified person (AQP ¹). 3.Any contaminated material either remediated in situ, encapsulated, or removed/transported to an approved landfill for disposal, and waste tracking information recorded and submitted. 4.Validation testing confirms that contaminated materials have been removed or remediated. 5.Evidence that all measures required in contaminated land assessments have been implemented. 6.If required, a site investigation report including a site suitability statement prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act. Additional PMLU Criteria for RA6 (Grazing): 1.Contaminated land assessment conducted to verify the proposed use is suitable. 2.No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion. Additional PMLU Criteria for RA5 (Native Vegetation): 1.Contaminated land assessment conducted to verify the proposed use is suitable. 2.No exposed hazardous materials at surface determined by results of site contaminated land investigation including exposure due to erosion. ¹AQP: a person who has professional qualifications, training, skills, or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods, or literature.
RM3	Installation of Cover System/Capping	1.Certification from an AQP that tailings have dried and settled prior to capping. 2.Minimum capping layer of 4 m of non-acid forming material. 3.Certification from appropriately qualified person that surface capped with suitable material that has been certified as complying with design requirements.
RM4	Vegetation Removal	1. All vegetation is stripped from the landform and lawfully disposed of. 2. Topsoil stripped at a depth of 200 mm and stockpiled in accordance with the topsoil management plan.
RM5	Landform Development	1.All major earthworks completed to landform design in accordance with Condition F20 of the EA EPML00844613. 2.Final landform provides flood protection to all residual voids up to and including a 0.1% AEP and, where landform is required to function as permanent flood protection for a residual void, achieves a FoS of 1.2 and meets engineering design. 3.Where required, water management and erosion control structures (e.g. drainage swales and diversion channels) installed per design and certified by an AQP. 4.Geotechnical stability of built landforms confirmed by AQP. 5.Voids are backfilled to ground level or higher (for settlement) and self-draining, according to criteria in Condition F20 of the EA. 6.Spoil is shaped to be sympathetic to and consistent with the surrounding unmined areas, in accordance with Condition F20 of the EA. 7.Records retained of as built drawings to completely backfill void to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA. 8.Records retained of reshaping of out-of-pit waste emplacement to certify that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA. 9. Water management infrastructure and erosion control structures installed as required.
RM5 Continued	Landform Development	Additional PMLU Criteria for RA1, RA8, RA12 and RA13 (Grazing): 1.Slopes are no greater than 12.5%. 2.Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 0.4 m to minimise erosion. Additional PMLU Criteria for RA2, RA9, RA 10 and RA11 (Native Vegetation): 1.Slopes are no greater than 27%. 2.Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 1 m to minimise erosion. Additional PMLU Criteria for RA3 (Native Vegetation [Riparian]): 1.Slopes are consistent with Twelve Mile Creek Diversion Functional Design. 2.Certification from an AQP that the diversion is constructed to design. Additional PMLU Criteria for RA4 (Water Storage): 1.Geotechnical stability confirmed by appropriately qualified hydro-geotechnical engineer. 2.Bywash/spillway structures confirmed to have adequate capacity. Additional PMLU Criteria for RA6 (Grazing): 1.Slopes are no greater than 12.5%. 2.Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 0.4 m to minimise erosion. 3.A suitability qualified geotechnical engineer certifies that batters are safe and achieves a minimum factor of safety of 2. Additional PMLU Criteria for RA5 (Native Vegetation): 1.Slopes are no greater than 25%. 2.Where required, benign Permian spoil cover is spread to a depth of 1 m and rock mulch to a depth of 1 m to minimise erosion. 3.A suitability qualified geotechnical engineer certifies that batters are safe and achieves a minimum factor of safety of 2.
RM6	Surface Preparation	1.Certification that the growth medium has physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate to sustain vegetation growth and chemical properties do not limit its suitability for vegetation growth. 2.Topsoil, or other growth medium such as benign waste rock or subsoil, is spread to a depth of 200 mm (+/- 50 mm). 3.Ameliorate spoil as required to a depth of a minimum of 200 mm to suitably stabilise the landform and promote vegetative establishment. 4.Ameliorants, where required, applied by an appropriately qualified person to achieve the PMLU at the following rates: - 5 t/ha of gypsum; - 50 kg/ha DAP with added zinc; - 100 kg/ha of urea; and - 100 kg/ha of coated (slow release) urea. Additional PMLU Criteria for RA1, RA6, RA8, RA12 and RA13 (Grazing): 1.Soil ripped on the contour.
RM7	Revegetation	1.Water management and erosion control structures, where required, are vegetated with stoloniferous grasses or other suitable ground cover. 2.Vegetated with a mix of perennial pasture species (grasses and legumes) and low-density wooded vegetation (for livestock shelter) suited to the reinstated soils, capable of sustaining grazing activities and providing stabilising groundcover. Additional PMLU Criteria for RA1, RA6, RA8, RA12 and RA13 (Grazing): 1. Direct seeding of palatable perennial pasture species seed mix at 1-4 kg/ha. Additional PMLU Criteria for RA2, RA5, RA9, RA 10 and RA11 (Native Vegetation): 1.Seeding of native species at 1-4 kg/ha for grasses, 1-2 kg/ha for legumes, 0.2-1 kg/ha for shrubs and 0.2-1 kg/ha for trees. 2.Planting of native species and/or tubestock at 350 stems per hectare, where required. Additional PMLU Criteria for RA3 (Native Vegetation [Riparian]): 1.Planting of native species and/or tubestock at 350 stems per hectare, where required. 2.Seeding with riparian and riverine vegetation at 1-4 kg/ha for grasses, 1-2 kg/ha for legumes, 0.2-1 kg/ha for shrubs and 0.2-1 kg/ha for trees.
RM8	Surface Conditions - Grazing	1.No active rill, piping, or gully erosion. 2.Certification by an AQP that drainage follows appropriate pathways. 3.Vegetation dominated by pasture grass and legume species. 4.Vegetation dominated by >70% palatable perennial pasture cover.
RM9	Safe, stable and Sustainable Condition – Grazing	1.Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. - Erosion rates comparable to reference sites as determined by Condition F15 of the EA. - Soil nutrient concentrations and nutrient cycling comparable to reference sites as determined by Condition F15 of the EA. - Annual monitoring indicates an absence of declared pest and weed species. - Evidence of natural recruitment (flowering, germination, viable seed and emergence) of palatable perennial pasture species. - Groundcover comprises >70% palatable perennial pasture cover. - Water quality in receiving waters does not exceed the limits in EA Table C5. - Run-off into receiving waters does not exceed the limits in EA Table C2. - Land suitability assessment by an AQP certifies that land has achieved a minimum post-mine land suitability Class of 4, and land is capable of supporting light intensity grazing. - Evidence that measures required in site contaminated land investigation report have been implemented. Additional PMLU Criteria for RA6 (Grazing): 1.Final surface is free-draining and includes drainage structures to channel run-off and to minimise erosion and surface water ponding.

Attachment 1 - Progressive Rehabilitation and Closure Schedule

RM10	Surface Conditions – Native Vegetation	1.No active rill, piping or gully erosion. 2.Certification by an AQP that drainage follows appropriate pathways. 3.Wooded vegetation density achieves a minimum of 350 stems per hectare. 4.Tree, shrub, and grass diversity and cover % are on a demonstrated trajectory towards being comparable to reference sites described in Condition F15 of the EA. 5.A minimum of eight target species per hectare established.
RM11	Safe, stable and Sustainable Condition – Native Vegetation	1.Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2.Erosion rates comparable to reference sites as determined by Condition F15 of the EA. 3.Soil nutrient concentrations and nutrient cycling comparable to reference sites as determined by Condition F15 of the EA. 4.Annual monitoring indicates an absence of declared pest and weed species. 5.Evidence of natural recruitment (flowering, germination, viable seed, and emergence) of native trees and shrubs. 6.Pest and weed density comparable to reference site determined by Condition F15 of the EA. 7.Water quality in receiving waters does not exceed the limits in EA Table C5. 8.Run-off into receiving waters does not exceed the limits in EA Table C2. 9.Ground cover comprises >30% living ground cover and >70% overall groundcover (includes live, dead, and non-vegetative). 10.Evidence that measures required in site contaminated land investigation report have been implemented. Additional PMLU Criteria for RA5 (Native Vegetation): 1.Final surface is free-draining and includes drainage structures to channel run-off and to minimise erosion and surface water ponding.
RM12	Surface Conditions – Native Vegetation (Riparian)	1.No active rill, piping, or gully erosion. 2.Certification by an appropriately qualified person that drainage follows appropriate pathways. 3.Vegetation dominated by native riparian species. 4.Similar geomorphology to regional ephemeral drainage lines as part of design plan in Condition F20 of the EA.
RM13	Safe, stable and Sustainable Condition – Native Vegetation (Riparian)	1.Hazard and Safety Assessment completed by an appropriately qualified person demonstrates hazards are consistent with the type and severity of hazards typical of the creek system in unmined landscape. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2.Certification by an AQP that the creek diversion functions as designed, and that the integrity of Twelve Mile Creek and adjoining watercourses will be maintained long-term. 3.Certification by an AQP that the creek diversion and associated structures will maintain equilibrium and functionality and will not require ongoing maintenance. 4.Vegetation dominated by mixed riverine vegetation suitable for sandy clay soils along watercourses. 5.Evidence of natural recruitment. 6.Ground cover comprises >30% living ground cover and >70% overall groundcover (includes live, dead, and non-vegetative). 7.Water quality in receiving waters does not exceed the limits in EA Table C5. 8.Run-off into receiving waters does not exceed the limits in EA Table C2.
RM14	Safe, stable and Sustainable Condition – Water Storage	1.Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2.Records of retained of structural integrity of permanent retention of water storage structures, and certification that it is operating in accordance with landform and mine closure design and associated criteria in Condition F20 of the EA EPML00844613. 3.Removal of any contaminated sediments identified by site contaminated land investigation. 4.Water quality in receiving waters does not exceed the limits in EA Table C5. 5.Run-off into receiving waters does not exceed the limits in EA Table C2. 6.Management inputs required to sustain aquatic habitat are comparable to selected reference sites determined by Condition F15. 7.Retained water storage water quality parameters are below the trigger values for livestock drinking water defined in ANZECC and ARMCANZ 2000.
RM15	Safe, stable and Sustainable Condition – Retained Infrastructure	1.Hazard and Safety Assessment completed by an AQP demonstrates hazards are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. 2.All built structures form part of a landholder agreement (as approved by relevant agencies). 3.Audit records demonstrate that areas subject to AS1940:2004 (The Storage and Handling of Flammable and Combustible Liquids) that are retained for use by the post-mining landholder comply with the standard. 4.Where required, diversion drains designed and built to have similar morphology and functionality to regional ephemeral drainage lines. 5.Evidence from an AQP the retained infrastructure is structurally and functionally sound before providing/selling such infrastructure to a future landholder.

- 1) Insert new rows below the table to record more Rehabilitation Area Milestones for the project
- 2) Ensure all Rehabilitation Milestones recorded in this table align with those included in the RA sheets in this form.
- 3) See the PRCP guideline before developing site-specific Rehabilitation Area Milestones

Attachment 1 - Progressive Rehabilitation and Closure Schedule

Milestone reference	Management milestone	Milestone criteria
MM1	High- and Low Wall Treatment	1.Highwall slope in competent rock is no greater than 70 degrees. 2.Highwall slope in incompetent rock is no greater than 45 degrees. 3.Low wall slope is no greater than 37 degrees. 4.Battering back, partial backfilling, regrading, and reshaping completed according to table F1 and Condition F20 of the EA. 5.Records retained of as built drawings to completely backfill void to certify that it is operating in accordance with Condition F20 of the EA. Additional Criteria for A-Pit: 1.maximum depth of 113 m; 2.maximum area of 126 ha; and 3.maximum volume of 40 Mm³. Additional Criteria for CE-North: 1.maximum depth of 40 m; 2.maximum area of 53 ha; and 3.maximum volume of 8 Mm³. Additional Criteria for DOM2N: 1.maximum depth of 100 m; 2.maximum area of 103 ha; and 3.maximum volume of 41 Mm³. Additional Criteria for DOM2S: 1.maximum depth of 59 m; 2.maximum area of 45 ha; and 3.maximum volume of 7 Mm³.
MM1 Continued	High- and Low Wall Treatment	Additional Criteria for DOM5: 1.maximum depth of 50 m; 2.maximum area of 133 ha; and 3.maximum volume of 41 Mm³. Additional Criteria for DOM6: 1.maximum depth of 54 m; 2.maximum area of 25 ha; and 3.maximum volume of 10 Mm³. Additional Criteria for YEN-Pit: 1.maximum depth of 129 m; 2.maximum area of 223 ha; and 3.maximum volume of 121 Mm³. Additional Criteria for YES-Pit: 1.maximum depth of 129 m; 2.maximum area of 174 ha; and 3.maximum volume of 87 Mm³.
MM2	Surface Conditions	1.Bund wall installed with a minimum height of 2 m, a minimum base of 4 m, and be located at least 10 m beyond the area potentially affected by instability of the pit edge or a fence. 2.Security fencing installed around entire perimeter and up to the highwall. 3.Appropriate signage placed to clearly identify and convey the purpose (e.g. EP Act 1994 Non-Use Management Area No Entry). 4.Any contaminated material either remediated in situ or removed/transported to an approved landfill for disposal, and waste tracking information recorded and submitted. 5.Validation testing confirms that contaminate materials (e.g. PCBs, dioxins, mercury, hydrocarbon contaminate soils) have been removed or remediated. 6.If required, a site investigation report including a site suitability statement prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act.
MM3	Achievement of Sufficient Improvement	1.Certification from an AQP that the residual void low walls, highwalls and end walls are safe and achieve a minimum FoS of 2.0. 2.Certification from an AQP that residual voids are internally draining. 3.Certification from an AQP that the residual void is safe to humans and livestock. 4.No exposed hazardous materials at surface determined by the results of site contaminated land investigation including exposure due to erosion. 5.Residual void acts as a groundwater sink in perpetuity. 6.Water balance modelling demonstrates that residual void water is contained with no potential for overflow events. 7.If required, evidence that measures required in site contaminated land investigation report have been implemented.

1) Insert new rows below the table to record more Improvement Area Milestones for the project

2) Ensure all Management Milestones recorded in this table align with those included in the IA sheets in this form.

3) See the PRCP guideline before developing site-specific Improvement Area Milestones

Native Vegetation PMLU - Direct Seeding		
Species (scientific)	Species (common)	Application rate
<i>Eucalyptus crebra</i>	Narrow Leaved Ironbark	0.2 kg/ha
<i>Eucalyptus melanophloia</i>	Silver Leaved Ironbark	0.2 kg/ha
<i>Corymbia tessellaris</i>	Moreton Bay Ash	0.2 kg/ha
<i>Corymbia clarksoniana</i>	Bloodwood	0.1 kg/ha
<i>Corymbia gummifera</i>	Red Bloodwood	0.1 kg/ha
<i>Acacia victoriae</i>	Bardi Bush	0.2 kg/ha
<i>Atriplex nummularia</i>	Old Man Saltbush	0.2 kg/ha
<i>Enchylaena tomentosa</i>	Ruby Saltbush	0.2 kg/ha
<i>Bothriochloa insculpta</i>	Creeping Bluegrass (cultivas Hatch or Bisset)	2.5 kg/ha
<i>Bothriochloa bladhii</i>	Forest Bluegrass (cultivas Swann)	2.5 kg/ha
<i>Digitaria eriantha</i>	Digit Grass (cultivas Premier)	2 kg/ha
<i>Bothriochloa pertusa</i>	Indian Bluegrass (cultivas Keppel or Bowen)	1 kg/ha
<i>Urochloa mosambicensis</i>	Sabi Grass (cultivas Saraji)	2 kg/ha
<i>Melinis repens</i>	Red Natal Grass	1 kg/ha
<i>Cynodon dactylon</i>	Greencouch	2 kg/ha
<i>Bothriochloa ewartiana</i>	Desert Bluegrass	1 kg/ha
<i>Dichanthium sericeum</i>	Queensland Bluegrass	1 kg/ha
<i>Heteropogon contortus</i>	Black Speargrass	0.2 kg/ha
<i>Themeda triandra</i>	Kangaroo Grass	0.2 kg/ha
<i>Cymbopogon refractus</i>	Barbed Wire Grass	0.2 kg/ha
<i>Bothriochloa decipiens</i>	Pitted Bluegrass	0.2 kg/ha
<i>Chloris gayana</i>	Rhodes Grass	1 kg/ha
<i>Wynn cassia</i>	Round Leaf Cassia	1 kg/ha
<i>Clitoria ternatea</i>	Butterfly Pea	1 kg/ha

Native Vegetation PMLU - Tubestock		
Species (scientific)	Species (common)	Application rate
<i>Eucalyptus cambageana</i>	Blackbutt	100 stems/ha
<i>Eucalyptus ochrophloia</i>	Yapunyah	101 stems/ha
<i>Acacia harpophylla</i>	Brigalow	102 stems/ha
<i>Corymbia citriodora</i>	Spotted Gum	103 stems/ha
<i>Eucalyptus argophloia</i>	Chinchilla White Gum	104 stems/ha
<i>Casuarina cristata</i>	Belah	105 stems/ha
<i>Cassia brewsteri</i>	Leichardt Bean	106 stems/ha
<i>Eucalyptus molucanna</i>	Grey Box	70 stems/ha
<i>Allocasuarina luehmannii</i>	Bulloak	70 stems/ha
<i>Eucalyptus populnea</i>	Poplar Box	30 stems/ha
<i>Eremophila mitchellii</i>	False sandalwood	45 stems/ha
<i>Owenia acidula</i>	Emu Apple	25 stems/ha
<i>Carissa ovata</i>	Currant Bush	30 stems/ha
<i>Brachychiton rupestris</i>	Narrow-Leaved Bottle Tree	30 stems/ha
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree	3 stems/ha
<i>Geijera parviflora</i>	Wilga	30 stems/ha

Grazing PMLU - Direct Seeding		
Species (scientific)	Species (common)	Application Rate (kg/ha)
<i>Medicago truncatula</i>	Barrel Medic	1 kg/ha
<i>Cynodon dactylon</i>	Bermuda couch	2 kg/ha
<i>Heteropogon contortus</i>	Black Speargrass	0.2 kg/ha
<i>Clitoria ternatea</i>	Butterfly pea	2 kg/ha
<i>Stylosanthes seabrana</i>	Caatinga stylo	1 kg/ha
<i>Bothriochloa insculpta</i>	Creeping Bluegrass	2.5 kg/ha
<i>Desmanthus virgatus</i>	Desmanthus	1 kg/ha
<i>Bothriochloa bladhii</i>	Forest Bluegrass	2.5 kg/ha
<i>Bothriochloa pertusa</i>	Indian Bluegrass	2.5 kg/ha
<i>Corymbia citriodora</i>	Lemon Scented-Gum	0.03 kg/ha
<i>Atriplex nummularia</i>	Old Man Saltbush	0.3 kg/ha
<i>Setaria incrassata</i>	Purple Pigeon Grass	2 kg/ha
<i>Dicanthium sericeum</i>	Queensland Bluegrass	3 kg/ha
<i>Chloris gayana</i>	Rhodes grass	3.5 kg/ha
<i>Chamaecrista rotundifolia</i>	Round-leafed cassia	0.5 kg/ha
<i>Enchylaena tomentosa</i>	Ruby Saltbush	0.3 kg/ha
<i>Urochloa mosambicensis</i>	Sabi Grass	3.5 kg/ha
<i>Stylosanthes scabra</i>	Shrubby stylo	1 kg/ha
<i>Digitaria milanijana</i>	Tall Finger Grass	1 kg/ha

Attachment 2

Landholder Agreement

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15 January 2020

Department of Environment and Science
Business Centre (Coal)
PO Box 3028,
EMERALD QLD 4720

Email: CRMining@des.qld.gov.au

Attention: Anthony Baker, Manager, Environmental Services and Regulation

Dear Mr Baker,

RE: YARRABEE COAL MINE - INFRASTRUCTURE TO BE RETAINED POST-MINING

I confirm that an application for a decision on the estimated rehabilitation cost (ERC) for the Yarrabee Coal Mine has been lodged with the Department, as a requirement under the provisions of the *Environmental Protection Act 1994* and Environmental Authority EPML00844613.

Yarrabee Coal Company Pty Ltd (YCC) is the holder of Environmental Authority EPML00844613. YCC is also the owner of the land on which the Yarrabee Coal Mine has been developed and to which this Environmental Authority applies.

The ERC application includes retaining the following mining related infrastructure upon closure of the Yarrabee Coal Mine:

- eight water storages;
- two access roads;
- a workshop and administration building; and
- a powerline owned by Ergon Energy.

The indicative location of this infrastructure and underlying landownership is shown on the accompanying figure.

As a Director and authorised officer of YCC, I confirm that YCC consents to this infrastructure being left behind on its land, and accepts liability and responsibility for the retention of this infrastructure post-closure.

Yours sincerely

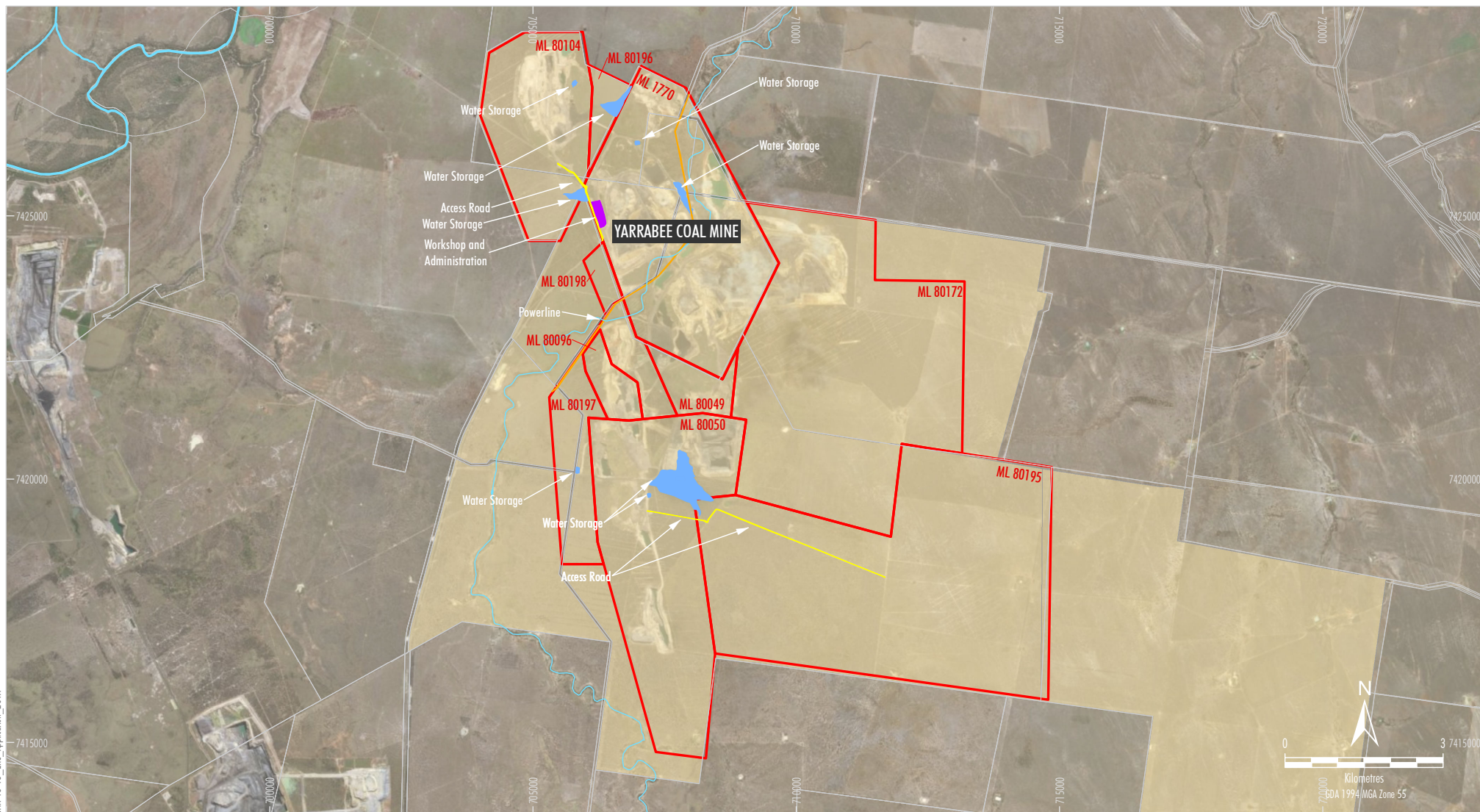


Reinhold Schmidt

Director

Yarrabee Coal Company Pty Ltd

Figure 1 – Location of Infrastructure to be Retained Post-closure



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (2017); Yancoal Australia (2013; 2018; 2019; 2020); Department of Natural Resources Mines and Energy Queensland (2017; 2019; 2020);



YARRABEE COAL MINE
Location of Infrastructure to be
Retained Post-closure

Figure 1