Poitrel Mine Progressive Rehabilitation and Closure Plan

Poitrel Mine

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Definitions

Key terms and abbreviations, and associated definitions used in this report are listed below.

Term	Definition
3P Grasses	Perennial, productive and palatable
AC	Acid Consuming
AEP	Annual Exceedance Probability
AMD	Acid and Metalliferous Drainage (AMD). Includes acid/acidic drainage (AD), pH-neutral and metalliferous drainage (NMD) and sulphide-derived saline drainage (SD) – and/or any combination of these.
ANC	Acid Neutralising Capacity
AMWU	Australian Manufacturing Workers' Union
AQP	Appropriately Qualified Person
ASC	Australian Soil Classification
bcm	Bank cubic meter. One cubic meter of material as it lies in the natural bank state.
Biodiversity Act	Biodiversity Act 2004 (Queensland)
CCP	Community Consultation Plan
CEC	Cation Exchange Capacity
CHPP	Coal Handling and Preparation Plant
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DAWE	Department of Agriculture, Water and Environment (Australia)
DEM	Digital Elevation Model
DESI	Department of Environment, Science, and Innovation (Queensland). (The Administrating Authority)
DM	Dry matter (with reference to vegetation)
DoR	Department of Resources (Queensland) (previously referred to as the Department of Natural Resources, Mines and Energy)
DSI	Detailed site investigation
DSITI	Department of Science, Information Technology and Innovation (Queensland)
EA	Environmental Authority (in terms of the Environmental Protection Act 1994, Queensland)
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EV	Environmental Value
EP Act	Environmental Protection Act 1994 (Queensland)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmentally Relevant Activities
ESP	Exchangeable Sodium Percentage
FCCM	Fort Cooper Coal Measures
FOS	Factor of Safety
FVLMP	Final Void and Landform Management Plan

Term	Definition
GAI	Geochemical Abundance Index
Ha	Hectares
Interburden	Non-carbonaceous or carbonaceous mine waste located between coal seams. In this report the term 'overburden' shall be used to define overburden and interburden.
IDC	Index of Diversion Condition
IRC	Isaac Regional Council
km	Kilometre
lcm	Loose cubic meter. One cubic meter of material which has been disturbed and has swelled as a result of movement
LDRMP	Land Disturbance and Rehabilitation Management Plan
LGA	Local Government Area
LOA	Life-of-Asset
LOD	Land outcomes document
LOM	Life-of-Mine
LSA	Land suitability assessment
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018 (Queensland
Mine Waste	Material comprising overburden, ± coarse/fine reject (dewatered), ± Waste coal. Sometimes called 'mineral waste' or 'mining waste'
ML	Mining Lease
MLES	Matter of Local Environmental Significance
MNES	Matter of National Environment Significance
MCM	Moranbah Coal Measures
MPA	Maximum Potential Acidity
MSES	Matter of State Environmental Significance
NAF	Non-Acid Forming
NAPP	Non-Acid Producing Potential
NC Act	Nature Conservation Act 1992 (Queensland)
NUMA	Non-Use Management Area
Overburden	Non-carbonaceous or carbonaceous mineral waste located above (overburden proper) or between (interburden) coal seams. Carbonaceous overburden is generated during mining of non-ore material and may be represented by sedimentary units (non-coal) rich in organic carbon. Carbonaceous overburden does not include coarse reject, seam floor, seam roof or coal partings. Overburden reports to spoils dumps
PAF	Potentially Acid forming
PMLU	Post Mining Land Use
PRC Plan	Progressive Rehabilitation and Closure Plan *"… for land the subject of an ineligible mining activity, means a progressive rehabilitation and closure plan for the land that consists of two parts –* • The rehabilitation planning part – PRC Plan, and • The approved part – PRC Plan Schedule that includes milestones and conditions"

Term	Definition
	(PRC Plan Guidelines, 2023) (in terms of the Environmental Protection Act 1994 (Queensland)
PRC Plan Guideline	Progressive Rehabilitation and Closure Plan Guideline (April 2023) (DES, Queensland)
PTM	Poitrel Mine
RA	Rehabilitation Area As defined in the PRC Plan Guideline: a rehabilitation area, for a post-mine land use, means an area of land in the post-mine land use to which e rehabilitation milestone for the post-mining use relates.
RE	Regional Ecosystems
Reject	Waste material produced during coal washing, separated from run-of-mine (ROM) coal in the coal handling and preparation plant (CHPP). Can be separated and disposed as fine rejects (tailings) and coarse reject, or co-disposed as mixed plant reject which is a mixture of coarse reject and 'dewatered' fine reject.
ROM	Run-of-Mine
RM	**Rehabilitation Milestone** As defined in the PRC Plan Guideline: a rehabilitation milestone, for the rehabilitated land, means each significant event or step necessary to rehabilitate the land to a stable condition (section 115 of the EP Act).
RRR	Residual risk rating (with reference to the risk assessment)
Qld	Queensland
SMART	Specific, measurable, achievable, reasonable/relevant, time-specific
SMC	Stanmore SMC Pty Ltd
SMU	Soil Mapping Unit
Spoil	Mine waste comprising non-ore (non-ROM) material such as overburden and waste coal. Within this report, unless stated otherwise, spoil is assessed as a whole (bulk material) with no distinction made between carbonaceous and non-carbonaceous overburden.
SQP	Suitably Qualified Person
TDS	Total Dissolved Solids
TEC	Threatened Ecological Communities
Waste Coal	Sub-economical coal that reports to the spoil dumps as waste. Waste coal can be fresh or oxidised. All oxidised and coked (cindered) coal is waste.

1. INTRODUCTION

This transitional Progressive Rehabilitation and Closure Plan (**PRC Plan**) has been prepared for Poitrel Mine (**PTM**) in accordance with the requirements of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (**MERFP Act**). This PRC Plan has been developed to meet the requirements of the *Environmental Protection Act 1994* (EP Act) and the Progressive Rehabilitation and Closure Plan Guideline (**PRC Plan Guideline**) (DES, 2023).

Environmental Authority Holder:	Stanmore SMC Pty Ltd
Environmental Authority Number:	EPML00963013 (1 March 2024)
Land Description	ML4749 and ML70116

Environmentally relevant activities (**ERAs**) at PTM are mining black coal, chemical storage, waste disposal, resource recovery and transfer facility operation and sewage treatment. They are undertaken under the conditions of the site's Environment Authority (**EA**) EPML00963013 (Appendix 1). This EA is the land outcome document (LOD) for this transitional PRC Plan.

This PRC Plan comprises two parts:

- **Section A:** Rehabilitation Planning - providing information about the site, the rehabilitation plans, and evidence and justification to support the development of the proposed PRC Plan Schedule.
- **Section B:** PRC Plan Schedule - including maps of rehabilitation and closure outcomes for the site, and tables of time-based rehabilitation milestones.

This PRC Plan also includes Appendices, providing key information and technical studies used to support development of this plan.

2. TRANSITIONAL PROVISIONS

PTM is an established open-cut coal mine located 35 kilometres east of Moranbah, Queensland. PTM operates under an existing site-specific EA, EPML00963013. The mine has operated under the EA since 2006. Stanmore SMC Pty Ltd (**Stanmore**) acquired the controlling interest in PTM in May 2022, with the EA previously held by BHP Mitsui Coal Pty Ltd.

The mine and EA meet the transitional provisions for PRC Plans (EP Act, Part 27), in the following ways:

- Stanmore is a 'mining EA holder' for the purposes of the definition in section 750 of the EP Act;
- The EA was granted in February 2006, prior to the assent of the progressive rehabilitation and closure plan amendments to the EP Act (introduced by the MERFP Act). Accordingly, the transitional provisions in Chapter 13, Part 27 of the EP Act apply; and
- A Transition Notice for a PRC Plan was sent to BHP Billiton Mitsui Coal Pty Ltd on 3 December 2020, stating that a PRC Plan must be submitted to the administering authority by 1 July 2023. The EA was transferred to Stanmore in May 2022, and the due date for the PRC Plan submission was subsequently extended to 1 July 2024.

2.1 Land Outcome Documents

In accordance with section 750 of the EP Act, the following land outcome documents are applicable to this PRC Plan:

- EA EPML00963013, as last issued on 1 March 2024.
- *Land Disturbance and Rehabilitation Management Plan* (PRM_ENV_PLN_0009 V6), dated March 2014.
- *Poitrel Mine Final Void & Landform Management Pla*n, dated 23 June 2010.
- *Assessment Report under the Environmental Protection Act 1994 on the Environmental Impact Statement for the Poitrel Coal Mine*, dated November 2005.

The land outcome documents list as per section 750 of the EP Act is hierarchical (i.e. the document appearing higher in the list takes precedent over those lower in the list). Where inconsistencies exist between LOD, the highest order of LOD is elected as the primary LOD.

2.1.1 Environmental Authority

The PTM EA is the primary LOD for the purposes of rehabilitation and residual void authorisation, with conditions relevant conditions generally presented in Schedule E, particularly Conditions E3-E12.

Condition E3 of the PTM EA states the following:

> *Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with **Table E1 (Rehabilitation Requirements)**.*

Table E1 provides the basis for the nominated PMLUs, rehabilitation milestone criteria, and rehabilitation completion criteria presented in **Section 3.3** of this PRC Plan.

2.1.2 Land Disturbance and Rehabilitation Management Plan

Condition E5 of the PTM EA requires the development of a Rehabilitation Management Plan as follows:

> *Review and update an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria by **30 June 2010** for the administering authority review and comment. The Rehabilitation Management Plan must, at a minimum:*
>
> *a) map existing areas of rehabilitation;*
>
> *b) develop design objectives for rehabilitation of disturbed areas and post mining land uses across the mine;*
>
> *c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation;*
>
> *d) detail rehabilitation methods applied to areas;*
>
> *e) contain landform design criteria including end of min design;*
>
> *f) detail how landform design will be consistent with the surrounding topography;*
>
> *g) identify success criteria for areas and itemise revegetation criteria;*
>
> *h) explain planned native vegetation rehabilitation areas and corridors;*
>
> *i) identify at least a minimum of **three (3) reference** and **three (3) rehabilitation** sites to be used to develop rehabilitation success criteria;*
>
> *j) describe the rehabilitation indicators and the monitoring program to be used;*
>
> *k) develop a contingency plan for rehabilitation maintenance or redesign;*
>
> *l) describe end of mine landform design plan and post mining land uses across the mine; and*
>
> *m) include a cost benefit analysis / triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.*

The above requirements are acquitted by the *Land Disturbance and Rehabilitation Management Plan* (March, 2014), and the document is considered an LOD under paragraph (b) of the definition in section 750 of the EP Act

2.1.3 Poitrel Mine Final Void & Landform Management Plan

Condition E7 of the PTM EA requires the development of a Residual Void Management Plan as follows:

> *Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria and landform design criteria by 30 June 2010 for administering authority review and comment. On acceptance of the criteria proposed in the Residual Void Management Plan, the criteria must be specified in the environmental authority.*

The investigation must at a minimum include the following:

a) a study of options available for minimising final void area and volume;

b) develop design criteria for rehabilitation of final voids;

c) a void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term;

d) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events;

e) a study of void capability to support native flora and fauna; and

f) a proposal/s for end of mine void rehabilitation success criteria and final void areas and volumes.

The above requirements are acquitted by the *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010), and the document is considered an LOD under paragraph (b) of the definition in Section 750 of the EP Act.

2.1.4 Assessment Report under the *Environmental Protection Act 1994*

The *Assessment Report under the Environmental Protection Act 1994 on the Environmental Impact Statement for the Poitrel Coal Mine* (November, 2005) was drafted by the administering authority, and is considered an LOD under paragraph (e) of the definition in Section 750 of the EP Act.

2.2 Feasibility of Implementing Historical Conceptual Final Landform Designs in 2024

The documents listed in **Section 2.1** were reviewed against the PTM EA (the primary LOD) during the NUMA options assessment detailed in **Section 3.4.3.**

An iterative options assessment was conducted, and based on the current, EA approved life of mine plan and modern closure studies included in this PRC Plan. The purpose of assessing alternative options was to understand the potential for minimising the NUMA extent against final landform designs that have evolved since the *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) and *Land Disturbance and Rehabilitation Management Plan* (March, 2014) LODs.

Constructing the void in accordance with dimensions listed in conceptual final landforms presented in the *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) and *Land Disturbance and Rehabilitation Management Plan* (March, 2014) is not feasible for the following reasons:

- The *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) was developed four years after the commencement of first mining. The then EA holder was operating on a geologic model with approximately 30% of the technical information the 2024 geologic model now has. This is an important consideration in mine planning and associated scheduling of waste removal, which has changed over time due to the improved understanding of the coal resource since 2010.

- The *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) did not consider closure specific hydrogeological, hydrologic, erosion and mining studies as the statutory requirements at the time did not include robust assessment mechanisms. As a result, chapters related to void locations and dimensions such as the regraded slopes and final stability of low wall and highwalls stated further research was required to support the final landform design as the feasibility of the design put forward was too conceptual.

- Attachment 4 of the *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) is *Figure 2-9 Conceptual Landform – Year 20* from the 2005 EIS identified as the original closure concept scenario. However, Year 20 was not the proposed closure year at that time or currently, rather an operational year without consideration of the final landform dimensions. It is therefore used incorrectly and a misrepresentation of the conceptual closure landforms and void locations.

- The *Land Disturbance and Rehabilitation Management Plan* (March, 2014) does not rely on updated mining studies and *Figure 2-9 Conceptual Landform – Year 20* from the 2005 EIS for the void closure size, which had incorrectly been used to define angle of repose ramps and low wall spoil slopes at that

point in time. Therefore, final landform dimensions listed in this document were inaccurate and not in accordance with the life of mine as understood at that time.

In sum, the void dimensions stated in the *Poitrel Mine Final Void & Landform Management Pla*n (June, 2010) and *Land Disturbance and Rehabilitation Management Plan* (March, 2014) LODs are based on preliminary versions of the geologic model. All dimensions proposed in these documents were caveated with limitation statements and noted the likely potential for changes. As the mine evolved, updated closure studies and final landform designs were conducted by the previous EA holder, but the EA conditions that required a point-in-time Final Void & Landform Management Plan and Rehabilitation Management Plan did not have scope for revisions.

The final landform presented this PRC Plan has been iteratively designed and informed by technical studies that demonstrate the reduction of environmental harm, ensures stability, improved mine technology, and current life of mine with the overall aim to minimise the extent of the NUMA where feasible.

3. REHABILITATION PLANNING PART

Legislative Requirement

In accordance with Section 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part of the PRC Plan must include a description of:

- each resource tenure, including the area of each tenure;
- the relevant activities to which the application relates;
- the likely duration of the relevant activities;
- how and where the relevant activities are to be carried out, including maps.

PRC Plan Guideline

The following spatial information must be submitted as part of the PRC Plan:

- the location and maximum extent of disturbance footprint for the mine life;
- the PMLUs and NUMAs for the area within the resource tenures;
- any sensitive receptors.

In addition to the list above, the PRC Plan must include spatial information outlining the rehabilitation and improvement areas that correspond to the proposed PRC Plan Schedule. The spatial information must show the locations of the rehabilitation and improvement areas for a 10-year period (minimum).

All spatial information must be prepared and submitted in accordance with the guideline 'Spatial Information Submission' (ESR/2018/4337).

3.1 Project Planning

3.1.1 Project Description

3.1.1.1 Geographic Location

PTM is an open cut coal mine located in the Northern Bowen Basin subregion of Central Queensland, approximately 20km southwest of Coppabella and approximately 25km southeast of Moranbah and is located within the Isaac Regional Council Local Government Area (Figure 1).

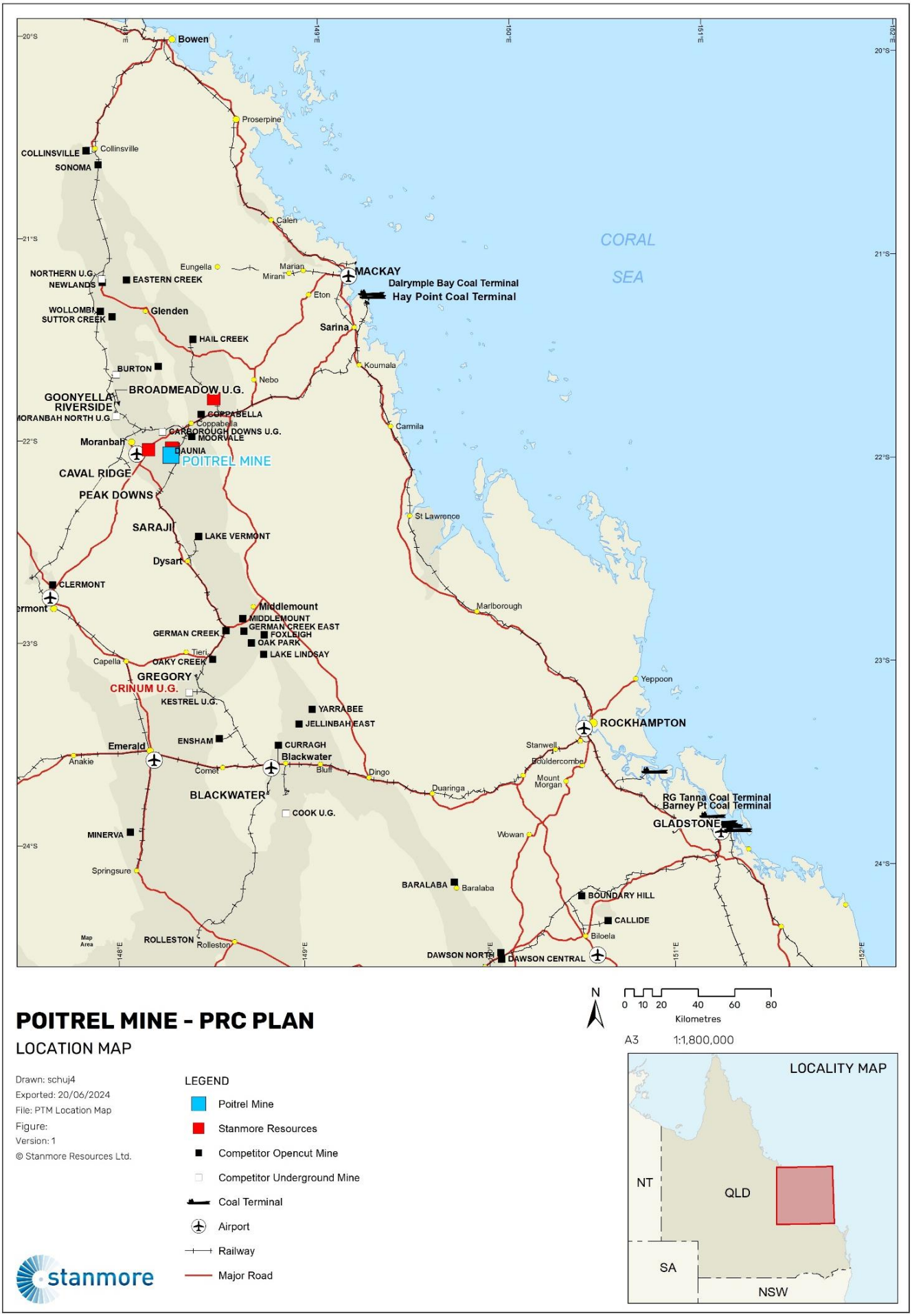


Figure 1 Location Map

3.1.1.2 Relevant Activities

The ERAs and location details approved within the EA for PTM are summarised in Table 1.

Table 1 Environmentally Relevant Activities and Location Details at PTM

Environmentally Relevant Activity	Locations
Schedule 3 13: Mining black coal.	ML4749, ML70116
Ancillary 08 - 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).	ML4749, ML70116
Ancillary 60 - Waste disposal 1(a) - Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a) - less than 50,000t.	ML4749, ML70116
Ancillary 62 - Resource recovery and transfer facility operation 1(c) - Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 2 regulated waste.	ML4749, ML70116
Ancillary 63 - Sewage Treatment 1(b-i) - Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of 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.	ML4749, ML70116

PTM operates under EA EPML00963013 for activities on ML 4749 and ML 70116.The area of the PTM MLs are provided in Table 2 and location presented in Figure 2. As shown in Figure 3, there are some infrastructure areas within ML70116 that are managed under the Daunia Mine (Whitehaven Coal formerly BMA) EA and PRC Plan.

Table 2 PTM Mining Tenements

Mining Lease No.	Name	Date Granted	Area (ha)
ML4749	Poitrel	8 July 2004	3361
ML70116	Red Mountain	13 July 1978	754

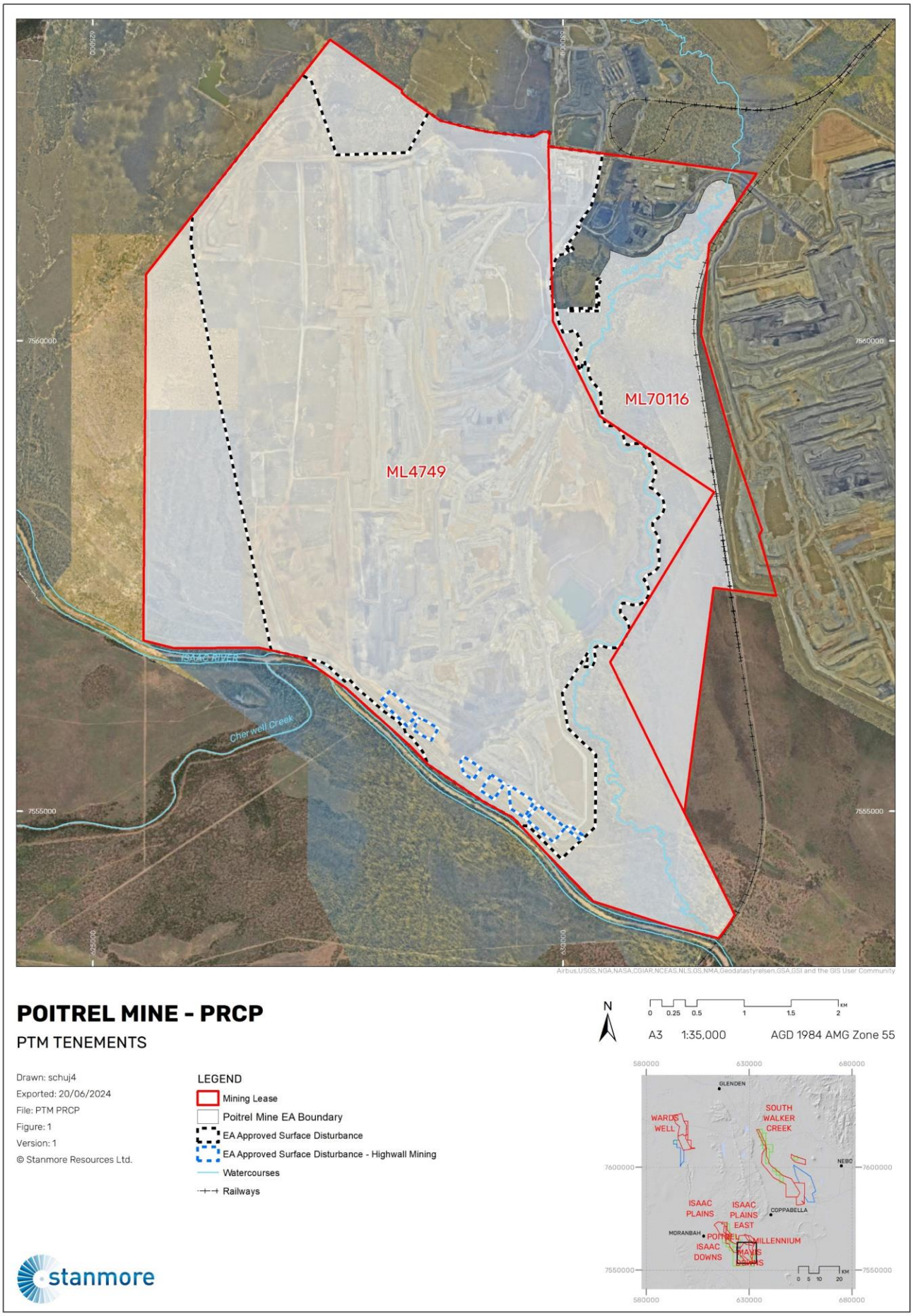


Figure 2 PTM Tenements

3.1.1.3 Primary Mine Features and Infrastructure

The main features and infrastructure approved within the EA for PTM are summarised in Table 3. The current site layout is shown in Figure 3. Of note, there are large portions of the MLs that are undisturbed (including three undisturbed exclusion areas) that do not form part of the PTM PRC Plan Schedule due to their undisturbed nature (Refer also Section 3.1.4.2 and 3.3).

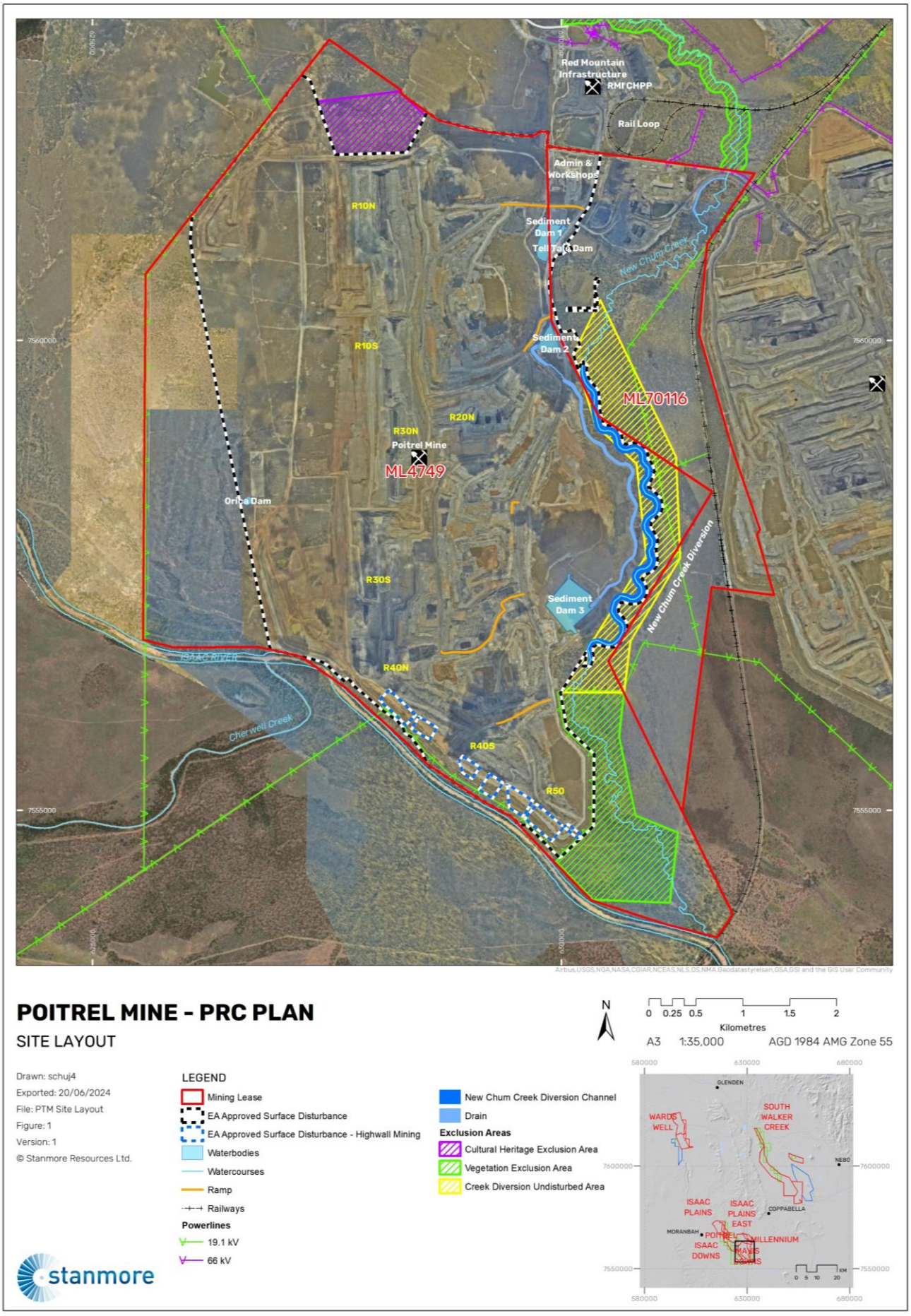


Figure 3 PTM Site Layout

Table 3 Primary Mine Features and Infrastructure at PTM

Mine Domain	Mine Feature Name
Pits and Ramps	• R10N, R10S, R20N, R30N, R30S, R40N, R40S and R50 pits with associated ramps
Stockpiles	• In-pit spoil and out-of-pit spoil dumps, including co-disposal (coarse rejects and dewatered fine rejects)
Dams	• Water storage dams
Creek Diversions	• 4.5km New Chum Creek Diversion
Flood Protection	• Levee
General Infrastructure	• Administration • Workshop • Fuel, oil, and chemical storage • Fuel and wash bays • Pipes and pumps (including Braeside pipelines) • Power lines • Switchyard and substations • Communications towers • Fences
General Disturbance	• Laydown areas • Access roads • Haul roads • Drains • Topsoil stockpiles
Undisturbed Area	• Land that has not been impacted by mining operations

3.1.1.4 Type of Mining Operation

PTM has a strike extent of 6km north to south (Figure 3). The mine comprises a series of open-cut pits, and shares process and rail loading facilities with neighbouring Millennium Mine to the immediate north of PTM. Daunia Mine is located immediately to the east of PTM. Mining commenced at PTM in 2006 and has included the extraction of coal through open cut strip mining from a series of pits that progress in a general east to west direction (Figure 3). Mining activities to date have resulted in a continuous but partially backfilled void that includes a series of mining areas, which (from north to south) are designated Ramp 10, Ramp 30 and Ramp 40.

PTM is predominantly a strip mine operating the cast, doze, excavate method (CDX), although a single pit of truck excavator terrace mining is also planned in an area of highly structured geology. Overburden stripping operations advance to the west, with overburden progressively backfilled into already mined strips.

The PTM mine plan moves approximately 50M BCM of Prime waste per annum to mine ~5.8M ROM tonnes per annum and produce ~4M Product tonnes per annum. Mine production tapers off as pits are completed with final coal mined 2033.

PTM has been mapped as three separate rock units: Permian Rocks, Tertiary Sediments and Post-Tertiary Sediments. The deposit occurs in the Late Permian Rangal Coal Measures in a drag syncline within the Burton Range fault system. The local structures, the Isaac Fault and New Chum Fault, form the western and eastern limits of the deposit respectively.

Mining occurs on mining lease ML 4749. ROM coal is transported to ML 70312 (Red Mountain Infrastructure) Coal Handling Preparation Plant (CHPP) for washing. Product coal is transported from PTM's train load out (TLO) for railing to the Dalrymple Bay Coal Terminal (DBCT) for export. Rejects (coarse and fine) from the CHPP are deposited within overburden dumps and pits respectively in accordance with authorised EA conditions.

3.1.1.5 Proposed Duration

Operations commenced at PTM in 2006. Current approved areas are planned to be mined until 2033. The current long-term mine plan outlines that mining operations have a LoA of approximately 9 years.

3.1.2 Baseline Information

PRC Plan Guideline (Section 3.1)

In addition to the legislative requirements, the following information about the site, where relevant, is considered necessary by the administering authority (as per section 126C(1)(j) of the EP Act) to decide whether to approve the PRC Plan Schedule:

- site topography (locally and regionally)
- climate (general and specific (rain, evaporation, temperatures)) including long-term projections.
- geological setting
- site hydrology and fluvial networks
- groundwater levels and properties
- soil types, properties, and productivity
- land stability (pre-existing land degradation/erosion and predisposition to ongoing stability issues)
- vegetation communities and ecological data (including existing regional ecosystem mapping)
- fauna presence and populations
- pre-mining land use
- identification of underlying landholders

Transitional PRC Plans must include any baseline information collected as part of an EIS process or original EA application. If this information is unavailable, the reasons should be explained in this section of the rehabilitation planning part. Transitional PRC Plans are not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance. However, any expansion to an existing site must demonstrate how it has been designed for closure. The rehabilitation/improvement planning must include data from when mining first commenced up until planned surrender. The transitional provisions of the EP Act include an exceptional circumstance for when land is available for rehabilitation.

3.1.2.1 Site Topography

The pre-mining topography of the study area is dominated by gently undulating grazing lands with low relief. The location of PTM straddles a low ridge line which runs roughly north south and forms the catchment divide between New Chum Creek on the east and an unnamed creek to the west. The topography surrounding PTM ranges from 283 mAHD to the north, down to 52 mAHD in the south. The surrounding land is characterised by poorly defined ephemeral drainage lines that flow only immediately after rain, draining into New Chum Creek (Landloch, 2022).

3.1.2.2 Climate

The climate of the Study Area is sub-tropical, with a distinct wet and dry season. The Queensland government operates a database of long-term climate data termed SILO (Scientific Information for Landowners) with interpolation across a statewide grid based on observation stations (Queensland Government, 2024).

Historical climate data for the period from January 1970 to January 2024 from the SILO database for the grid point closest to the PTM Area (latitude -22.05, longitude 148.25) is presented in Table 4. The SILO database provides the most comprehensive long-term dataset and is therefore the most useful for assessing long term rainfall and evaporation trends in the vicinity of the PTM Area.

Long-term average monthly rainfall, Moreton's areal actual evapotranspiration and Class A Pan evaporation from SILO is presented in Table 4. The PTM locality is characterised by a long-term average rainfall of approximately 591mm per year, with wetter conditions during the summer months of December, January and February and relatively dry conditions during the remainder of the year. As shown in Figure 4, average monthly evaporation and evapotranspiration exceed rainfall in all months. The highest rate of evapotranspiration occurs along creek lines, where the water table is closer to ground surface and deeper-rooted vegetation is present.

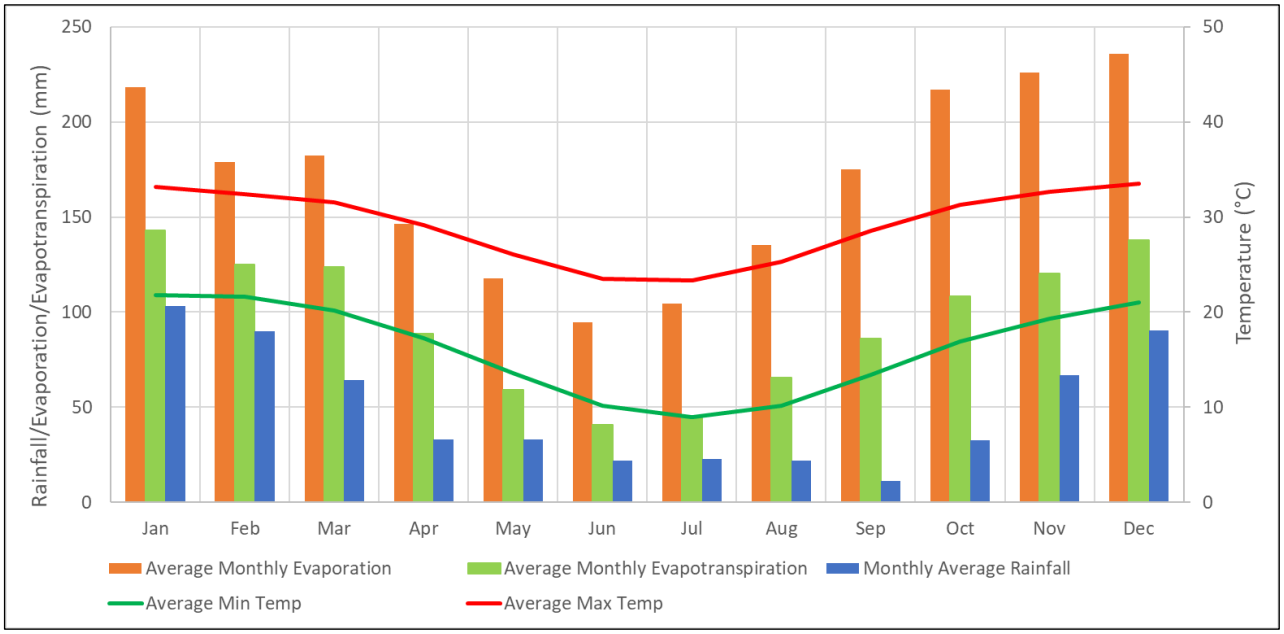


Figure 4 Average Monthly Evaporation, Evapotranspiration, Rainfall and Temperature (January 1970 to January 2024) – SILO.

To place rainfall over the years into an historical context, cumulative rainfall departure (CRD) was calculated for the full data period (Figure 5). This is a summation of the monthly departures of rainfall from the long-term average monthly rainfall. A rising slope in the CRD plot indicates periods of rainfall above the long-term average, as is the case from March 2022 to January 2023, whereas a falling slope indicates periods when rainfall is below the long-term average (e.g. May 2017 to May 2021). Rainfall volumes over the more recent period of the record (i.e., January 2023 to January 2024) have been lower than average, as is indicated by the falling slope in the CRD (Figure 5).

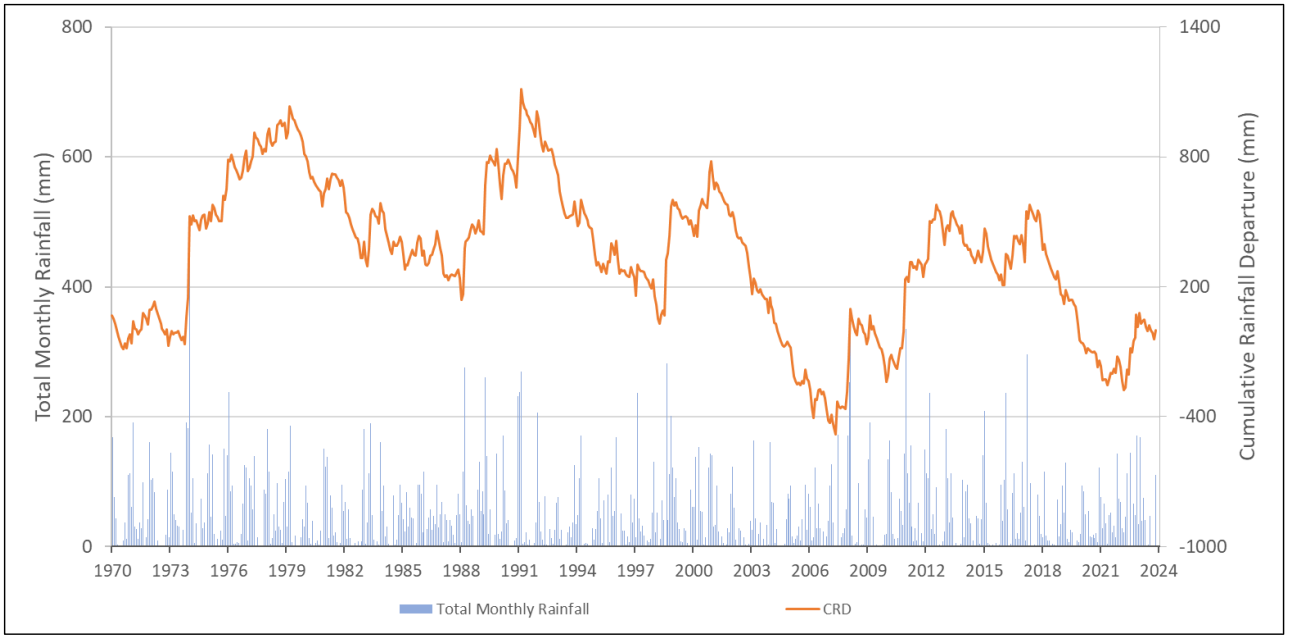


Figure 5 Cumulative Rainfall Departure and Total Monthly Rainfall – SILO

Table 4 Total Monthly Rainfall, Evaporation and Evapotranspiration (January 1970 to January 2024) - SILO

Month	Rainfall	Evaporation (Class A Pan) (mm)	Evapotranspiration (Moreton's Areal Actual) (mm)
January	103	219	143
February	90	179	125

Month	Rainfall	Evaporation (Class A Pan) (mm)	Evapotranspiration (Moreton's Areal Actual) (mm)
March	64	183	124
April	33	146	89
May	33	118	59
June	22	95	41
July	23	105	45
August	22	135	66
September	11	175	86
October	32	217	108
November	67	226	120
December	91	236	138
Total	**591**	**2032**	**1143**

3.1.2.2.1 Wind

Wind records for Moranbah for January-April show an easterly predominance of moderate strength (1-20km/h), with easterlies continuing to dominate for remainder of the year but with some south-easterly influence during May-July and north to north-easterly influences from October to December.

3.1.2.2.2 Climate Variability and Long-Term Projections

The 2020 State of the Climate Report by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) underscores the high variability of Australian rainfall, posing challenges in identifying consistent trends. Since 1900, the average annual rainfall in Northern Australia has risen, primarily attributed to heightened precipitation from October to April each year.

The report affirms that Australia's weather and climate are responding to a warming global climate system, with a temperature increase of approximately 1.44°C (+/-0.24 C) since 1910. The majority of this warming occurred post-1950, and each successive decade since then has been warmer than its predecessor. Warming is evident across Australia in all months, affecting both daytime and nighttime temperatures and contributing to a rise in extreme heat events. The warmest year on record was 2019, and from 2013 to 2019, seven out of nine years rank among the warmest.

This warming trend occurs amidst year-to-year climate variability, notably associated with El Niño and La Niña in the tropical Pacific Ocean. Rainfall and streamflow have increased in parts of northern Australia since the 1970s, with heavy rainfall events expected to intensify as the climate warms.

Australia's shift to a warmer climate is accompanied by an increase in extreme heat events on daily, multi-day, and seasonal scales. Models predict more intense short-duration heavy rainfall events nationwide, a decrease in tropical cyclones, but a higher proportion of high-intensity cyclones, subject to significant year-to-year variations.

Since the 1950s, there has been an increase in extreme fire weather and the duration of the fire season across large parts of Australia. Specifically, the Bowen Basin region has experienced a notable rise in dangerous fire weather days.

According to the CSIRO (2024), the impacts from climate change up to 2050 for the site location include an increase of maximum temperature by approximately 1.8℃, approximate 0.1mm/day decrease in precipitation, an approximate 0.88mm/day increase in pan evaporation, and approximate 1.2% decrease in relative humidity (CSIRO, 2024).

3.1.2.3 Geological Setting

PTM is located in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000km^2. The Bowen Basin is a north-northwest to south-southeast oriented basin and contains the

largest coal reserves in Australia. The southern half of the Bowen Basin is covered by the Surat Basin, and the Galilee Basin exists to the west (Geoscience Australia, 2017).

Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which is comprised of generally fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Moranbah Coal Measures, Fort Cooper Coal Measures and Rangal Coal Measures. The Permian strata occur at outcrop on the eastern and western edges of the Basin and are generally unconformably overlain by the Triassic aged terrestrial sedimentary rocks of the Rewan Group. The economic coal seams that are targeted by PTM are contained in the Late Permian Rangal Coal Measures.

The Permian and Triassic units are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (i.e., Isaac River and its main tributaries). Volcanic intrusions and extrusions (i.e., basalt) are also present within the region. The generalised regional stratigraphy is summarised in Table 5 (SLR, 2024) and shown in Figure 6 (GHD, 2019).

Table 5 PTM Stratigraphy

Period		Stratigraphic Unit		Description	Distribution
Cainozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand, and gravel.	Surficial cover localised in the vicinity of the PTM Area along Isaac River and its unnamed tributaries, and Cherwell Creek.
		Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qr, Qr\b and TQa)		Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts and muds derived from weathered basalts.	Surficial cover throughout much of PTM and surrounding areas.
		Duaringa Formation (Tu)		Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite and basalt.	Isolated outcrop to the far south-east of the Study Area.
Triassic		**Mimosa Group**	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	Isolated outcrop to the far south-east of the Study Area.
			Rewan Group (Rr) (Rewan Formation and Sagittarius Sandstone)	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.	Outcrops or subcrops within the PTM Area.
Permian	**Late**	**Blackwater Group**	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone and mudstone.	Within the PTM Area; shallowest Permian unit at PTM.

Period		Stratigraphic Unit		Description	Distribution
			Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff.	Within the PTM Area; underlies Rangal Coal Measures at PTM.
			Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone, and coal.	Within PTM Area; underlies Fort Cooper Coal Measures at PTM.
	Early to Middle	**Back Creek Group (Pb)**		Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies PTM; Outcrops west of the Study Area.

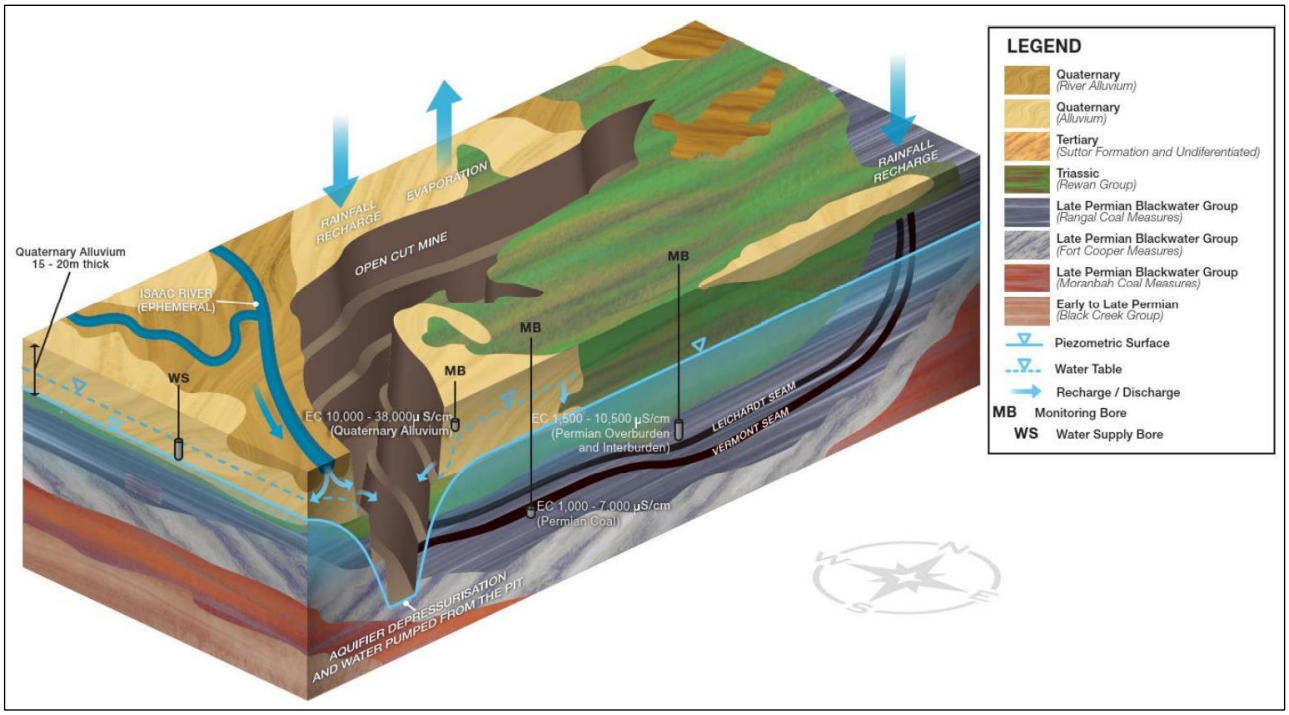


Figure 6 Baseline Hydrogeological Conceptual Model (GHD, 2019)

3.1.2.4 Site Hydrology and Fluvial Networks

PTM is located within the headwaters of the Isaac sub-catchment within the greater Fitzroy Basin with the Isaac River flowing from the north-west to south-east. The total catchment of the Isaac River is 2,711km^2, with headwaters in the Denham Range approximately 100km north of PTM, joining with the Connor's River 120km south the ML 4749, eventually converging with the Mackenzie River before joining the Fitzroy (Table 6). Several minor tributaries join the Isaac River in the vicinity of PTM, including Cherwell Creek near the southwestern boundary of the PTM, and New Chum Creek which has been diverted for mining operations to progress (Table 7). New Chum Creek runs along the eastern portion of the PTM site, and the New Chum creek diversion will remain in place post mining (Refer to Section 3.6.1).

Several smaller ephemeral streams also traverse the PTM site from west to east. The confluence of the Isaac River and New Chum Creek is approximately 6km upgradient of where the Cherwell Creek flows into the Isaac River. The Isaac River, New Chum Creek and Cherwell Creek are reported to be ephemeral waterways which drain to the Fitzroy River. Burton Gorge Dam, the only significant water retaining structure of the Isaac River is located approximately 47km north of PTM site.

The total length of the Isaac River channel is approximately 450km. The flood channel is characterised by extensive deposits of course sand indicating a sediment excess, and sand point bars deposit on the inside of channel meanders, occasionally with well- developed riparian vegetation. Broad, vegetated lower terraces fringe the river in some areas, although on outer meander bends and straighter sections of the river, the upper terrace plunges relatively steeply to the riverbank. Riverbanks are generally well vegetated with eucalypts and have eroded to near vertical for depths of 1m to 2m along much of channel length. The river has seasonal surface flows during the wetter months from November to April though reduces to subsurface flows in the channel sands from May to October (WRM 2020). On average, when the Isaac River flows, 161,863ML/year of surface water is discharged downstream.

The surface water environmental values (EVs) and water quality objectives (WQO) for the region are specified under the *Queensland Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity (EPPWWB)) and within the Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (Part) including all waters of the Isaac River Sub-basin (including Connors River) (DEHP, 2011) Figure 7. The site is located within the Central Tributaries zone. Relevant EVs for receiving waters are displayed in Table 8.

Surface water sampling at PTM is undertaken in accordance with EA conditions, including a Receiving Environment Monitoring Program (REMP) and water release sampling. Water sampling locations nominated in the EA are provided in Table 9.

Table 6 PTM Catchment Areas

Sub-Catchment Level 1	Sub-Catchment Level 2
Isaac River –from Denham Range to Connors River – 2711km^2	New Chum Creek
	Cherwell Creek

Table 7 Waterways Within and Immediately Surrounding the PTM Site

Watercourse	Perennially	Hierarchy	Stream Order
Isaac River	Non Perennial	Minor	6
Cherwell Creek	Non Perennial	Minor	5
New Chum Creek	Non Perennial	Minor	3

Table 8 Environmental Values of Receiving Waters (EPP Water and Wetland Biodiversity, 2019)

Environmental Value	Applicable to PTM
Protection of aquatic ecosystems	✓
Suitability for crop irrigation	✓
Suitability for farm supply / use	✓
Suitability for stock water	✓
Suitability for aquaculture	✗
Suitability for human consumers of aquatic foods	✓
Suitability for primary recreation	✓
Suitability for secondary recreation	✓
Suitability for visual recreation	✓
Suitability for drinking water	✓
Suitability for industrial use	✓
Protection of cultural and spiritual values	✓

Table 9 Surface Water Monitoring Locations

Monitoring Point	Receiving Waters Location Description	Easting (GDA94)	Northing GDA94
Upstream Background Monitoring Points			
MP4[1]	New Chum Creek – Upstream of the diversion	630824	7560800
MP5	Isaac River – 4760m upstream of the confluence of New Chum Creek and Isaac River	627831	7556405
Downstream Background Monitoring Points			
MP2[1]	New Chum Creek – downstream of the diversion	631136	7554887
MP3	Isaac River – 3000m downstream of the confluence of New Chum Creek and Isaac River	633694	7552809

[1] Requires only in situ samples taken using electronic sampling equipment. Data obtained from MP4 and MP2 are for information purposes only and is not subject to condition F22 of the EA.

Water quality data for New Chum Creek and the Isaac River has been compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) as part of the PTM EIS (2005). These comparisons addressed the protection of upland river aquatic ecosystems in tropical Australia, using 90% protection trigger levels for metal toxicants due to the degraded nature of the catchment. Additionally, the comparisons covered water quality for irrigation, general use, and livestock drinking water quality values.

- Both the Isaac River and New Chum Creek exhibit degraded conditions for aquatic ecosystems. The pH, electrical conductivity, and turbidity can exceed guideline levels at times. Phosphorus levels regularly surpass guideline values, and metals such as copper and iron frequently exceed the values recommended for the protection of aquatic ecosystems.

- The water in the Isaac River and New Chum Creek is generally suitable for irrigation and stock use. The pH levels are generally alkaline, reaching up to 8.60. Electrical conductivity and total dissolved solids (TDS) can exceed guideline values, likely in pools that form after flow events. Total suspended solids (TSS) and turbidity are often high, reflecting the agricultural influence in the catchments. Metal concentrations in these water systems are generally low, with occasional elevated iron levels during major flow events.

Surface water quality monitoring is also conducted by the Department of Regional Development, Manufacturing and Water (DRDMW) at several locations along the Isaac River. Although continuous monitoring sites are not present on New Chum Creek, a single-event monitoring was conducted for the EIS. Key monitoring sites include the Goonyella site, located 35km upstream of the confluence of the Isaac River and New Chum Creek, and the Deverill site, situated 21km downstream of the confluence.

The condition of New Chum Creek at the time of the EIS was variable, with areas ranging from highly disturbed to sections with good riparian vegetation. The vegetation primarily consists of Eucalypt open woodland and Brigalow communities, though it has been disturbed by grazing. Some sections of the creek had experienced moderate erosion due to farming practices.

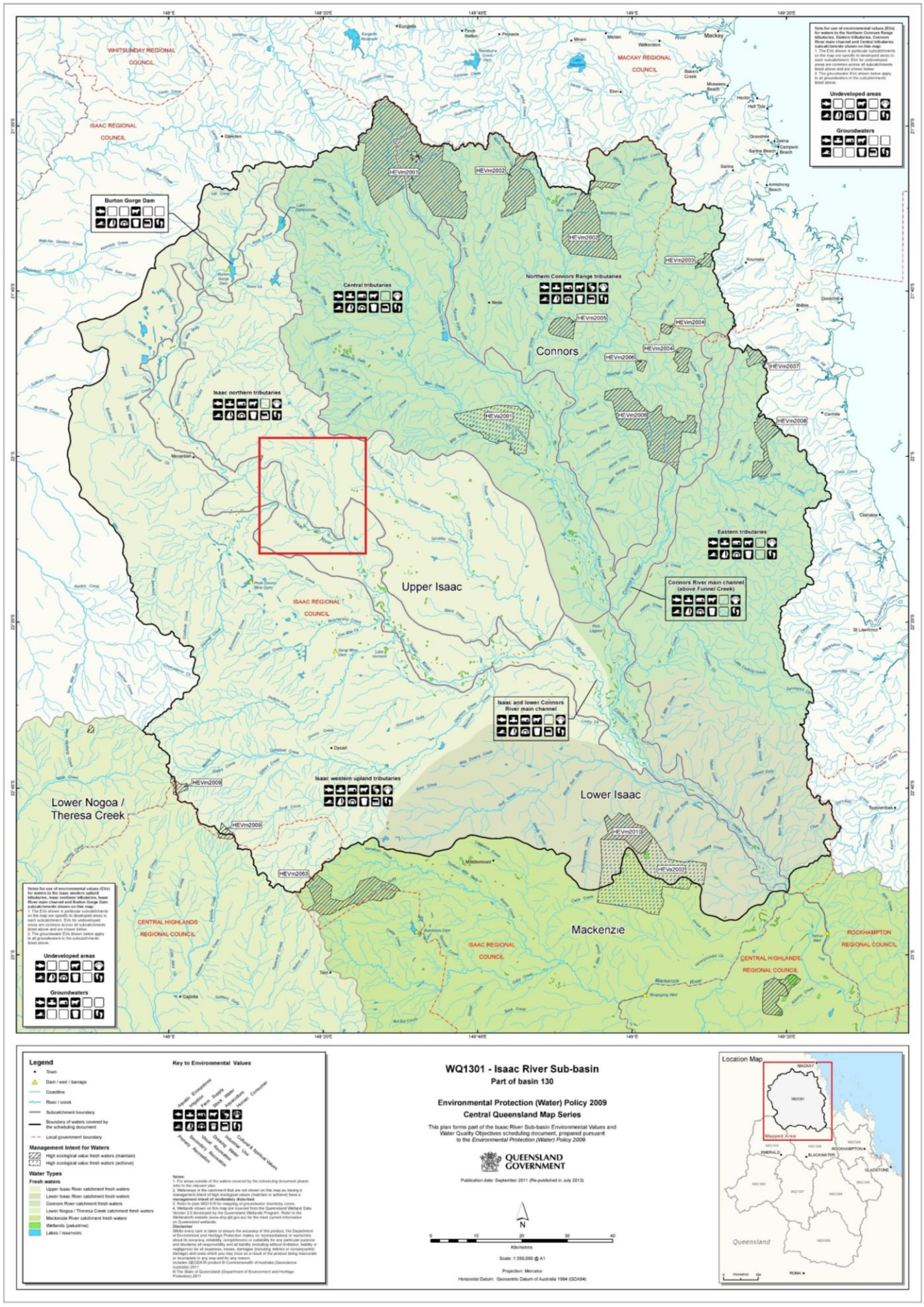


Figure 7 Regional Catchments and Waterways Surrounding the Site Area (refer red polygon)

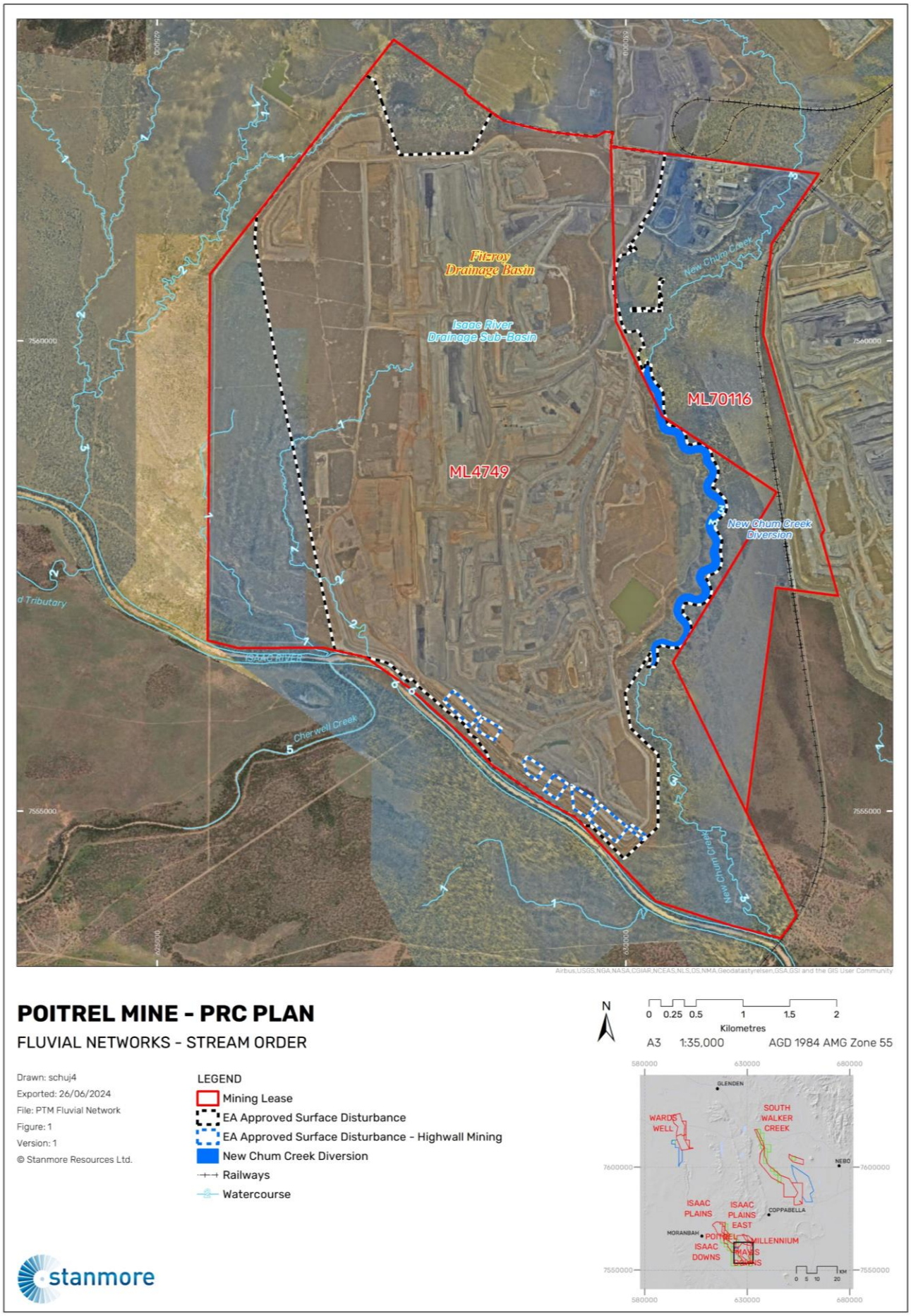


Figure 8 Fluvial Networks, Creek Diversion and Local Hydrology

3.1.2.5 Groundwater Properties, Levels and Values

3.1.2.5.1 Hydrogeological Units

The hydrogeological units relevant to PTM comprise of the following (Figure 6):

- Quaternary alluvium – unconfined aquifer where sparsely saturated (water-bearing strata of permeable rock, sand, or gravel) localised along the Isaac River and effectively in direct hydraulic connection with the underlying Regolith unit.
- Quaternary to Tertiary alluvium, colluvium and weathered units (collectively termed Regolith) – unconfined and largely unsaturated unit bordering alluvium and effectively in direct hydraulic connection with the alluvium.
- Triassic Rewan Group – Considered a regional scale aquitard, however, some saturated more hydraulically conductive horizons exist, particularly within the upper weathered zone.
- Permian Coal Measures - Coal seams of this unit form the primary regional aquifer. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden (SLR, 2024).

3.1.2.5.2 Groundwater Levels

Limited historic groundwater levels and monitoring data exists for Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium) at PTM due to sporadic saturation occurrences. Five current and historic monitoring bores are installed in these sediments, with records predating 2024. Four are in the unconsolidated alluvial sediments of the Isaac River (OBS5, OBS7, OBS8, and SP_Levee_3), and one (OBS 11) is in New Chum Creek sediments. Historic water level data from these bores is shown in Figure 9. Three additional bores along PTM's southern boundary were installed in February 2024 (SLR, 2024).

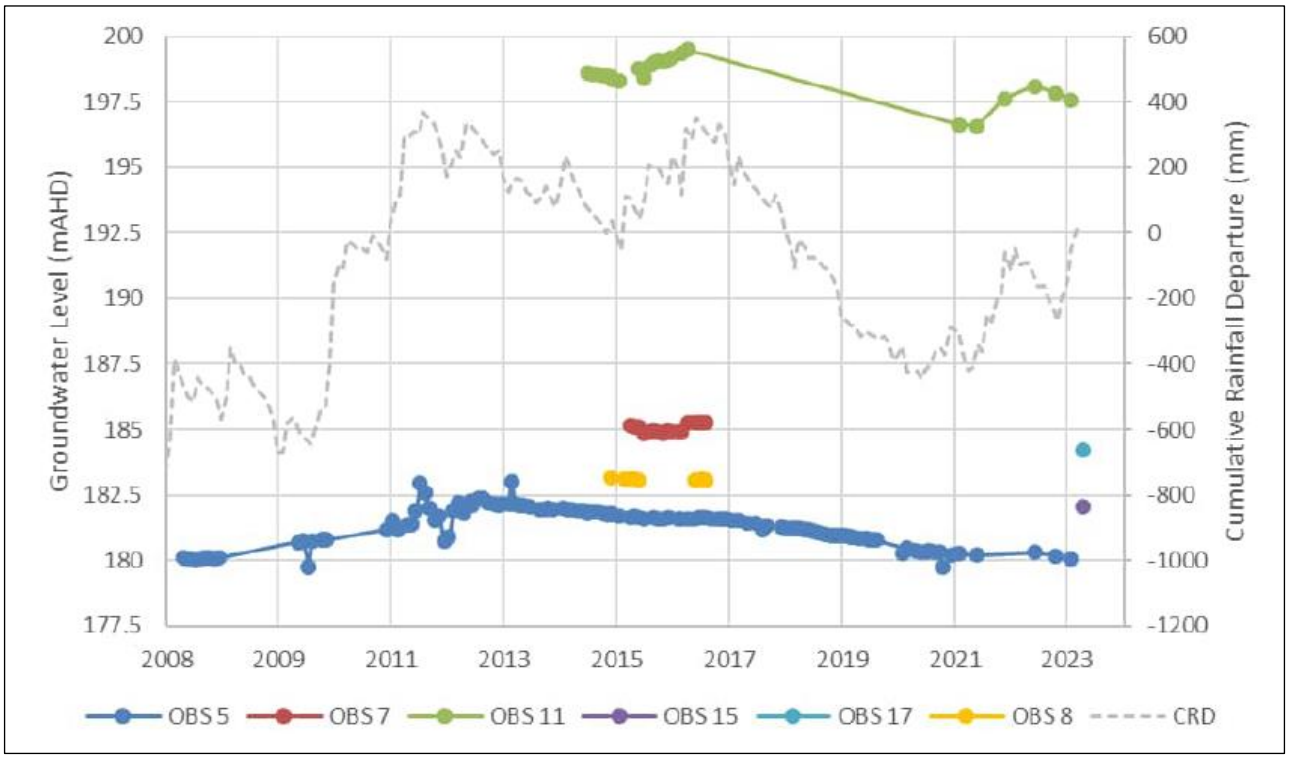


Figure 9 PTM Monitoring Bore Hydrograph – Cainozoic Sediment Aquifer

Figure 9 depicts OBS5's increasing trend before 2013, followed by a marginal long-term decline since 2014, paralleling general rainfall trends. Mining influence likely contributes to OBS5's post-2014 groundwater level drop of around 2m over 10 years. OBS7 and OBS8 exhibit stable water levels with slight increases, aligning with rainfall trends until monitoring ceased in 2017 due to drying. OBS11's monitoring data also reflects a response to rainfall patterns.

During the 2016-2017 period, groundwater levels from multiple bores indicate consistent flow direction in Cainozoic sediments, mirroring the Isaac River's direction (OBS7: 185 mAHD, OBS8: 183 mAHD). OBS11 (198-199 mAHD) suggests a north-south flow towards OBS8, aligning with New Chum Creek's surface flow.

Recently installed EA monitoring bores (installed between 17/02/24 and 03/03/24) along PTM's southern boundary show levels ranging from 184.2 mAHD (OBS17) to 182.1 mAHD (OBS15), with OBS19 reported as 'dry'. Given the amount of data currently available, bore stabilization and reliability of these water levels will be determined after the appropriate amount of data has been collected.

3.1.2.5.3 Groundwater Environmental Values

According to the Fitzroy Basin Groundwater Chemistry Zones (Basin 130; Environmental Protection (Water) Policy 2009), PTM is located within the Issac Groundwater Zone and is mapped as 'saline', with an ionic balance dominated by sodium (Na+) and chloride (Cl-) ions. The following EVs for Issac Groundwater are identified under EPP Water and Wetland Biodiversity (2019) and within the Isaac River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011). These are outlined in Table 10 and displayed in Figure 10.

Table 10 Summary of Groundwater Environmental Values for Issac Groundwater Zone (DEHP, 2011)

Environmental Values	Applicable to PTM
Aquatic ecosystem	✓
Irrigation	✓
Farm Supply/Use	✓
Stock Water	✓
Aquaculture	×
Human Consumer	×
Primary Recreation	✓
Secondary Recreation	×
Visual Recreation	×
Drinking Water	✓
Industrial Use	×
Cultural and Spiritual Values	✓

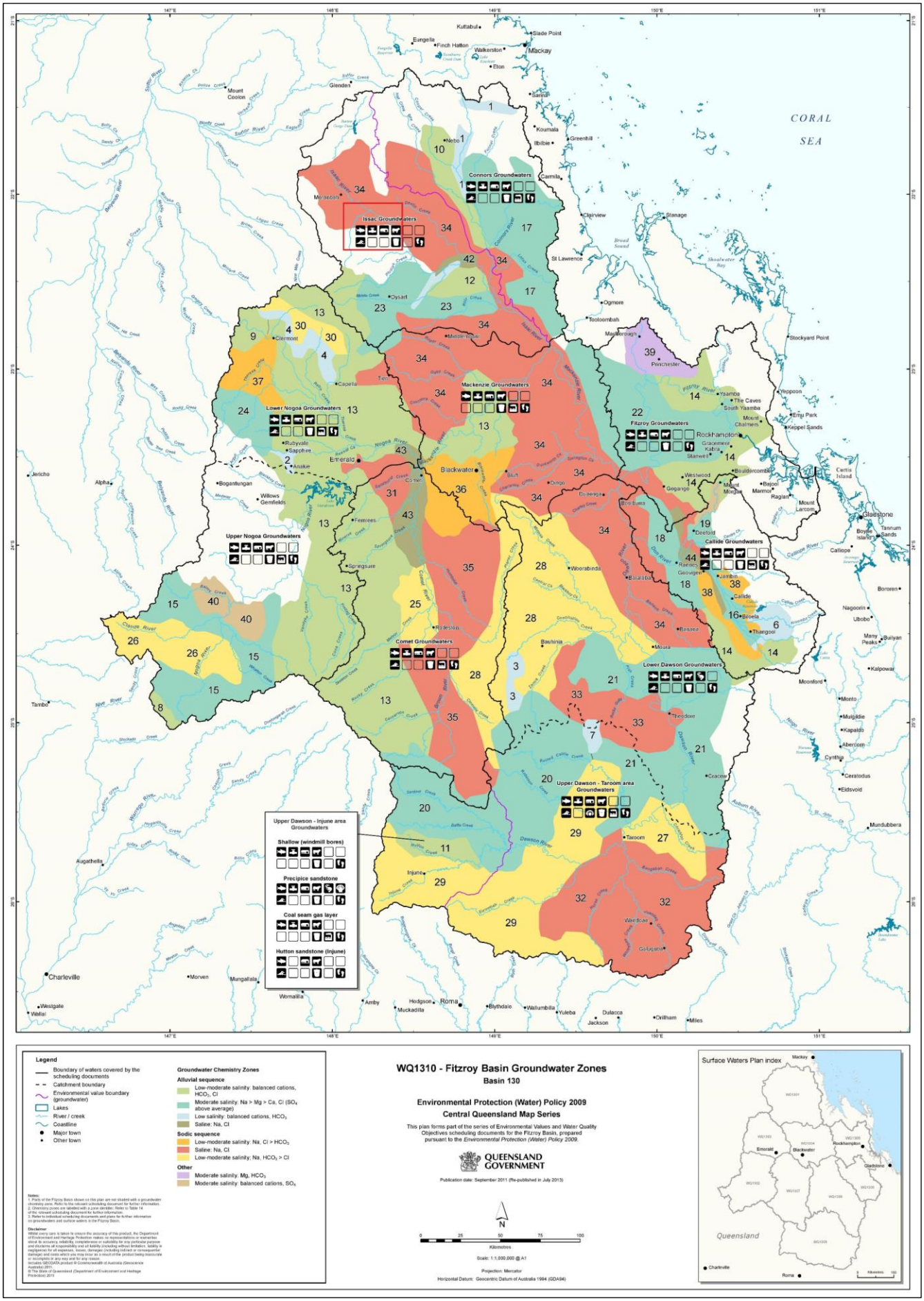


Figure 10 Groundwater Zones Surrounding the PTM Site (see red polygon)

Desktop mapping of potential aquatic and terrestrial Groundwater Dependent Ecosystems (GDEs) near PTM indicates varying levels of groundwater interaction along Isaac River, Cherwell Creek, and New Chum Creek. No known GDEs or springs are mapped within 10km of PTM. A portion of the high potential aquatic GDE along Isaac River is identified as a High Ecological Significance (HES) wetland, as per the Map of Queensland wetland environmental values. Wetland protection areas (WPA) buffer HES wetlands to limit nearby development, with a trigger area extending onto the PTM site but outside its mining footprint. Further details on GDE ground-truthing at PTM are discussed in Section 3.6.1.1.

3.1.2.6 Soil Types, Properties and Productivity

3.1.2.6.1 Soil Context

Pre-mining soil and land suitability assessment of the region, that includes the study area, was completed by CSIRO (Story, Galloway, Gunn, & Fitzpatrick, 1967) and agricultural management units were described by Bourne and Tuck (1993). Both surveys produced land and soils information at a scale of 1:500 000. A more detailed soil survey was conducted as part of the EIS (BHP Billiton, 2005), which included approximately 203 survey sites at a scale of 1:25 000 across the Study Area. Across all surveys, a total of 13 soil mapping units (SMU) were identified, including 3 variants (Landloch, 2022).

A summary of all SMUs, including the Australian Soils Classification (ASC) and Agricultural Management Units (AMU) are detailed in Table 11 and Figure 11. Chemical properties and productivity potential of soil types identified within the PTM locality are detailed in Table 12 (PTM EIS, 2005).

Table 11 Summary details of the SMUs developed in the previous soil assessments for the mine site (BHP Billiton, 2005)

SMU Code	SMU Concept	Description	ASC	AMU (Bourne and Tuck, 1993)	Area on MLs at Time of Study (ha)
A1	Alluvial – Deep Isaac Sands	Alluvial soils adjacent to the Isaac River which are either uniform deep coarse sands or duplex with coarse loamy sands extending past 50cm. River red gum and Moreton Bay Ash.	Arenic Rudosol	Isaac	98.6
A2	Alluvial -Sandy Hard Duplex	Hard setting sandy loam duplex soils alongside New Chum Creek often with bleached A2 over hard, coarse structured medium yellow clay often heavily mottled. Poplar Box mixed woodlands with associated Brigalow and Blackbutt.	Brown Sodosol	Lascelles	600.8
A3	Alluvial – Uniform Brigalow Clay	Deep, generally alkaline with carbonate nodules, possibly bleached A2 Horizon, uniform medium sandy clay which is non-cracking. Brigalow, Blackbutt, and Bauhinia.	Brown Dermosol	Rolleston	150.0
B1	Red / Brown Deeper Uniform Clay Undulating Mixed Brigalow Plains	Undulating plains up to 3% slope of mostly cleared Brigalow, Blackbutt, and Bauhinia. A firm to hard setting sandy surface, often gravely, overlies stiff medium sandy clays which are neutral and red to brown coloured. Weathered parent material or gravels generally predominate by 80cm depth.	Red Dermosol	Glengallan	1520.7
B2	Gravely Clay on Ridgelines	Relic ridgelines and scree slopes associated with residual mesas. Uniform non-cracking clay and thin duplex with hard setting sandy clay surface with strong gravel layer starting from 10-15cm depth underlying light clay is pale to red coloured. Mostly cleared of original Brigalow, Blackbutt with minor Poplar Box.	Petroferric Red Chromosol	Glengallan / Highlands	202.0
B3	Brigalow Lowlands With Grey / Brown Clays and Areas of Gilgai	Generally non-cracking uniform grey/brown clay but includes areas of normal gilgai (up to 40cm deep) which may crack. Also includes isolated areas of B4 (melanholes) in lower slope positions.	Brown Dermosol	Rolleston	251.3
B3v	Melon Holed Brigalow Clay Lowlands	Approx. 50% or more of land surface is Melan holed, (40-100 cm deep) with deep grey cracking clay.	Brown Dermosol	Lonesome	-
B4	Friable Brigalow Scrub Soil	Deep well-structured black cracking clay with granular surface mulch.	Black Vertosol	Picardy	141.5

SMU Code	SMU Concept	Description	ASC	AMU (Bourne and Tuck, 1993)	Area on MLs at Time of Study (ha)
B4v	Variant to B4	Fine granular non-cracking red / brown Brigalow scrub soil.	Brown Dermosol	-	35.2
B5	Linear Gilgai Complex of Black Cracking Clay and Red/Brown Non-Cracking Clay. (Brigalow)	Dark cracking clay in association with red noncracking clay in linear gilgai complex.	Crusty Black Vertosol	Rolleston	348.0
E1	Sandy Duplex Plains with Poplar Box	Undulating plains of Poplar Box and blackbutt with very uniform duplex soils with 30-40cm sandy clay loam over hard yellow / brown clays, often with a bleached A2.	Brown Sodosol	Lascelles	535.9
E2	Residuals (Mesas)	Mixture of outcropping rock, skeletal and shallow, gravely duplex soils with a range of vegetation. Includes mesa tops and rugged margins.	Sodosol	Highlands	25.0
E3	Thin Duplex – Poplar Box and Brigalow	Duplex soils with thin sandy loam A Horizon.	Brown Chromosol	Lascelles	210.4

All the soils, apart from the residual mesas have been used for beef cattle grazing for many years. Only the better Brigalow clays are known to have cropping potential in the district.

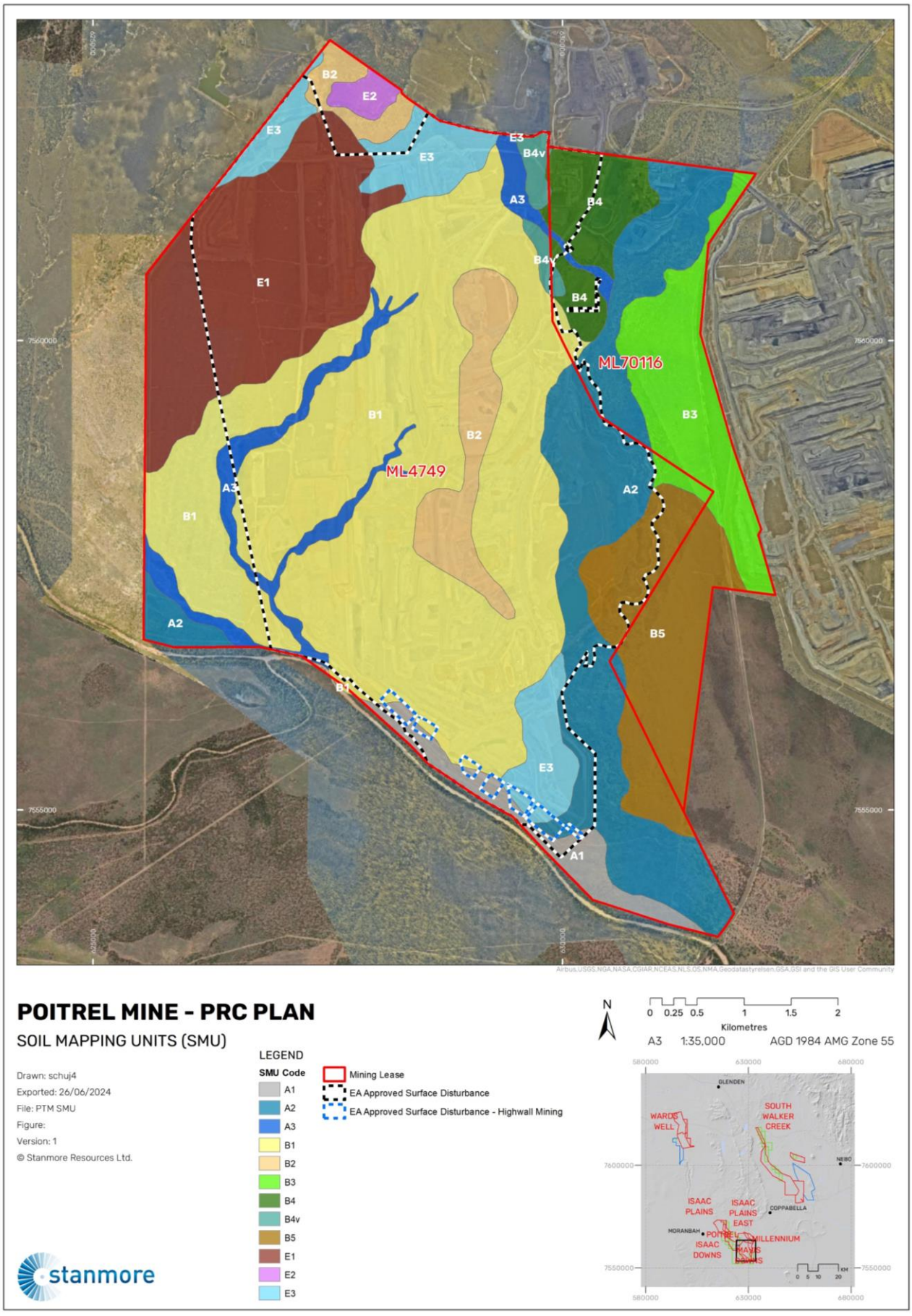


Figure 11 Soil Mapping Units

Table 12 Chemical Properties and Productivity Potential of Soil Types Identified Within the PTM Locality (PTM EIS, 2005)

	SMU Codes											
Analysis (Unit)	**A1**	**A2**	**A3**	**B1**	**B2**	**B3**	**B3v**	**B4**	**B5**	**E1**	**E2**	**E3**
Soil pH (H20)	6.6	6.4	6.2	6.9	6.5	7.6	8.4	7.5	7.9	6.9	not recorded	7.2
Soil EC (dS/m)	0.03	0.02	0.16	0.09	0.42	0.12	0.54	0.11	0.15	0.09	not recorded	0.09
R1 Dispersion	0.84	0.72	0.46	R1 not recorded (ESP 2.8)	0.52	0.33	0.45	0.29	0.39	0.77	not recorded	0.28
Preferred Use / Productivity	Grazing native pastures. Deep sandy A horizon improves short term water availability	Grazing native pastures. Hard coarse clay B horizon restricts moisture availability and root exploitation	Grazing improved pastures. The local microrelief (i.e., braided creek channels) increases k and p restrictions	Grazing of improved pastures. Susceptible to erosion degradation	Grazing of improved pastures. Highly susceptible to erosion degradation	Grazing of improved pastures. Productive grazing lands with possibility of opportunist forage in good years.	Waterlogging in saline depressions severely restricts pasture.	Excellent grazing land. Could be used for opportunist forage or cropping.	Variable soils create management difficulties if cropped. Very good grazing land.	Broadscale grazing if well managed.	Very marginal grazing lands.	Marginal grazing land.

Note: Samples above were taken 0-10cm depths

Red/brown clays are the main soil type at the PTM, typically dark brown to reddish brown with clay loam to medium clay textures. Gravel content is usually below 10%, occasionally reaching 20%. These clays are non-sodic and generally stable, comparable to the most stable clay topsoils in the area for rehabilitation. Red/grey loams are a smaller portion, less than 15% of samples, with sandy loam to sandy clay loam textures and 10–20% gravel content. They are non-sodic but prone to slaking and dispersion. See Table 13 for a summary of their key properties (Refer also to Appendix 7).

Table 13 Summary of Key Chemical and Physical Properties for Stockpiled Soils

Analysis	Red/Brown Clay	Red/Grey Loam
pHw (pH units)	Neutral to strongly alkaline (7.1–8.5)	Neutral to strongly alkaline (6.9–8.5)
EC1:5 (dS/m)	Low to moderate (0.9–0.28)	Low (0.12–0.14)
ESP (%)	Non-sodic (1.2–4.9)	Non-sodic (2.8–3.5)
Total N (mg/kg)	Low the moderate (270–1,384)	Low (396–471)
Available P (mg/kg)	Low (4–16)	Low (4–14)
Available K (mg/kg)	Low the moderate (76–364)	Low the moderate (124–222)
Organic C (%)	Low to moderate (0.57–1.82)	Low (0.29 – 0.83)
Clay content (%)	>30	<30
Rock content (%)	<20	10 – 20
Dispersion (EAT)	Slightly dispersive to stable (3b–7)	Slightly dispersive to slaking (3b–5)

Note: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed.

3.1.2.6.2 Pre-Mining Land Suitability

The 13 SMUs identified during the EIS were classified using the five-class land suitability classification (DSITI, DNRM, 2015) ,with land suitability decreasing progressively from class 1 to class 5. The five land suitability classes are summarised as follows:

- Class 1 - Suitable land with negligible limitations
- Class 2 - Suitable land with minor limitations
- Class 3 - Suitable land with moderate limitations
- Class 4 - Unsuitable land with severe limitations
- Class 5 - Unsuitable land with extreme limitations

The PTM SMUs and pre-mining Land Suitability for Cattle Grazing or Cropping are presented in Table 14

Table 14 Pre-Mining Land Suitability for Cattle Grazing and Cropping (PTM EIS, 2005)

SMU Code	SMU Concept	Land Suitability Class – Cattle Grazing	Land Suitability Class - Cropping
A1	Alluvial – Deep Isaac Sands	Class 3	Class 5
A2	Alluvial -Sandy Hard Duplex	Class 4	Class 5
A3	Alluvial – Uniform Brigalow Clay	Class 2	Class 4
B1	Red / Brown Deeper Uniform Clay Undulating Mixed Brigalow Plains	Class 3	Class 5
B2	Gravely Clay on Ridgelines	Class 3	Class 5

SMU Code	SMU Concept	Land Suitability Class – Cattle Grazing	Land Suitability Class - Cropping
B3	Brigalow Lowlands With Grey / Brown Clays and Areas of Gilgai	Class 3	Class 5
B3v	Melon Holed Brigalow Clay Lowlands	Class 3	Class 5
B4 and B4v (variant to B4)	Friable Brigalow Scrub Soil – Black Cracking Clay	Class 2 (B4) Class 2 (B4v)	Class 3 (B4) Class 3 (B4v)
B5	Linear Gilgai Complex of Black Cracking Clay and Red/Brown Non-Cracking Clay. (Brigalow)	Class 3	Class 4-5
E1	Sandy Duplex Plains with Poplar Box	Class 4	Class 5
E2	Residuals (Mesas)	Class 5	Class 5
E3	Thin Duplex – Poplar Box and Brigalow	Class 4	Class 5

3.1.2.7 Land Stability

Susceptibility to erosion is influenced by soil characteristics such as exchangeable sodium percentage (which predisposes dispersion), Ca:Mg ratios (which can inhibit dispersion), particle size distribution (critical with respect to physical stability), R1 Dispersion Index (% dispersed silt+clays/ total silt +clays) and profile morphology. Naturally, pre-mining erosion susceptibility varied across PTM, depending on soil type, vegetation cover and topography. The vegetated deep cracking clays were found to be less prone to erosion, while lithosols and sodic duplex soils had formed gullies, due to stock tracks and vehicle tracks concentrating overland flow. During the EIS, instability of Brigalow soils (considered to be of better quality) was evidenced by the presence of heavily eroded drainage lines, likely formed/degraded further from clearing and pasture establishment.

SMUs identified during the EIS were characterised based on similarity in morphology, physical and chemical characteristics, vegetation, soil origin and topographic position. The principal soil types present were non-cracking sandy clay, associated with the undulating Brigalow plains and associated gravely ridgelines (SMU B1 and B2). The identified SMUs susceptibility to landform instability (by means of erosion) is summarised as follows:

- Soil units A1 to A3 predominantly consist of alluvial soils with varying degrees of moisture retention, workability, and nutrient availability. They are suitable for grazing native pastures, with some variations in preferred use based on specific soil characteristics.
- Soil units B1 to B5 exhibit characteristics such as red/brown clay, gravelly clay, and linear gilgai complexes. These soils are generally suitable for grazing improved pastures but are susceptible to erosion degradation, particularly units B2 and B3.
- Soil units B3v and B4/B4v include Brigalow clay lowlands and scrub soils with varying degrees of moisture retention, workability, and nutrient availability. These soils are generally suitable for grazing improved pastures, with B4/B4v potentially suitable for opportunistic forage or cropping.
- Soil units E1 to E3 comprise sandy duplex plains, residuals, and thin duplex soils. These soils are generally marginal for grazing, with varying degrees of erosion susceptibility and nutrient availability.

3.1.2.8 Vegetation Communities and Regional Ecosystems

PTM is situated in the Northern Bowen Basin and the Isaac-Comet Downs biogeographical subregions of the Brigalow Belt Bioregion. The Brigalow Belt Bioregion is one of the suites of the 13 biogeographical areas defined for Queensland (Sattler & Williams, 1999).

Landscape connectivity in the area primarily relies on existing vegetation along riparian corridors of waterways and river systems.

A desktop assessment and review of previous ground-truthed ecological studies, environmental databases, maps, and associated literature was conducted by BAAM in 2021 (BAAM, 2022). The study area for this assessment focused on undisturbed areas within the EA approved surface disturbance footprint Figure 13.

These assessments identified 11 Regional Ecosystems (REs) within the EA approved disturbance area and broader MLs (Table 15 and Figure 12).

The REs of the undisturbed footprint is shown in Figure 14, which visually shows how the pre-mining landscape did not host large areas of high value biodiversity.

Table 15 Regional Ecosystems in PTM MLs and the EA Approved Disturbance Footprint (BAAM, 2021)

				Total Area Within MLs	
RE Code	**Short Description**	**BD Status**	**VM Act Status**	**Remnant (ha)**	**High-Value Regrowth (ha)**
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered	28	0
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Of Concern	Of Concern	14	0
11.3.25	*Eucalyptus tereticornis or E. camaldulensis* woodland fringing drainage lines	Of Concern	Least Concern	45	0
11.3.27	Freshwater Wetlands. Occurs in a variety of situations including lakes, billabongs, oxbows, and depressions on floodplains. Palustrine	Of Concern	Least Concern	3	0
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plain	Of Concern	Of Concern	12	0
11.3.4a	*Corymbia tessellaris* woodland. On alluvial sand ridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict	Of Concern	Of Concern	16	0
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered	8	0
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered	0	149
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	No Concern	Least Concern	6	0
11.7.2	*Acacia spp.* woodland on Cainozoic lateritic duricrust. Scarp retreat zone	No Concern	Least Concern	16	0
11.7.3	*Eucalyptus persistens, Triodia mitchellii* open woodland on stripped margins of Cainozoic lateritic duricrust	No Concern	Least Concern	1	7

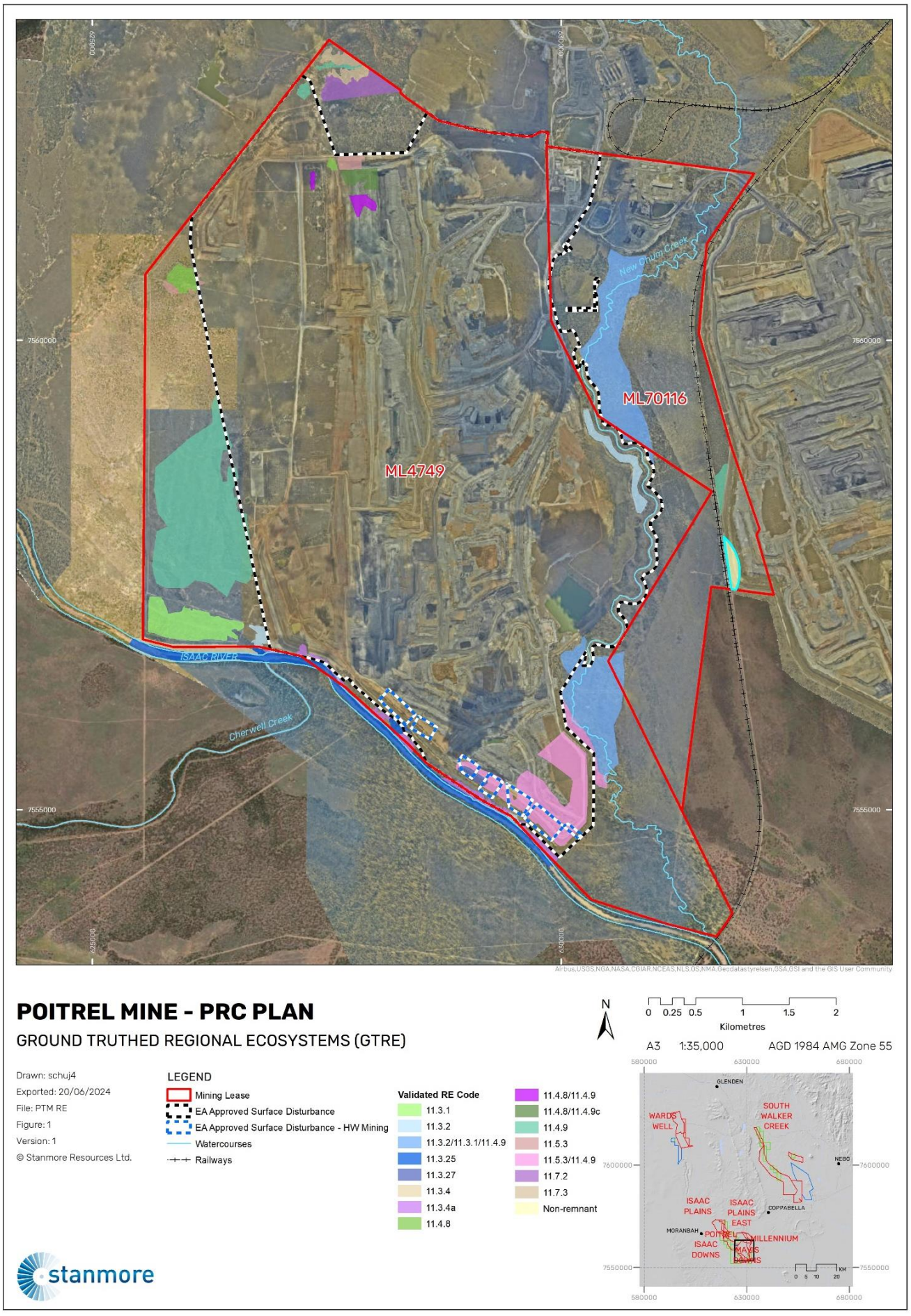


Figure 12 Regional Ecosystems within the PTM Leases and the EA Approved Disturbance Footprint (BAAM, 2021)

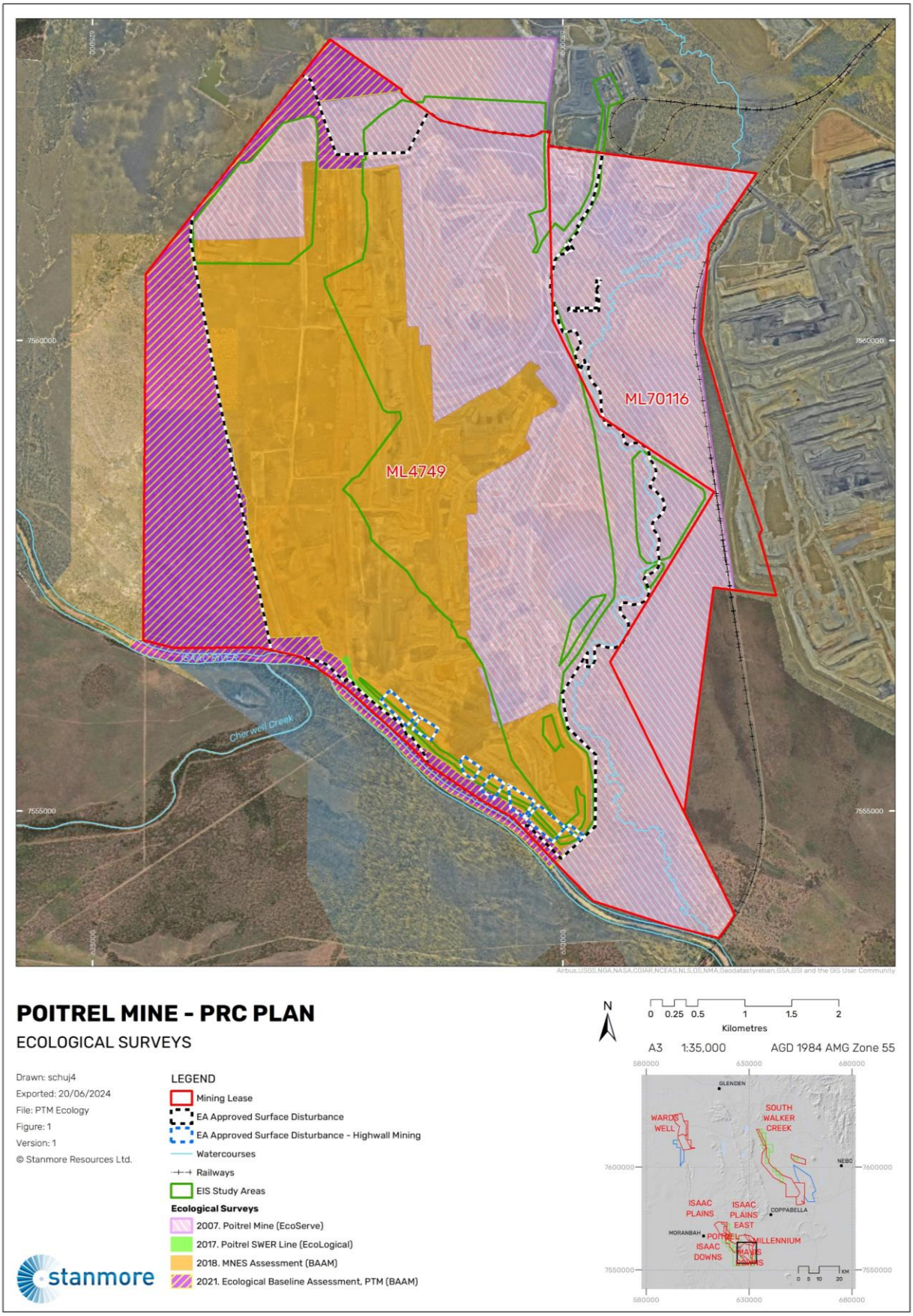


Figure 13 Ecological Surveys

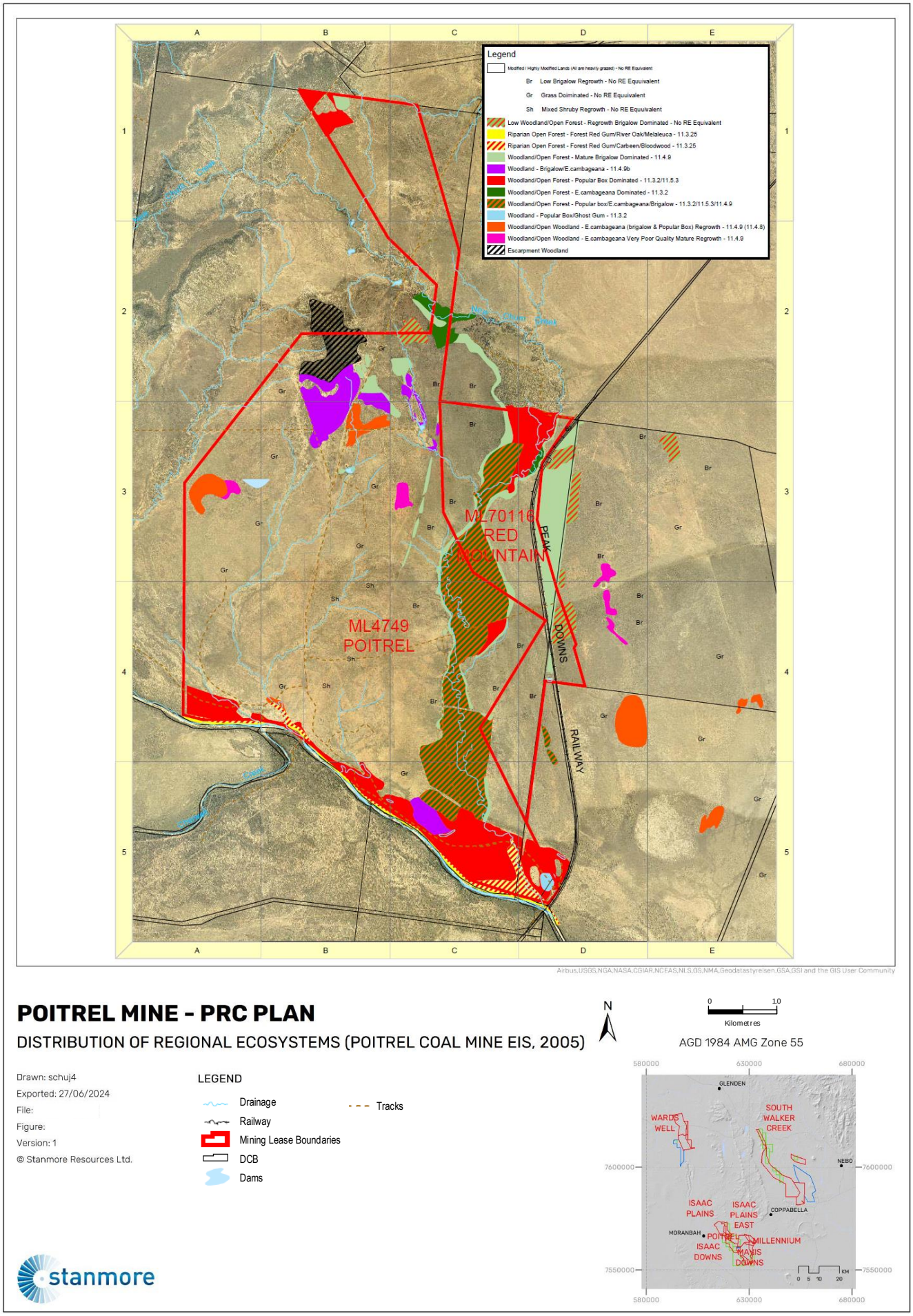


Figure 14 Distribution of Regional Ecosystems (Poitrel Coal Mine Project EIS, 2005)

3.1.2.8.1 Species Conservation Significance

Species of conservation significance are identified in Table 18. PTM has no obligations requiring specific inclusion of species of conservation significance in the revegetation planning. Nonetheless, the proposed woodland habitat and watercourse PMLUs, in particular those associated with riparian vegetation, will provide connectivity between rehabilitated areas and existing vegetation and habitat values. Additionally, areas rehabilitated to a watercourse PMLU will connect existing riparian habitat values for potential conservation significant species.

3.1.2.8.2 Threatened Flora Species

According to the EIS (2005), areas within PTM did not comprise of significant vegetation or habitat that supports threatened species but are dominated by common disturbance tolerant fauna species and introduced fauna. No threatened flora species under the EPBC Act were recorded during the 2021 field survey (BAAM). Table 16 outlines an assessment of likelihood of occurrence of threatened flora species from database searches.

Table 16 Assessment of Likelihood of Occurrence of Threatened Flora Species Identified from Database Searches

Threatened Flora Species	EPBC Act	NC Act	Likelihood of Occurrence	Comments
Capparis humistrata	-	Endangered	Unlikely	Only one record is shown 27km east of ML.
Dichanthium queenslandicum	Endangered	Vulnerable	Potential	Accurate records occur 10km west of ML.
Eucalyptus raveretiana	Vulnerable		Potential	Potential to occur within REs 11.3.25, 11.3.4, 11.3.1 and 11.3.2. Accurate records occur 38kms northeast of ML.
Ptilotus uncinellus	-	Endangered	Unlikely	Accurate records occur over 90kms north.
Samadera bidwilli	Vulnerable	Vulnerable	Unlikely	Records are more than 100km east of the ML and no preferred habitat occurs within the ML.
Solanum adenophorum	-	Endangered	Potential	An accurate record occurs 12km south-east of the site. Potential habitat within the ML is based on the mapping of REs 11.3.1, 11.4.8 and 11.4.9.
Solanum elachophyllum	-	Endangered	Potential	An accurate record occurs 12km east of the site. Potential habitat within the Study Area is based on the mapping of REs 11.3.1, 11.4.8 and 11.4.9.

3.1.2.8.3 Threatened Ecological Communities (TEC)

According to the state mapping and search of the EPBC Protected Matters Search Tool (PMST) undertaken by BAAM (2021) three EPBC Act listed Threatened Ecological Communities are known or may occur locally.

Table 17 Threatened Ecological Communities – Likelihood of Occurrence

Threatened Ecological Community	EPBC Act	VM Act	Likelihood of Occurrence	Comments
11.4.9 - Brigalow (*Acacia harpophylla* dominant and codominant)	Endangered	Endangered	Known	None of the potential patches of Brigalow TEC within the 2021 survey met the approved conservation criteria.

Threatened Ecological Community	EPBC Act	VM Act	Likelihood of Occurrence	Comments
11.4.4 - Natural Grasslands pf the Queensland Central Highlands and Northern Fitzroy Basin	Endangered	Least Concern	Potential	It is considered unlikely to occur within the MLs. During the 2021 survey (BAAM), potential areas of the Natural Grassland TEC were assessed as too small (≤1ha), with greater than 30% projected woody shrub cover, and/or greater than 10% projected crown cover, indicating these areas did not meet the condition thresholds required to be considered the Natural Grasslands TEC.
11.3.2 - Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Of Concern	Known	None of the potential patches of Poplar Box TEC within the 2021 survey met the approved conservation criteria.

3.1.2.8.4 Weed Species

Weed surveys conducted at PTM identified several weed species as being present on the MLs and the surrounding areas. Weeds have the potential to impact on the ecological values of the rehabilitated areas. The 2021 survey identified four Weeds of National Significance (WoNS) on site. These include:

- Parthenium (*Parthenium hysterophorus*).
- Bellache Bush (*Jatropha gossypifolia*).
- Prickly pear (*Opuntia spp.*).
- Lantana *(Lantana camara)* – Class 3 Pest Plant.

All weeds listed above are classified as *'Restricted Invasive Plants'* under the Biosecurity Act 2014. The Act requires that all reasonable and practical steps be taken to minimise the risks associated with invasive plants.

3.1.2.9 Threatened Fauna

Two threatened fauna species (Ornamental Snake and Greater Glider) were recorded during the field survey conducted at PTM in November 2021 (BAAM, 2022). Two other conservation significant species are also likely to occur within PTM or in the adjacent MLs (Table 18).

Table 18 Conservation Significant Fauna Recorded or Likely to Occur within or Adjacent to PTM MLs

Species	EPBC Act Status	NC Act Status	Likelihood of Occurrence	Potential Habitat Area in MLs (ha)[1]
Squatter Pigeon *Geophaps scripta scripta*	Vulnerable	Vulnerable	Likely to Occur	Total 882ha – includes103ha, 2021(BAAM) survey -includes adjacent Isaac River area) and 778ha identified in 2017 survey.
Koala *Phascolarctos cinereus*	Endangered	Vulnerable	Likely to Occur	109ha – comprising of 87ha preferred habitat, 16ha suitable habitat and 6ha marginal habitats.
Ornamental Snake *Denisonia maculata*	Vulnerable	Vulnerable	Known to Occur	Total 310ha – comprising of 151ha preferred habitat, 130ha suitable habitat and 25ha marginal habitats.
Southern Greater Glider *Petauroides volans*	Endangered	Endangered	Known to Occur	Total 108ha.

Species	EPBC Act Status	NC Act Status	Likelihood of Occurrence	Potential Habitat Area in MLs (ha)[1]
Grey Falcon *Falco hypoleucos*	Vulnerable	Vulnerable	Potential	Total 103ha.

[1] Note includes the adjacent Isaac River Corridor.

Potential habitat areas for the species listed in Table 18 are detailed in Figure 15 to Figure 18.

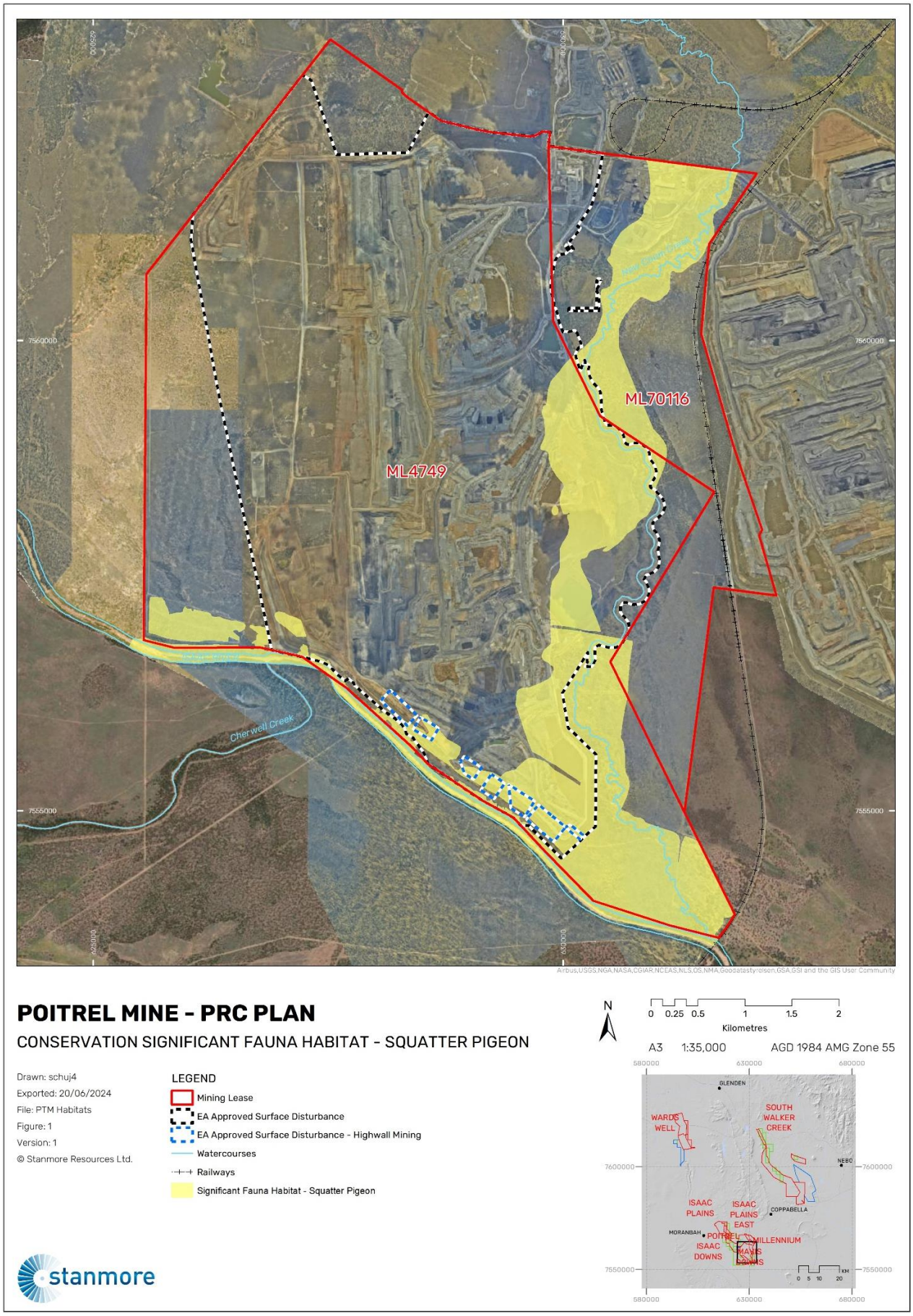


Figure 15 Squatter Pigeon Habitat

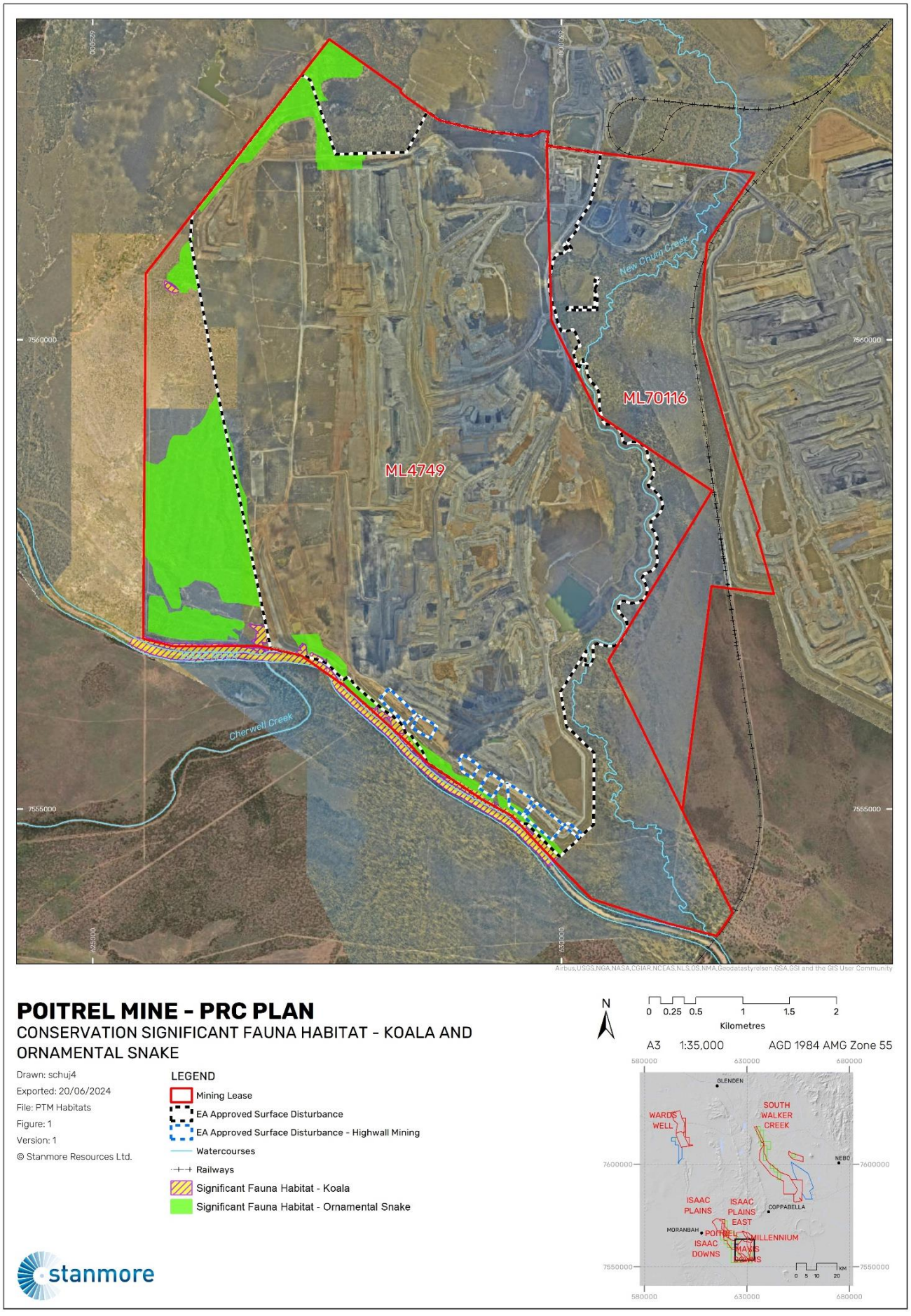


Figure 16 Koala and Ornamental Snake Habitat

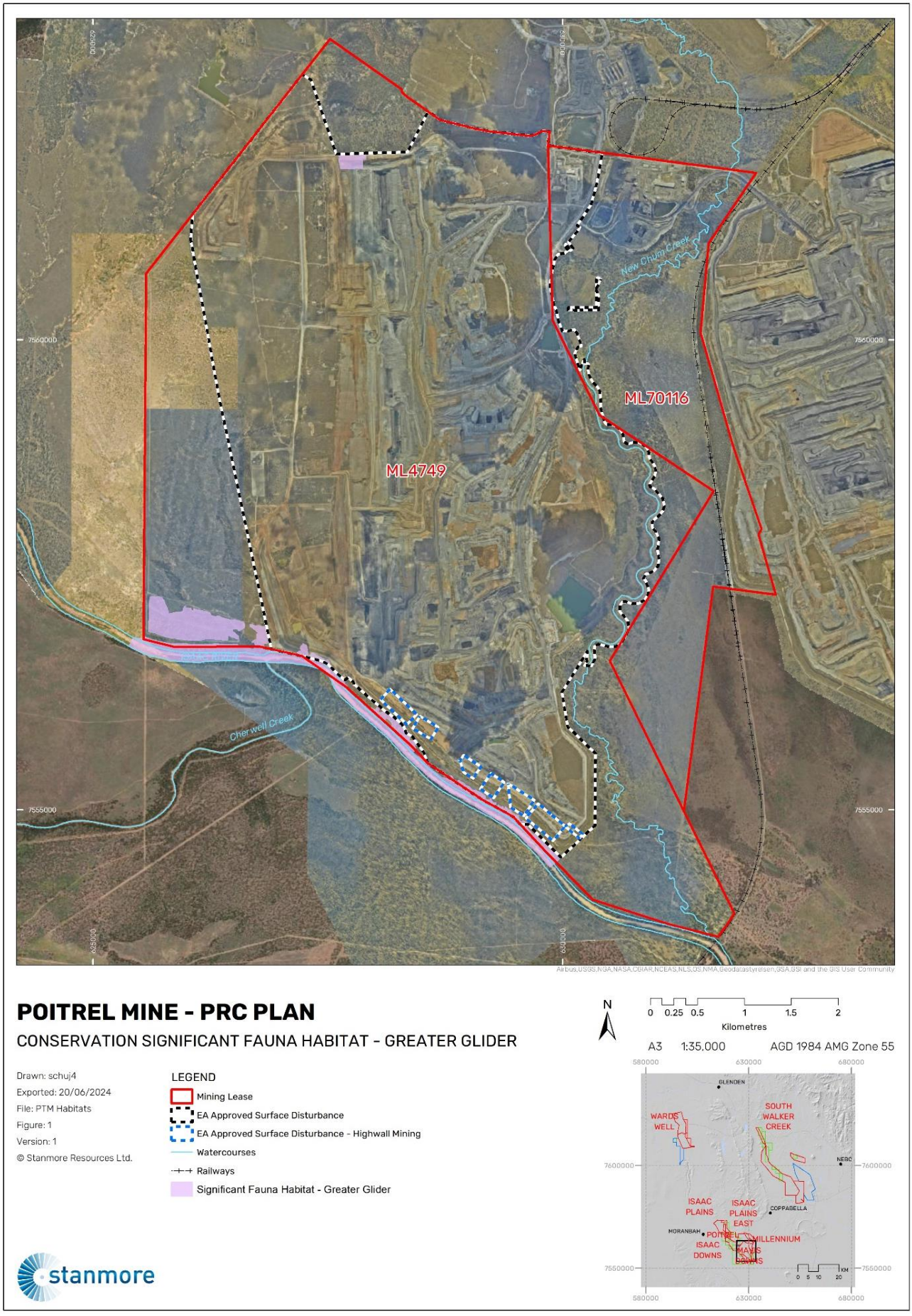


Figure 17 Greater Glider Habitat

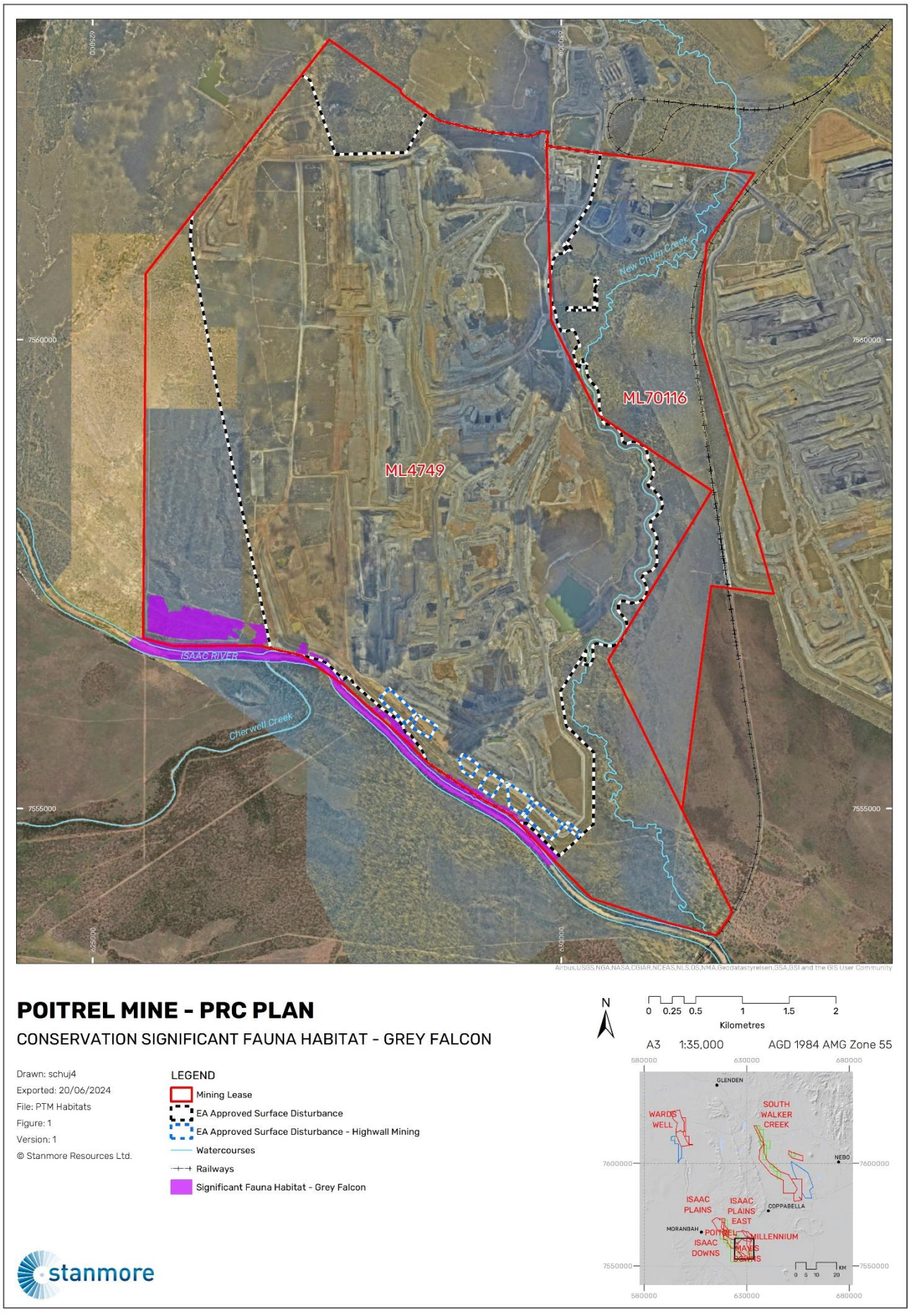


Figure 18 Grey Falcon Habitat

3.1.2.9.1 Fauna Corridors and Connectivity

At a regional level the landscape is characterised by a mosaic of historically cleared land for pastoral uses and mining, natural grasslands, and native woodlands. Landscape connectivity in the region is predominantly provided by extant vegetation occurring along riparian corridors of waterway and river systems, providing wildlife movement opportunities.

No state or regional corridors have been mapped on PTM.

3.1.2.10 Pre-Mining Land Use

The land utilisation prior to mining operations primarily involved cattle grazing on both native and improved pastures (Figure 19). Adjacent land uses encompassed grazing, coal mining, and limited forestry activities. Presently, the neighbouring land uses comprise grazing, cropping, and continued coal mining activities (PTM EIS, 2005).

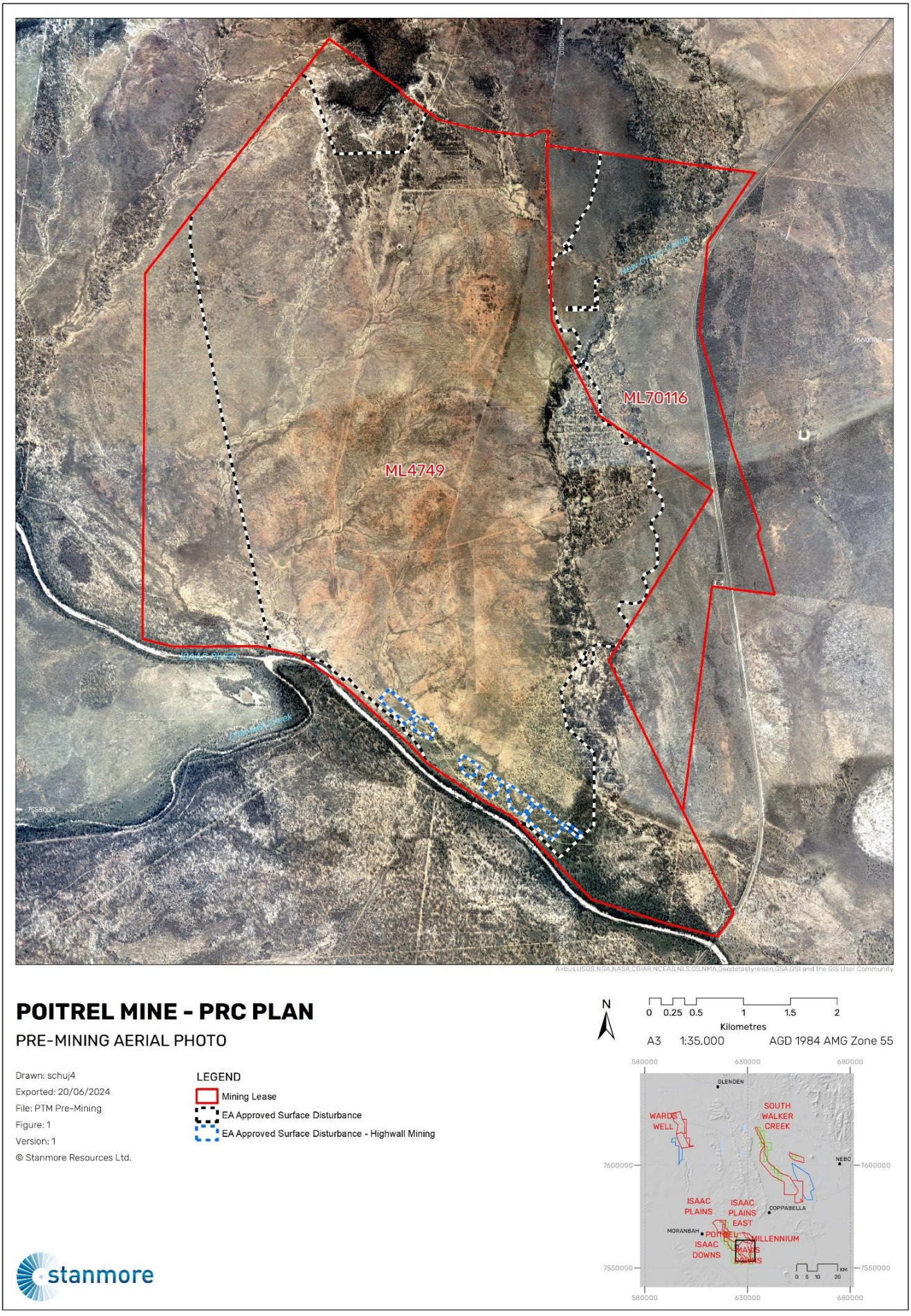


Figure 19 Pre-Mining Aerial Photo of PTM (2004 Imagery)

3.1.2.11 Underlying Landholders

B. Neilson holds the majority of land within the designated surface disturbance zone (refer to Figure 20). Queensland Rail possesses the land and infrastructure pertaining to the train load-out and rail corridor. A.G.H. Williams owns the land encompassing the Olive Downs area situated in the southern sections of ML 4749 and ML 70116. Other neighbouring landholders are also outlined in Figure 20.

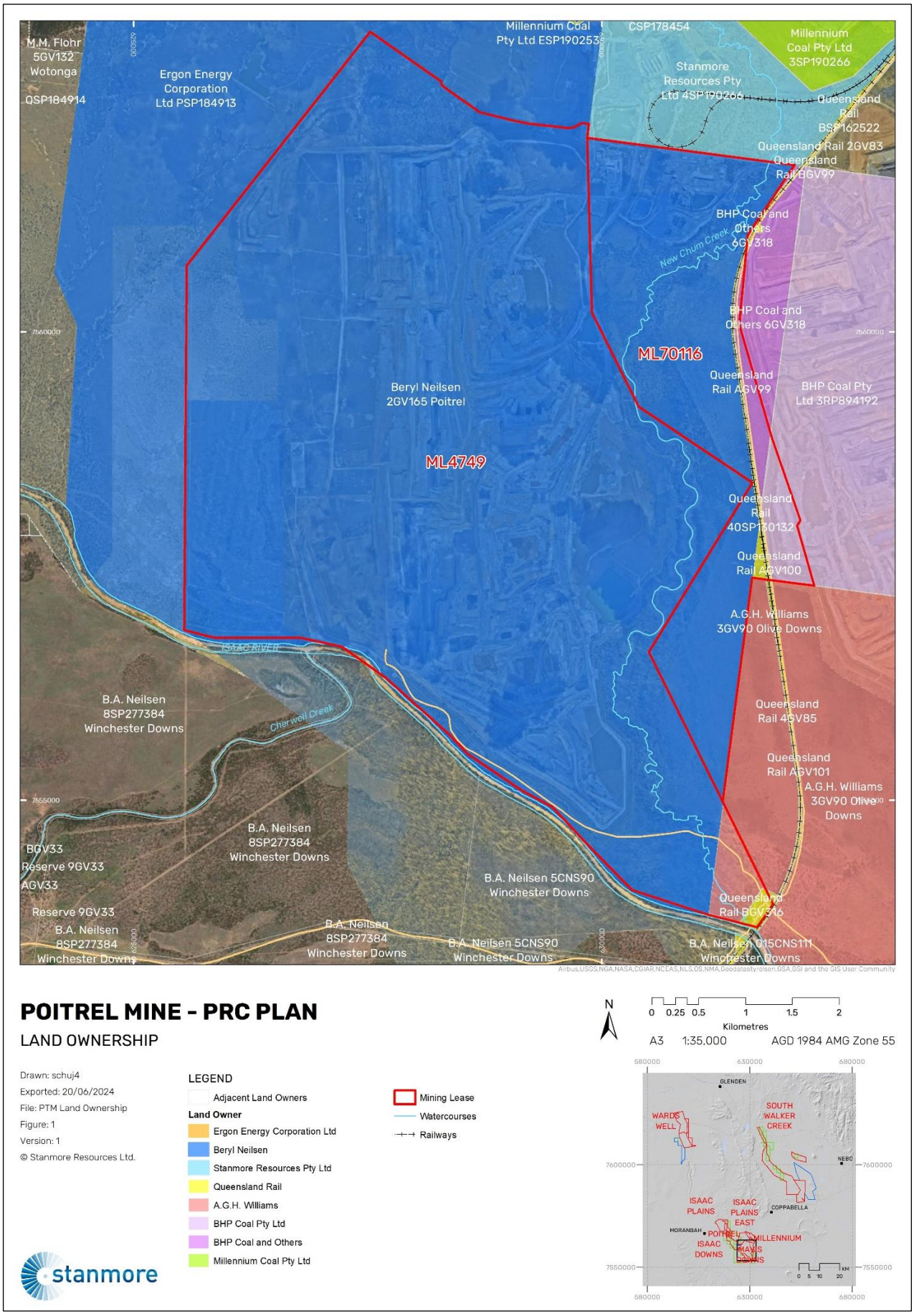


Figure 20 Land Ownership Surrounding PTM

3.1.3 Design for Closure

As this PRC Plan for PTM is subject to transitional PRC Plan provisions it is not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance (PRC Plan Guideline, Section 3.1).

3.1.4 Rehabilitation and Improvement Planning

Legislative Requirement

In accordance with sections 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part must include:

- identification of all relevant activities on the mine site
- the predicted duration of each of the relevant activities proposed for the mine site
- the size/extent of the relevant activities
- whether the different relevant activities can be progressively rehabilitated

PRC Plan Guideline (Section 3.1)

Under section 126C(1)(j) of the EP Act, transitional PRC plans must also include the following details about any existing rehabilitation already completed at the time of submission of the proposed PRC plan:

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

3.1.4.1 Relevant Activities Requiring Rehabilitation

The rehabilitation areas (RA) included in the PRC Plan Schedule for PTM are referred to throughout this PRC Plan.

A RA is defined in the PRC Plan Guideline (DES, 2023) as an area of land in the post-mine land use to which a rehabilitation milestone for the post-mining use relates.

The PTM RAs and their relevant activities at PTM that will require rehabilitation are provided in Table 19 along with their PMLUs, predicted duration (time from which RA was first disturbed to when it becomes available for the first rehabilitation milestone), area and availability for progressive rehabilitation. Progressive rehabilitation has been optimised in the PRC Plan Schedule within the constraints of the current mine plan operations. Any infrastructure that is beneficial to the PMLU on the proponent land tenure may be retained and will not be available for rehabilitation.

Of note, RA8 constitutes a riparian buffer on the northern side of the Isaac River, with a PMLU of woodland habitat. The riparian buffer supports the continued presence and return of fauna habitat.

All RAs are shown in Figure 21.

The areas on site that are undisturbed, including the three undisturbed exclusion areas, are not mapped with a RA (Refer also Section 3.1.1.3).

Table 19 Relevant Activities Requiring Rehabilitation at PTM and Associated PMLUs

Rehabilitation Area (RA)	PMLU	Relevant Activity	Predicted Duration	Size (ha)	Availability for Progressive Rehabilitation
RA1 Existing Rehabilitation	Cattle Grazing	Existing Rehabilitation	2010-2030	203	NA
RA2 Infrastructure for Decommissioning	Cattle Grazing	Mining Infrastructure Administration Workshop Roads, laydown, and general disturbance areas Water storages Topsoils stockpiles Exploration bores	2004-2040	203	Required for the life of the project. Depending on the location, will be available either at the end of mining, or final rehabilitation
RA3 Infrastructure to be Retained	Cattle Grazing	Dams and drains	2006-2040	42	Generally required for the life of the project. Depending on the location, will be available either at the end of mining, or final rehabilitation
RA4 Landform Embankment	Woodland Habitat	Embankment	2010-2025	36	Available for progressive rehabilitation as areas reach final position
RA5 WRD and Topsoil Dumps (Woodland)	Woodland Habitat	Waste rock dumps and topsoil dumps	2007-2035	569	Available for progressive rehabilitation as areas reach final position
RA6 WRD and Topsoil Dumps (Grazing)	Cattle Grazing	Waste rock dumps and topsoil dumps	2007-2030	1056	Available for progressive rehabilitation as areas reach final position
RA7 Permanent Watercourse	Watercourse	Existing Watercourse diversion	2006-2030	45	Existing diversion tracking towards rehabilitation milestones
RA8 Infrastructure for Decommissioning (Riparian Buffer)	Woodland Habitat	Riparian Buffer Zone Exploration bores	2010-2039	68	Required for the life of the project

Rehabilitation Area (RA)	PMLU	Relevant Activity	Predicted Duration	Size (ha)	Availability for Progressive Rehabilitation
RA 9 New Chum Creek Diversion Disturbance	Watercourse	Return section of watercourse diversion to a more natural state	2006-2025	3	Required for the life of the project

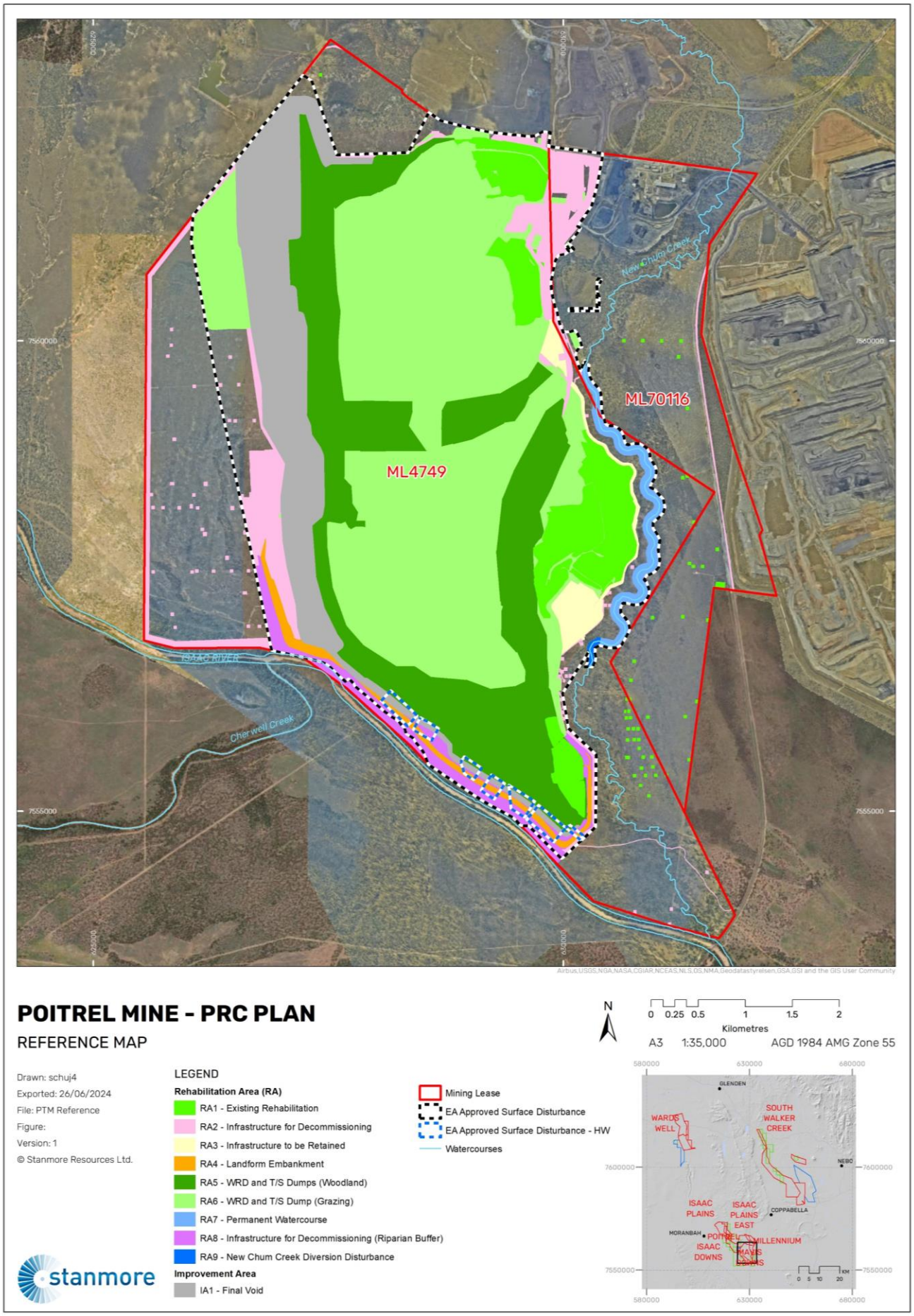


Figure 21 Schematic Illustration of PTMs Rehabilitation Areas – Reference Map

3.1.4.2 Rehabilitation Areas and Milestones

The rehabilitation milestones (RM) included in the PRC Plan Schedule for PTM are referred to throughout this PRC Plan. A RM is each significant event or step necessary to rehabilitate the land to a stable condition (section 112 of the EP Act).

The RMs are detailed in Table 20. As required by the PRC Plan Guideline, only PMLU areas where disturbance has occurred or will occur, are mapped as a RA. Areas that are undisturbed including exclusion areas are expected to remain undisturbed through the mine life and are therefore not mapped as a RA. To support ongoing operations, exploration and minor ancillary activities may be required in areas not mapped as a RA. Minor ancillary activities can occur without a PRC Plan amendment and may include roads, access tracks and culverts, fences, underground services, low-impact telecommunication facilities, electrical sub-stations and switch yards, transmission grid works and supply network works, storage depots, pipelines and pumps, groundwater bores, gas drainage bores, monitoring and investigation works and exploration activities. Disturbance must be rehabilitated in accordance with the provisions detailed in the Eligibility criteria and standard conditions for exploration and mineral development projects (DEHP, 2016) or its successor, with the exception that land must be rehabilitated to a stable condition and achieve the proposed PMLU.

Table 20 Rehabilitation Milestones for PTM

Rehabilitation Milestones (RM)	
RM1	Infrastructure decommissioning and removal
RM2	Identification and remediation of contaminated land
RM3	Landform establishment
RM4	Surface preparation
RM5	Revegetation
RM6	Achievement of stable condition
RM7	Achievement of cattle grazing PMLU
RM8	Achievement of woodland habitat PMLU
RM9	Achievement of watercourse PMLU

3.1.4.3 Improvement Areas and Milestones

The improvement areas (IA) and management milestones (MM) included in the PRC Plan Schedule for PTM are referred to throughout this PRC Plan (Table 21 and Table 22).

An IA is defined in the PRC Plan Guideline as, for a NUMA, an area of land in the NUMA to which a management milestone for the NUMA relates and a MM is each significant event or step necessary to achieve best practice management of the area and to minimise risks to the environment (section 112 of the EP Act).

There is one (1) residual void that will be retained as a NUMA. Relevant safety features of the NUMA are incorporated into the MMs (Section 3.4.3) and include:

- Safety bund is constructed, where required, at the geotechnical set-back distance.
- Fencing erected around perimeter of safety bund, where required.
- Warning signage placed along fence line, where required.

Refer to Section 3.4 for more information on the assessment of NUMAs for PTM.

Table 21 Improvement Areas (IAs) for PTM

Improvement Area (IA)	**Non-Use Management Area (NUMA)**	**Relevant Activity**	**Area (ha)**
IA1	No Use	Final Void	316

Table 22 Management Milestones for PTM

Management Milestone	
MM1	Achievement of structural stability
MM2	Achievement of surface requirements
MM3	Achievement of sufficient improvement

3.1.5 Existing Rehabilitation

PTM has commenced approximately 203.12ha of progressive rehabilitation between 2009 and 2024, categorised as approximately 4.8ha of established rehabilitation and 198.32ha of seeded rehabilitation. These areas have been seeded to achieve cattle grazing and woodland habitat PMLUs with the majority being cattle grazing. In addition to this, there is also existing rehabilitation related to the New Chum Creek diversion in which the riparian vegetation along the diversion is establishing and on a trajectory for relinquishment (Refer to Section 3.6.1).

A total of nine monitoring sites have historically been established and monitored (seven rehabilitation monitoring sites and two reference sites) at PTM which encompass initial and majoring monitoring events as per the site's rehabilitation monitoring plan (Section 3.8). This existing rehabilitation was completed between the years 2009 -2024 (Ecological, 2023).

3.1.5.1 Progressive Rehabilitation

No rehabilitation areas at PTM have been applied for progressive certification under the EP Act.

3.2 Community Consultation

Legislative Requirement

- In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC Plan must include:
- details of the consultation undertaken by the applicant in developing the proposed PRC Plan, and
- details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.

PRC Plan Guideline (Section 3.5)

In developing the proposed PRC Plan, the community should at least be engaged on the plan for the mine, PMLUs or NUMAs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation, and closure timeframes. Ongoing community consultation should continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community.

Community consultation carried out through different processes (such as an EIS) may be used to address the requirements in section 126C(1)(c) of the EP Act. The details of this consultation must be provided in the rehabilitation planning part of the proposed PRC Plan).

Transitional PRC Plans are still required to meet the legislative requirements in section 126C(1)(c) of the EP Act. All proposed PRC Plans must contain a community consultation plan regardless of whether the site has an existing EA.

3.2.1 Community and Stakeholder and Engagement Plan

This Community and Stakeholder Engagement Plan (CSE Plan) provides an overview of community and stakeholder engagement activities for PTM as they relate to the PRC Plan, to help guide the organisation in its engagement approach. Following the recent acquisition of the BHP Mitsui Coal Pty Ltd (BMC) joint venture, the proponent has recognised an opportunity to formally revisit its stakeholder engagement approach to ensure it aligns with best practice, and to achieve both synergies and efficiencies across the organisation.

The purpose of this CSE Plan is to ensure the proponent's stakeholder engagement function supports the organisation in delivering on its vision:

> *To be a leading resources company in Australia, creating value to our stakeholders through sustainable development.*

The CSE Plan is designed to tell a compelling benefits story for the proponent. The proponent is a facilitator of regional employment, economic growth, and future opportunities, while being a responsible steward of the environment. The proponent drives positive engagement with its critical stakeholders and the community, in relation to key operational, exploration, development and production milestones and projects. Critical stakeholder groups identified and discussed in this CSE Plan include Federal and State governments, industry groups and businesses, local community, and Traditional Owners of the land on which the proponent operates.

The CSE Plan provides a comprehensive overview of the environment in which communication and stakeholder engagement will occur, and includes:

- Identifying a clear and realistic goal and objectives that determine the proponent's position.
- Analysis of challenges to provide a thorough understanding of potential 'pain points', as well as strategies to help mitigate/manage potential risks/issues.
- Analysis of opportunities, including strategies to leverage those opportunities during stakeholder engagement.
- Identification of stakeholders classified according to their level of interest and influence in the proponent's operations.
- A strategic approach to engagement and tactical plan for implementation, including how and when communication and stakeholder engagement will be undertaken in relation to the proponent's operations and role in the community.

- Key messages to position the proponent among its stakeholders, ensuring alignment of communication activities across the organisation.

It is recommended this CSE Plan is reviewed and updated as required to reflect emerging issues and opportunities, and any changes to the proponent's or PTM's strategic priorities.

This CSE Plan is positioned as a site-specific Community and Stakeholder Engagement Plan, developed in line with local requirements and projects (e.g., Environmental Impact Assessment public consultation activities).

A corporate-level document for business-as-usual engagement has been developed and is currently being reviewed for incorporation into the proponent's newly developed Social Performance Strategy.

3.2.2 Consultation to Date

Engagement with affected landowners for PTM was undertaken to develop compensation, leasing and agistment agreements, based on the assumption that land disturbed for mining will be rehabilitated to be suitable for its previous use (grazing) after the proponent's use of the land has ceased. The proponent continues to engage with underlying and neighbouring landholders regularly on land management including lease/license issues; and on operational matters (such as air quality monitoring) as required.

The proponent (formerly BMC) also provided PRC Plan briefings to Isaac Regional Council (IRC) (December 2020, April 2021, and February 2024).

Consultation undertaken by the proponent (formerly BMC) as part of PRC Plan preparation for PTM included:

- A letter to IRC regarding the PTM PRC Plan, and an invitation for further discussion with Council about their involvement in PRC Plan consultations.
- Letters to two landowners whose properties are adjacent to PTM, one landowner whose property is not adjacent but accommodates the access road to PTM and two landholders who are affected by or adjacent to Daunia or Millenium Mines.
- A letter to utility owners/operators and the owners of overlapping tenures (gas exploration) within and adjacent to ML4749 and ML70116, including Aurizon, Queensland Rail, Powerlink, Ergon Energy and Arrow Energy.
- A letter to the owners of adjacent mining operations which include, Daunia Mine (Whitehaven Coal formerly BMA), and Peabody (Millenium Coal Pty Ltd) as owner of adjacent land.
- A letter to the Traditional Owners Group Barada Barna Aboriginal Corporation (BBAC) advising of the PRC Plan.
- Annual meetings with managers of Winchester Downs and PTM properties regarding rehabilitation progress and final landform plans. Routine discussions with the Winchester property manager regarding interactions with the project and environment teams.

3.2.3 Community Consultation Register

A community consultation register has been provided as part of the PRC Plan in compliance with section 126C(1)(c)(iii) of the EP Act and includes:

- Identification of each community member/stakeholder.
- Previous engagements with the community.
- Consultation date(s).
- Description of consultation type.
- Information provided to the community.
- Issues raised/discussed by the community.
- How issues have been considered.
- Decisions/outcomes of engagement.
- Commitments made by BMC (which will now be delivered by the proponent).

The stakeholders identified as part of this register are considered as having a genuine, demonstrable, and legitimate interest in PTM's ongoing rehabilitation and closure planning. Compensation agreements have been established and maintained with all landholders.

The community consultation register will be a live instrument for recording future consultation on PTM's PRC Plan. The community consultation register, and the community and stakeholder register are provided in Table 23 and Table 24, respectively.

Table 23 Community Consultation Register

Consultation Date	Community Member / Stakeholder	Consultation Type	Information Provided	Issues Raised by Community	How Issues Were Considered	Decisions and Outcomes	Commitments
Local Government							
December 2020	Isaac Regional Council (IRC)	Meeting	Planning Briefing – PRC Plan	No issues raised.	No issues raised.	Engagement for information purposes.	• Engagement for information purposes.
April 2021	Isaac Regional Council (IRC)	Meeting	Planning Briefing – PRC Plan	No issues raised.	No issues raised.	Engagement for information purposes.	• Engagement for information purposes.
February 2024	Isaac Regional Council (IRC)	Meeting	Planning Briefing – PRC Plan	No issues raised.	No issues raised.	Engagement for information purposes.	• Engagement for information purposes.
6 June 2024	Central Highlands Regional Council (CHRC)	Campaign Letter / Email	PRC Plan	No response to date.	No issues raised.	Engagement for information purposes.	• Annual updates the Progression of the PRC Plan.
Traditional Owner Group (BBAC)							
10 February 2023	Barada Barna Aboriginal Corporation (BBAC)	Incoming phone call	Query from BBAC regarding opportunities for participation in tender for rehabilitation work.	Contracting Activities; and Employment opportunities.	Continue to engage as required.	Continue to engage as required.	• Continue to engage as required.
4 June 2024	Barada Barna Aboriginal Corporation (BBAC)	Campaign Letter / Email	PRC Plan.	No response to date.	No issues raised to date.	Continue to engage as required.	• Annual updates the Progression of the PRC Plan.
Adjacent Landowners							
15 December 2022	Winchester Downs	Scheduled Interaction	Briefing for Winchester representatives regarding latest mine plan and PRC Plan.	No response to date.	Continue to engage as required.	Continue to engage as required.	• Compensation Agreement and Agistment License in place. • Annual updates the Progression of the PRC Plan.
16 March 2023	Winchester Downs	Scheduled Interaction	Site visit to inspect proposed fencing and amendments to the Agistment License; and Review of areas required for mining. Fencing standards. Water point options.	As per meeting agenda	Continue to engage as required.	Continue to engage as required.	• Compensation Agreement and Agistment License in place. • Regular interactions.
4 June 2024	Winchester Downs	Campaign Letter / Email	PRC Plan	No response to date.	Continue to engage as required.	Continue to engage as required.	• Compensation Agreement and Agistment License in place.
4 June 2024	Winchester Downs	Campaign Letter / Email	PRC Plan	No response to date.	Continue to engage as required.	Continue to engage as required.	• Annual updates the Progression of the PRC Plan.
23 October 2023	Olive Downs	Ad Hoc Interaction	PRC Plan; and Land Access - Access to dust monitoring equipment	-	-	Permission to access property provided.	• Continue to engage as required.
4 June 2024	Olive Downs	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	No rehabilitation/ closure commitments made.	• Annual updates the Progression of the PRC Plan.
Utility Owners							
4 June 2024	Aurizon	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	As per agreement	• Agreement in place. • Annual updates the Progression of the PRC Plan.
4 June 2024	Powerlink	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	As per agreement	• Agreement in place.

Consultation Date	Community Member / Stakeholder	Consultation Type	Information Provided	Issues Raised by Community	How Issues Were Considered	Decisions and Outcomes	Commitments
							• Annual updates the Progression of the PRC Plan.
4 June 2024	Arrow Energy	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	As per agreement	• Agreement in place. • Annual updates the Progression of the PRC Plan.
4 June 2024	Ergon Energy	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	As per agreement	• Agreement in place. • Annual updates the Progression of the PRC Plan.
Adjacent Mining Operations / Other Tenure Holders							
4 June 2024	Daunia Mine – BHP (now Whitehaven Coal)	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	No rehabilitation/ closure commitments made.	• Annual updates the Progression of the PRC Plan.
4 June 2024	Millenium Mine	Campaign Letter / Email	PRC Plan	No response to date.	Engagement for information purposes.	No rehabilitation/ closure commitments made.	• Annual updates the Progression of the PRC Plan.

Table 24 Relevant Community and Stakeholder Register

Stakeholder	Details	Key Interests
State Government		
• DoR • DESI • Member for Burdekin • Office of the Minister for Environment, Great Barrier Reef, Science, and the Arts	The proponent conducts as-needed engagement with Ministers and Members of Parliament and will provide briefings on PRC Planning as part of regular engagements. DoR's Deputy Director- General Georesources and Director Native Title Services and Coal Hub have been kept informed on PRC Planning.	• Legislative compliance. • Resource development. • Employment opportunities. • Public interest. • Environmental management. • Economic transformation (towards post-mining). • Financial assurance. • Environmental risk management. • Future land use and landform.
Local Government		
Isaac Regional Council (IRC)	The proponent has a long established and cooperative relationship with IRC. The proponent and IRC meet at least six monthly. BMC/ the proponent previously had three recent briefings with Council regarding PRC Plan requirements (December 2020, April 2021, and February 2024).	• Local employment and business opportunities. • Stock routes. • Effects on Council services and infrastructure. • Environmental management. • Rehabilitation progress. • Post-mining landforms. • Management of closure impacts on employment and businesses. • Alignment of rehabilitation plans with local/regional planning goals. • Economic transformation (towards post-mining) and community sustainability.
Traditional Owner Groups		
Barada Barna Aboriginal Corporation (BBAC)	Barada Barna people were engaged in the management of Aboriginal cultural heritage through a Cultural Heritage Management Plan for PTM. Barada Barna people's native title determination including areas of land within the Isaac, Central Highlands and Mackay LGAs was determined by the Native Title	• Cultural heritage impacts. • Impacts on Native Title (e.g., within stock routes or associated with the Isaac River). • Post-mining land use and landform/landscape. • Future access to and ownership of land.

Stakeholder	Details	Key Interests
	Tribunal in June 2016. Barada Barna People are represented by BBAC. The proponent is in regular communication with BBAC.	• Environmental management/stewardship. • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation.
Adjacent and Underlying Affected Property Owners		
Adjacent and Underlying Affected Property Owners	There are two landowners whose properties are adjacent to PTM, and one landholder whose property is not adjacent but accommodates the access road to PTM, Daunia Mine and Millenium Mines. Mavis Downs is located to the east of PTM and Isaac Downs is located to the west. The access road to PTM is on a property called Wotonga. PTM has compensation agreements with two landowners whose properties are affected by mining. The two properties are Winchester Downs and Wotonga. The proponent has constructive working relationships with all underlying and adjacent landowners.	• Water access – underground and surface water allocations. • Environmental management/stewardship. • Post-mining land use and landform/landscape. • Rehabilitation schedule. • Future access to and ownership of land.
Utility Owners		
• Powerlink • Aurizon • Queensland Rail • Ergon Energy • Arrow Energy	Aurizon operates the TLO and rail loop which are owned by Queensland Rail and are located on land leased from the proponent. Powerlink owns overhead and underground power lines. The proponent engages with utility owners as required, i.e., issue-specific, or transactional engagement.	• Impact on assets/asset value. • Rehabilitation of impacts on assets. • Service disruptions and mitigations. • Crossing/interface agreements.
Other Key Stakeholders		
Adjacent Mine Managers and Key Stakeholders	PTM is adjacent to Daunia to the south-east and interact with infrastructure at the TLO and rail loop. PTM utilise the RMI CHPP and a shared ROM with Millenium Mine.	• Any impacts on the use of land within overlapping tenures. • Water access. • CHPP access. • TLO and rail loop access. • Stakeholder (including employee/contractor) perceptions about closure.
Adjacent and Overlapping Mining Tenures		
Adjacent Mining Tenures – Millenium and Daunia Mines	Millennium Coal Mine re-commenced utilisation of PTM's processing and train load-out facilities in September 2021. Whitehaven Coal hold tenements to the south and east of PTM. Whitehaven Coal recently acquired the Daunia mine from BHP. Pembroke Resources has rights to a rail corridor alongside the existing Norwich Park Branch Line.	• Access to RMI processing capacity. • TLO access. • Future land use and ownership. • Access to rail corridor land.
Overlapping Tenure Holders	Arrow Energy holds an Authority to Prospect which overlaps the PTM ML.	• Future land use and tenure.
Interested Stakeholders		
The proponent Employees and Contractors	The proponent has operated PTM since 2022, using a predominately owner operated workforce that transferred over with the acquisition from BHP. The proponent communicates regularly with its personnel through various means. Information on PRC Planning and its relevance to PTM has been provided on-site by managers and through regular communications.	• Timing of closure. • Rehabilitation obligations. • Employment continuity and other employment opportunities. • Loss of employment/contracting opportunities at closure. • Closure planning in context with other mining industry changes e.g., autonomous haulage. • Workers' conditions. • Sustainability of communities that are dependent on mining.
Local Business		
Local Business	The proponent's procurement team have relationships with an extensive network of small business suppliers, including Indigenous businesses. As there is no likelihood of PTM's PRC Planning having a significant effect on businesses during the next ten (10)	• Opportunities to participate in supply chain (e.g., exploration, environmental management, rehabilitation). • Economic transformation (towards a post-mining landscape).

Stakeholder	Details	Key Interests
	years, business are considered interested rather than affected stakeholders at this point.	• Economic and community sustainability. • Loss of supply opportunities with closure.
Traditional Owner Groups and Businesses	There is potential to engage Traditional Owners and other Indigenous businesses in e.g., rehabilitation services as part of a broader portfolio-wide or business-wide program.	• Opportunities to participate in environmental management or rehabilitation.
Community Members and Other Local Groups		
• Moranbah Community • Coppabella Community	The Moranbah Community is the closest to PTM and is located approximately 35km east south-east of PTM. The Coppabella Community is located approximately 25km west north-west of PTM. Community members and groups in Moranbah and throughout the Bowen Basin have been provided with information about the PRC Planning through Community Consultation processes.	• Local employment and business opportunities. • With closure, loss of jobs and supply opportunities. • Community and regional sustainability. • Environmental management.
Fitzroy Basin Association (FBA)	Participation in workshops and meetings.	• Impact on water resources: – Environmental impact. – Post mine land use.

3.2.4 Ongoing Consultation

3.2.4.1 Consultation Objectives, Engagement Type and Frequency

Table 25 identifies stakeholders and details the current proponent relationships and potential planning areas of interest. A dedicated Community Consultation Plan (CC Plan) has been compiled for PTM's PRC planning (Table 25). This plan documents the iterative consultation process to be followed to enable ongoing PRC Plan-related engagement with the relevant stakeholders.

Table 25 Identified Stakeholders and Details on Current Proponent Relationships and Potential PRC Plan Planning Areas of Interest

Stakeholder	Details	Key Interests
Traditional Owner Group		
Barada Barna Aboriginal Corporation (BBAC)	• Barada Barna people were engaged in the management of Aboriginal cultural heritage through a Cultural Heritage Management Plan for PTM to achieve its duty of care obligation under the *Aboriginal Cultural Heritage Act 2003.* • Barada Barna people's native title to areas of land within the Isaac, Central Highlands and Mackay LGAs was determined by the Native Title Tribunal in June 2016. • Barada Barna People are represented by BBAC. • The proponent is in regular communication and has as constructive working relationship with BBAC.	• Cultural heritage impacts. • Impacts on Native Title (e.g., within stock routes or other associated areas i.e., Cultural Heritage Exclusion Areas). • Post-mining land use and landform / landscape. • Future access to and ownership of land. • Environmental management / stewardship. • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation.
Adjacent Property Owners and Licence Agreement Holders		
Adjacent and Affected Property Owners	PTM has compensation agreements with two (2) property owners: • Wotonga – Access Road to PTM and RMI; and • Winchester Downs – ML4749 and ML70116.	• Water access – underground and surface water allocations. • Environmental management / stewardship. • Post-mining land use and landform/landscape. • Rehabilitation schedule. • Future access to and ownership of land.
Underlying and Adjacent Property Owners and Properties	Other properties located adjacent to PTM include: • Olive Downs.	• Water access – groundwater and surface water allocations. • Environmental management / stewardship. • Post-mining land use and landform/landscape. • Rehabilitation schedule. • Future access to and ownership of land.
Utility Owners		
• Ergon Energy • Arrow Energy • Aurizon	Agreements are in place with the utility holders.	• Impact on assets / asset value. • Rehabilitation of impacts on assets. • Service disruptions and mitigations. • Crossing/interface agreements.
Adjacent and Overlapping Tenure Holders		

Stakeholder	Details	Key Interests
• Millenium Mine – Peabody Resources	Adjacent tenure and overlapping ML.	• Future land use and ownership. • Access to rail corridor land.
• Daunia Mine – Whitehaven Coal (formerly BHP)	Adjacent tenure.	• Future land use and ownership. • Access to rail corridor land.
• PCA 143 – CH4 Pty Ltd	Petroleum lease PCA143 overlaps ML4749.	• Future land use and tenure.
Interested Stakeholders		
The proponent Employees and Contractors	• The proponent communicates regularly with its personnel through various means. • Information on PRC Planning and its relevance to PTM has been provided on-site by managers and through regular communications.	• Job opportunities. • Loss of jobs with closure. • Closure planning in context with other mining industry changes e.g., autonomous haulage. • Workers' conditions. • Sustainability of communities that are dependent on mining.
Businesses	• The proponent's procurement team have relationships with an extensive network of small business suppliers, including Indigenous businesses. As there is no likelihood of PTM's PRC Planning having a significant effect on businesses during the next ten years, business is considered interested rather than affected stakeholders at this point. • There is potential to engage Traditional Owners and other Indigenous businesses in e.g., rehabilitation services as part of a broader portfolio-wide or business-wide program.	• Opportunities to participate in supply chain (e.g., exploration, environmental management, rehabilitation). • Economic transformation (towards a post-mining landscape). • Economic and community sustainability. • Loss of supply opportunities with closure.
Community Members and Groups	• The Moranbah and Coppabella communities are the closest communities to PTM. PTM is 20km southwest of Coppabella and approximately 25km southeast of Moranbah. • Community members and groups in Moranbah, Coppabella and throughout the Bowen Basin have been provided with information about PRC Planning through Community consultation processes.	• Local employment and business opportunities. • With closure, loss of jobs and supply opportunities. • Community and regional sustainability. • Environmental management.
State Government		

Stakeholder	Details	Key Interests
• DoR • DES • Office of the Minister for Environment, Great Barrier • Reef, Science, and the Arts	• Conduct as-needed engagement with Ministers and Members of Parliament and will provide briefings on PRC Planning as part of regular engagements. DoR's Deputy Director- General Georesources; and • Director Native Title Services and Coal Hub have been kept informed on PRC Planning.	• Legislative compliance. • Resource development. • Employment opportunities. • Public interest. • Environmental management. • Economic transformation (towards post-mining). • Financial assurance. • Environmental risk management. • Future land use and landform.

Table 26 Community Consultation Plan

Consultation Objective	Engage Key Stakeholders in Identifying Community Objectives and Aspirations for Post-Mining Land Use and Landform, and Social Value Opportunities			
Community Member	**Engagement Type**	**Proposed Consultation Frequency**	**Information to be Provided**	**How Feedback / Comments are Considered**
Landowners, Traditional Owner Groups, and Agreement Holders Within and Adjacent to PTM				
Barada Barna People (BBAC) Isaac Regional Council (IRC) Local Community Members	Advise landowners, lessees, Traditional Owners, and IRC in writing when the PRC Plan is approved.	Once-off	• Provide a copy of the approved PRC Plan for their information.	As per the Community and Stakeholder Engagement Plan.
	Meet with directly affected and adjacent landholders, BBAC and IRC to provide an update on the PRC Plan and progress with rehabilitation and invite their inputs and feedback for the following: • The approved PMLUs and post-mining landforms. • Any values or opportunities in specific disturbed areas. • Rehabilitation methods which would optimise future grazing opportunities, land management or water storage.	As requested, or as agreed with individual representatives / agencies.	• Provide a copy of the approved PRC Plan for their information.	As per the Community and Stakeholder Engagement Plan.

Consultation Objective	Engage Key Stakeholders in Identifying Community Objectives and Aspirations for Post-Mining Land Use and Landform, and Social Value Opportunities			
Community Member	**Engagement Type**	**Proposed Consultation Frequency**	**Information to be Provided**	**How Feedback / Comments are Considered**
	• Shared value initiatives, e.g., infrastructure retention, capacity building, environmental management, research, or delivery partnerships. • Rehabilitation methods, schedule, and progress towards milestones.			
	Meetings with IRC: • Provide an update on the status of the PRC Plans and rehabilitation. • Forecast upcoming PRC Plan consultation for other proponent assets. • Seek to understand Council's strategic analysis and planning for Isaac LGA and the PTM area.	Bi-annually, or as agreed with IRC.	• Provide an update on the status of the PRC Plans and rehabilitation. • Forecast upcoming PRC Plan consultation for other proponent assets. • Seek to understand Council's strategic analysis and planning for Isaac LGA and the PTM project area.	As per the Community and Stakeholder Engagement Plan.
	Participate in Council, community or industry led initiatives which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation/transition.	As invited.	• Community and Stakeholder Engagement Plan.	As per the Community and Stakeholder Engagement Plan.
	In cooperation with BBAC and other First Nations within Isaac LGA, and on a portfolio-wide basis: • Communicate the pipeline of opportunities relating to the rehabilitation work and land management. • Develop a shared understanding of business capabilities relevant to closure and rehabilitation works.	Once-off process.	• Communicate the pipeline of opportunities relating to rehabilitation work and land management.	As per the Community and Stakeholder Engagement Plan.

Consultation Objective	Engage Key Stakeholders in Identifying Community Objectives and Aspirations for Post-Mining Land Use and Landform, and Social Value Opportunities			
Community Member	**Engagement Type**	**Proposed Consultation Frequency**	**Information to be Provided**	**How Feedback / Comments are Considered**
	• Plan and implement an Indigenous business capability development program to match rehabilitation opportunities, if this is required.			
	PRC Plan-specific workshops or focus groups, seek the involvement of community members and groups in articulating community aspirations for rehabilitation, PMLUs and economic transformation.	Once-off, portfolio-wide process.		As per the Community and Stakeholder Engagement Plan.
Proponent Employees and Contractors	Keep the PTM workforce updated (via intranet news and Website, emails, and newsletters to personnel) if there are changes to the PRC Plan.	Ongoing engagement process.	• Project description. • Life of Mine (LOM) schedule. • Workplace transition.	As per the Community and Stakeholder Engagement Plan.
Moranbah and Coppabella Community Members and Groups	Using community forums such as interagency meetings, partnership meetings and community and business networks, provide community updates on PRC Planning (PTM-specific as relevant and portfolio wide).	Ongoing engagement process.	• Project description . • Life of Mine schedule. • Rehabilitation success. • How to provide feedback.	As per the Community and Stakeholder Engagement Plan.
Local Businesses and Proponent Suppliers	Provide information about the plan for closure of PTM and potential future supply opportunities as part of closure and rehabilitation.	Two (2) years prior to closure; subsequent consultation to be agreed.	• Project description. • Life of Mine schedule.	As per the Community and Stakeholder Engagement Plan.
Elected Representatives and Government Agencies	Provide updates via letters and/or meetings on PRC Planning to: • Office of the Minister for Resources (Queensland). • Office of the Minister for Environment, Great Barrier Reef, Science and Youth Affairs (Queensland).	As requested, or as agreed with individual representatives / agencies.	Project description. Life of Mine schedule. Existing rehabilitation tours. Rehabilitation success. Post-mining land uses.	As per the Community and Stakeholder Engagement Plan.

Consultation Objective	Engage Key Stakeholders in Identifying Community Objectives and Aspirations for Post-Mining Land Use and Landform, and Social Value Opportunities			
Community Member	**Engagement Type**	**Proposed Consultation Frequency**	**Information to be Provided**	**How Feedback / Comments are Considered**
	• Shadow Minister for Resources. • Shadow Minister for Environment, Great Barrier Reef, Science and Youth Affairs Resources. • Member for Burdekin (Queensland Parliament). • DES PRC Plan Team and Business Centre Coal. • Director, Native Title Services and Coal Hub, Department of Resources. • Deputy Director-General Georesources, Department of Resources. • Assistant Secretary Assessments and Governance Branch, DAWE.			
Adjacent Tenement Holders: Daunia Mine (Whitehaven Coal)	• Advise (letter) adjacent and overlapping tenement holders of any substantive changes to PTM's closure or rehabilitation schedule in future iterations of the PRC Plan. • At a business level, the proponent will participate in industry and research partnerships of relevance to PRC Planning and rehabilitation.	As requested, or as agreed with company representatives.	Project description. Life of Mine schedule.	As per the Community and Stakeholder Engagement Plan.
Overlapping Tenement Holders: • Arrow Energy	Consult with overlapping tenement holders regarding their interests in areas of overlapping tenure within PTM.	As requested, or as agreed with company representatives.	Project description. Life of Mine schedule.	As per the Community and Stakeholder Engagement Plan.
Utility Owners: • Aurizon • Powerlink	Maintain correspondence with Queensland Rail and Aurizon regarding progressive rehabilitation activities.	As requested, or as agreed with individual representatives / agencies.	Project description. Life of Mine schedule.	As per the Community and Stakeholder Engagement Plan.

Consultation Objective	Engage Key Stakeholders in Identifying Community Objectives and Aspirations for Post-Mining Land Use and Landform, and Social Value Opportunities			
Community Member	**Engagement Type**	**Proposed Consultation Frequency**	**Information to be Provided**	**How Feedback / Comments are Considered**
• Ergon Energy • Arrow Energy	Engagement regarding the decommissioning of the train load-out facility/rail interface.			

3.2.4.2 Community Consultation Information Sharing

Information to be released as part of ongoing community consultation will include:

- Rationale and scope for the PRC Plan and PRC Plan Schedule.
- Approved activities and PMLUs for PTM.
- On-site activities and areas of disturbance.
- Proposed rehabilitation methods, schedule, and milestones.
- Opportunities for community consultation as part of the PRC Plan's implementation.

Where required, communication tools could include:

- A holding statement for general enquiries.
- Frequently asked questions and answers (FAQs) and a PRC Planning fact sheet available to support consultation activities.
- Face-to-face and virtual meetings.

3.2.4.3 Addressing Feedback/Comments

As noted in the PRC Plan Guideline (DES, 2023), in addition to the annual return requirements that relate to the approved EA, if a PRC Plan applies to the activities, the annual return must also include an evaluation of the effectiveness of the PRC Plan, including the environmental management carried out under the PRC Plan Schedule, for the year to which the annual return relates.

The proponent will monitor and report on the progress and outcomes of progressive rehabilitation activities against rehabilitation milestones provided in the PRC Plan Schedule. This monitoring will aim to demonstrate a successful rehabilitation trajectory towards achievement of the approved PMLU, and/or to inform corrective action where required, which will be reported as part of annual returns.

Information about rehabilitation progress will also be delivered as part of the consultation methods detailed in and any feedback will be considered in subsequent updates of this PRC Plan.

The PRC Plan Community Consultation Register will also be updated as community consultation activities outlined are completed. Feedback recorded in the Community Consultation Register will be considered in framing and detailing future PRC Plan amendments for PTM.

3.3 Post-Mining Land Uses

PRC Plan Guideline (Section 3.2)

A PMLU is defined under section 112 of the EP Act as the purpose for which the land will be used after all relevant activities for the PRC Plan carried out on the land have ended. Relevant activity for a PRC Plan is defined in the EP Act as the relevant activities to be carried out on land the subject of the plan. It is not the intention of this definition to include third-party activities or assets that continue to exist once mining activities have ceased, such as third- party pipeline easements, power easements or overlapping tenures for other EAs.

The rehabilitation planning part of the PRC Plan must include a detailed description of the nominated PMLU(s) for the site. The description must include (where relevant), but is not limited to:

- a description of the use of the land.
- if applicable, the specific vegetation types (e.g., RE 13.2.9) or land suitability classification (e.g., Class 4).
- identification of any permanent or essential management infrastructure to be included as part of the PMLU.
- completion criteria for measuring whether the PMLU has be successfully achieved.

Where a PMLU has been previously addressed in a land outcome document and is able to be transitioned into the PRC Plan Schedule, the holder is not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for those PMLUs.

However, the legislative requirements under section 126C(1)(d) of the EP Act still apply. All PMLUs transitioned into the PRC Plan Schedule must still meet the requirements of a PMLU explained in this section, particularly that the PMLU can be rehabilitated to a stable condition.

Where PMLUs have not been pre-approved, the applicant must include all of the requirements stated in this section.

Legislative Requirement

In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRC Plan must state the extent to which each post-mining land use for land identified in the PRC Plan schedule for the plan is consistent with:

1. the outcome of consultation with the community in developing the plan, and
2. any strategies or plans for the land of a local government, the State or the Commonwealth.

3.3.1 Nominated PMLUs

The PMLUs proposed in this PRC Plan are transitioned from the PTM EA (Table E1) are outlined below and displayed in Figure 22.

- Cattle grazing.
- Woodland habitat.
- Watercourse.

In addition to the adhering to transitional provisions, the proposed PMLUs have been assessed and deemed to be appropriate based on:

- Rehabilitation objectives that focus on achieving a safe, stable, non-polluting and sustainable post-mining land use.
- Rehabilitation and closure technical assessments and investigations which underpin this PRC Plan. These include closure landform design, existing and pre-existing vegetation, existing and pre-existing ecological values, pre-mining land uses and the outcomes of the rehabilitation and closure studies supporting this PRC Plan.

As noted above, where a PMLU has been previously addressed in a LOD and is able to be transitioned into the PRC Plan Schedule, the proponent is not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for those PMLUs.

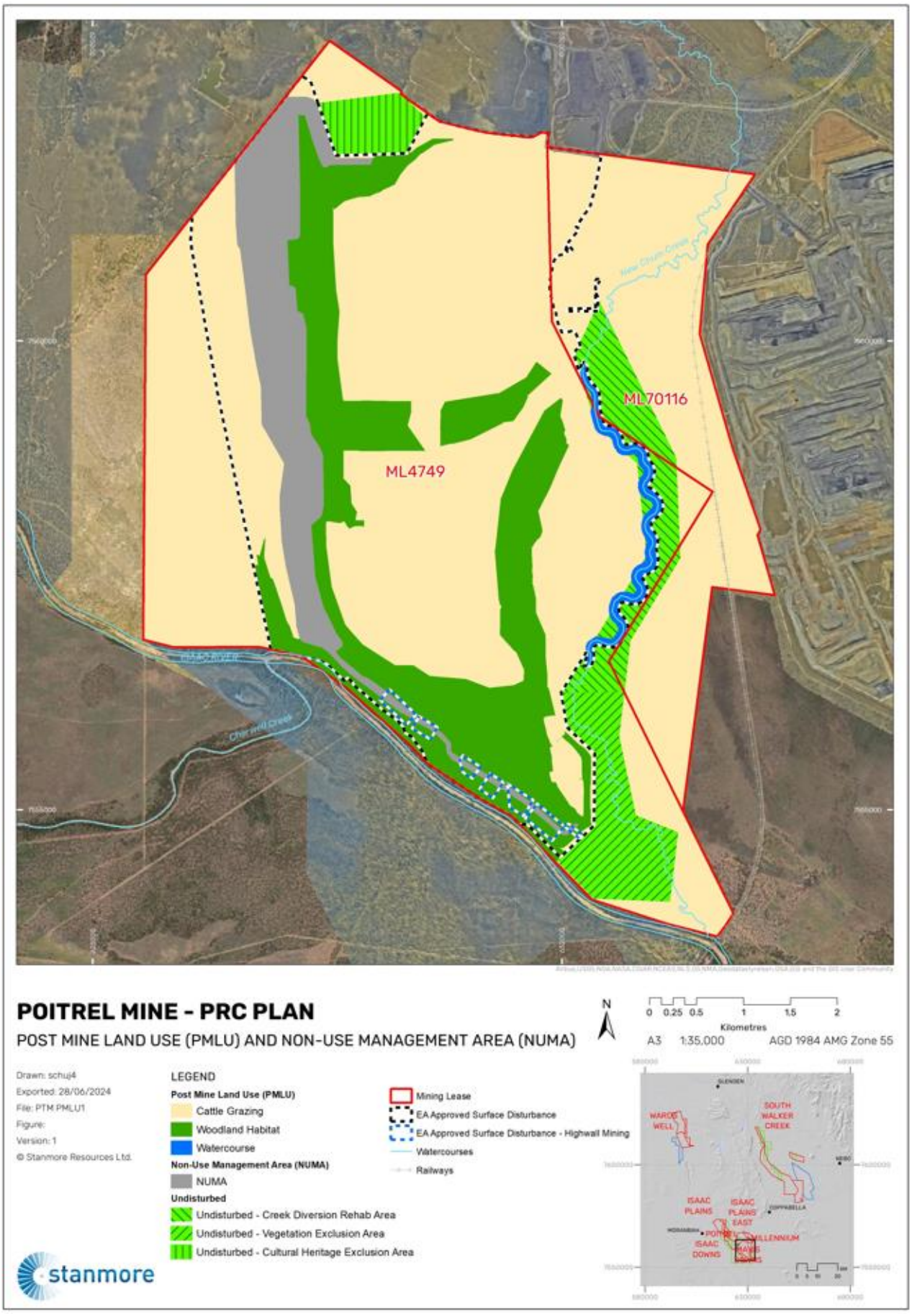


Figure 22 PTM Post Mining Land Uses (PMLU)

3.3.1.1 Cattle Grazing

The PMLU of grazing will be supported by retained water management structures which will provide safe access to water for livestock or other water management purposes. Any unnecessary water management structures or infrastructure not consistent with the grazing PMLU will be decommissioned and rehabilitated according to the proposed PRC Plan Schedule. Infrastructure will be retained for beneficial re-use where consistent with the PMLU and has been assigned a rehabilitation area (RA3).

The EA objectives, indicators, and acceptance criteria for cattle grazing PMLU are listed in Table 27.

The EA acceptance criteria have been transitioned to the milestone criteria. Modifications of the criteria have been undertaken to ensure they meet the SMART criteria. These criteria presented in the PRC Plan Schedule for the final milestone of achieving a safe, stable, non-polluting, and sustainable post mining land use.

As noted above, as the grazing PMLU has been previously addressed in a LOD (EA) and is able to be transitioned into the PRC Plan Schedule, the proponent is not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for the grazing PMLU.

Table 27 PTM EA Post Mine Land Use Objectives, Indicators and Acceptance Criteria – Cattle Grazing

Goal	Objective	Indicator	Approved Acceptance Criteria
Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
	Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover >50% 2. 70% of slopes ≤20%
Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
	Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
Able to sustain an agreed post mining land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen*

Goal	Objective	Indicator	Approved Acceptance Criteria
			Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder.
		Leucaena stem density	<250 stems 2m height per ha (1 per 40m^2), mean total area

3.3.1.2 Woodland Habitat

Revegetation activities for the woodland habitat PMLU will focus on the establishment of groundcover to facilitate stability and topsoil retention and shrub and tree cover to enable the return of fauna habitat. Native seed mixtures will contain a variety of perennial grass, shrub, and tree species introduced by direct seeding to establish a self-sustaining woodland ecosystem.

Current EA objectives, indicators, and acceptance criteria for the PMLU of woodland habitat are listed in Table 28.

As noted above, as the woodland habitat PMLU has been previously addressed in a LOD (EA) and is able to be transitioned into the PRC Plan Schedule, the proponent is not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for the woodland habitat PMLU.

Table 28 PTM EA Post Mine Land Use Objectives, Indicators and Acceptance Criteria – Woodland Habitat

Goal	Objective	Indicator	Approved Acceptance Criteria
Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5 unless an alternative is justified by an appropriately qualified person
	Rehabilitation is erosionally stable	Groundcover (steep slopes, >15%)	80%
		Groundcover (lesser slopes, ≤15%)	50%
Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
	Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.

Goal	Objective	Indicator	Approved Acceptance Criteria
Able to sustain an agreed post mining land use		Species richness: • Trees • Shrubs • Grasses	 • ≥2 • ≥3 • ≥4
		Tree canopy cover	≥16%

3.3.1.3 Watercourse

A watercourse is defined under the Water Act 2000 as *"…a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events, in a natural channel, whether artificially modified or not; or in an artificial channel that has changed the course of the stream"*.

A waterway as defined under the Fisheries Act 1994 includes a "river, creek, stream, watercourse, or inlet of the sea. This definition includes freshwater and tidal waters, both permanent and ephemeral waterways, and includes drainage features."

The EA objectives, indicators, and acceptance criteria for a PMLU of watercourse are listed in Table 29. These criteria have been developed for rehabilitated creek diversions. The EA acceptance criteria have been transitioned to the milestone criteria in the PRC Plan Schedule for the final milestone of achieving the post-mining land use to a stable condition.

As noted above, as the watercourse PMLU has been previously addressed in a LOD (EA) and is able to be transitioned into the PRC Plan Schedule, the proponent is not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for the watercourse PMLU.

Table 29 PTM EA Post Mine Land Use Objectives, Indicators and Acceptance Criteria – Watercourse

Goal	Objective	Indicator	Approved Acceptance Criteria
Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
Stable	Rehabilitation is geotechnically stable	Geomorphic index (IDC method)	Greater or equal to upstream or downstream values.
Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
Able to sustain an agreed post mining land use	Riparian vegetation	Riparian vegetation index (IDC method)	Greater or equal to upstream or downstream values.

3.3.2 Rehabilitation Milestones

The proposed rehabilitation milestones and milestone criteria are provided in Table 30. Within this table, the source of the milestone criteria has also been provided to show evidence of which milestone criteria has been transitioned from the existing LOD. SMART principles have been applied where possible, with consideration given to the following parameters:

- Milestone criteria has been transitioned from the LOD.
- Milestone criteria development has considered understanding of best practice.

Table 30 Milestone Criteria

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
RM1	Infrastructure decommissioning and removal	a. Services with no beneficial PMLU re-use are disconnected and decommissioned. b. All buildings with no beneficial PMLU re-use are demolished and removed. c. All mine roads and access tracks with no beneficial PMLU are removed. d. All pipelines with no beneficial PMLU, are drained, and removed. e. All waste removed from site. f. Mine water dams with no beneficial PMLU are decommissioned. g. All exploration drill holes have been rehabilitated in accordance with the eligibility criteria and standard conditions for exploration and mineral development projects – V2 (DEHP, 2016).	Bespoke milestone criteria to ensure: 1. Land available for rehabilitation to safe, stable outcome. 2. Waste removal from site to ensure land achieves safe, stable, non-polluting state. 3. Best practice 4. Achieves SMART principals. 5. Best practice and consistent with standard conditions outlined in current version of the eligibility criteria and standard conditions for exploration and mineral development projects – V2 (DEHP, 2016)
RM2	Identification and remediation of contaminated land	a. Contaminated land investigation completed by a suitability qualified person **(SQP)**[1] in accordance with the Environmental Protection Act (1994) including: – I. Contaminated and hazardous material either remediated in-situ or removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted. – II. Validation testing confirms that contaminated and hazardous materials have been removed or remediated successfully. – III. Contaminated land assessment indicates that no contamination unsuitable for the post-mining land use remains or is occurring. – IV. If required, a site investigation report including a site suitability statement must be prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act.	Bespoke milestone criteria to ensure: 1. Investigation and remediation of potentially contaminated land ensure safe, stable, non-polluting state is achieved 2. Achieves SMART principles 3. References EP Act (1994) 4. Best practice

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		– V. A Site suitability statement from a SQP confirms the uses or activities for which the land is suitable, aligns to the approved PMLUs for the site. [1] *Suitability qualified person (SQP): for performing a regulatory function under chapter 7, part 8 (Contaminated Land) of the EP Act or another function prescribed under a regulation, means a person who—* *(a) has qualifications and experience relevant to performing the function; and* *(b) if a regulation prescribes an organisation for this paragraph—is a member of the organisation*	
RM3	Landform establishment	**All rehabilitation areas** a. Engineering and design plans including drainage are developed by an AQP and finalised b. Bulk earthworks to achieve required landform and slopes are complete. c. Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. **Cattle grazing (RA2, RA3, RA6)** d. Landforms reshaped with maximum 15% slope e. Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. f. Retained dams are safe for stock access and have vegetated bank **Woodland Habitat PMLU (RA4, RA5, RA8)** g. Landforms reshaped with maximum 25% slopes h. Areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required	**All rehabilitated areas** 1. Considered best practice 2. Considered best practice 3. Considered best practice **Cattle grazing (RA2, RA3, RA6)** Note: EA requirement of 70% slopes <20% removed to achieve best practice and sustainable land use 4. Transitioned from Table E1 of EPML00963013 5. Transitioned from Table E1 of EPML00963013 6. Considered best practice **Woodland Habitat PMLU (RA4, RA5, RA8)** 7. Consistent with the objective of Table E1 of EPML00963013 to achieve stable and sustainable woodland habitat PMLU 8. Considered best practice and consistent with the objective of Table E1 of EPML00963013 to achieve stable and sustainable woodland habitat PMLU.

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		i. Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP j. Rock mulch thickness placed as required based on final slope and iterative waste rock characterisation and erosion assessments **Watercourse (RA9)** k. Updated hydraulic flood modelling using drainage designs l. Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use.	9. Considered best practice and therefore transitioned from Table E1 of EPML00963013 10. Proposed to ensure erosional stability of landform and successful establishment of woodland habitat vegetation. Best practice and consistent with DESI ERC Guideline ESR/2018/4425 **Watercourse (RA7)** 11. Considered best practice 12. Transitioned from Table E1 of EPML00963013
RM4	Surface preparation	a. Growth medium placed at a minimum depth of 100mm b. An assessment of growth media characteristics is completed by an AQP that identifies amelioration and other treatments required to achieve the following primary growth media quality targets^: c. Growth medium to meet the following suitability targets: Cation exchange capacity of above 14meq/100g for clays and 6meq/100g for loams. Major macronutrient concentrations in root zone (0–0.3m): Total nitrogen (N) above 1000 mg/kg. Available phosphorus (P) above 10 mg/kg. Potassium (K) above 160 mg/kg. Total organic carbon (TOC) above 1%. pHw range of soil is between 6.0–9.0 to at least 0.3m. Primary growth media (0–0.3m) salinity (EC1:5) is less than 0.75dS/m.	Considered SMART, proactive and best practice. Criteria has been informed by cover and revegetation assessments for PTM.

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		d. Rip along contour ^*Primary growth media quality targets: criteria provided as a post-ameliorant target. Initial soil analysis values may be outside of these ranges; however they must be achieved where that is a requirement of this PRC Plan Schedule.*	
RM5	Revegetation	**Cattle Grazing (RA2, RA3, RA6)** a. Complete seeding in accordance with target species of 3P (perennial, palatable and productive) and rate as per the PRC Plan Schedule Appendix 1: Grazing species and seeding rate. b. Primary growth media quality targets listed in RM4(c) are achieved based on a number of representative samples as determined by AQP **Woodland Habitat (RA4, RA5)** c. Completed seeding using a selection of species outlined in PRC Plan Schedule Appendix 2: Recommended species to be established for woodland habitat at RA4 and RA5 d. Completed seeding as per recommended sowing rates for individual species where possible and total recommended seeding rates for dominant tree species (5kg/ha), mid-storey species (5kg/ha), and groundcover species (5kg/ha). e. Primary growth media quality targets listed in RM4(c) are achieved based on a number of representative samples as determined by AQP **Woodand Habitat (RA8)** f. Complete seeding using a selection of species and sowing rates outlined in PRC Plan Schedule Appendix 3: Recommended species and sowing rates to be established for woodland habitat at RA8	**Cattle Grazing** 1. Productive and sustainable grazing PMLU. **Woodland Habitat** 2. Woodland habitat species have been selected on that basis that they are known to occur within the PTM region and are typically located on hilly, rocky terrain and/or substrates with poorer soils. The target RE for RA4, RA5 and RA8 is 11.10.1 and BVG is 10a. 3. Ensures successful rehabilitation to a sustainable ecosystem that has habitat values. **Watercourse** 4. Watercourse riparian (woodland habitat) species selection based on pre-mining flora and subsequent ecological surveys undertaken at PTM. The target RE for RA9 is 11.3.25 and BVG is 16a 5. Ensures successful rehabilitation to a sustainable ecosystem that has habitat values and is generally consistent with REs surrounding RA9. 6. Re-instates landscape connectivity in the area primarily relies on existing vegetation along riparian corridors of waterways and river systems.

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		g. Completed seeding as per recommended sowing rates for individual species where possible and total recommended seeding rates as established in PRC Plan Schedule Appendix 3 h. Primary growth media quality targets listed in RM4(c) are achieved based on a number of representative samples as determined by AQP **Watercourse (RA9)** i. Completed seeding using a selection of species outlined in PRC Plan Schedule Appendix 4: Recommended species to be established for watercourse at RA9 j. Completed seeding as per recommended sowing rates for individual species where possible and total recommended seeding rates for upper bank (5kg/ha), mid bank (5kg/ha), and lower bank (5kg/ha) k. Primary growth media quality targets listed in RM4(c) are achieved based on a number of representative samples as determined by AQP.	
RM6	Achievement of stable condition	a. Final landform for RA1, RA2, RA3, RA6 has achieved a geotechnically stable condition with minimum ≥ 1.5 factor of safety and slopes ≤15% b. Final landform for RA4, RA5, RA8 has achieved a geotechnically stable condition with minimum ≥ 1.5 factor of safety unless an alternative is justified by an AQP and slopes ≤25% c. Evidence that erosion for RA1, RA2, RA3, RA4, RA5, RA6 and RA8 is classified as 'minor' 'moderate' or 'severe' as defined by Appendix 7: Erosion classification framework. d. Assessment report completed by an AQP certifying that the diversion (RA7 and RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for	Transitioned from Table E1 of EPML00963013 with modifications to ensure safe, stable and non-polluting landform **Stable (a-e)** 1. Considered best practice, SMART and consistent with the intent of Table E1 of EPML00963013 to achieve stable landform **Non-polluting (c-j)** 2. Considered best practice, SMART and consistent with the intent of Table E1 of EPML00963013 to achieve an erosionally stable and non-polluting landform

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. e. Geomorphic index (IDC method) used to verify that Rehabilitation for RA7 and RA9 is erosionally stable with scores greater or equal to upstream or downstream values (IDC method) f. Receiving water quality must be monitored at the locations specified in the Appendix 8: Receiving Water Upstream Background Sites and Downstream Monitoring Points for a period of at least three (3) years. g. Surface water quality monitoring required by RM7(f) must be monitored for the following parameters. pH EC turbidity As Mb Se total recoverable hydrocarbons (C6–C9) total recoverable hydrocarbons (C10–C36) h. The downstream receiving water quality monitoring points (MP2 and MP3) must not be significantly higher (>15%) when compared to the upstream value at MP4 and MP5 for the water quality parameters specified in RM6(g) i. Groundwater bores specified in Table I2 in EPML00963013 must be monitored for quality and levels at the location specified in Appendix 9: Ground water monitoring points for a period of at least three years with monitoring intervals ≥ 4 weeks and ≤ 16 weeks.	3. Erosion classification framework justified as the cover design implemented through application of the Permian layer underlying the growth medium layer is sufficient to mitigate long-term erosion risk. 4. Not significantly different to upstream values and modified to align with SMART Principles 5. For rehabilitation monitoring of groundwater quality in Table E1 of EPML00963013 it currently specifies: EC not significantly different to: The EPP (Water and Wetland Biodiversity) schedule documents water quality objectives for relevant groundwater chemistry zones, or Local water quality objectives developed in accordance with the Queensland Water Quality Guidelines 6. In order to comply with SMART principles the above acceptance criteria has been modified. **Safe (all)** 7. Considered best practice, SMART and consistent with the intent of Table E1 of EPML00963013 to achieve a safe landform including to ensure water quality in retained water infrastructure meets Australian stock drinking water standards.

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		j. Ground water quality results for compliance bores must remain within the 95th percentile of the site-specific limits detailed in Table I2 of EPML00963013 for a minimum of 36 samples taken at intervals specified in RM6(i). k. Groundwater levels for compliance bores specified in Table I1 EPML00963013 must not exceed a drawdown ≥2m from the baseline RL level. l. Water quality in retained dams must not exceed the trigger values for livestock drinking water defined in ANZECC & ARMCANZ 2000	
RM7	Achievement of cattle grazing PMLU	a. Certification by an AQP that pasture meets pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per "Stocktake: Balancing Supply and Demand" (Developed by FutureBeef – futurebeef.com.au), as provided in PRC Plan Schedule Appendix 5: Pasture condition assessment, including: 1. Preferred pasture species (3P grasses^) diversity ≥2 species 2. Preferred pasture (3P) % DM yield ≥10% 3. Annual grass DM yield % <70% 4. Grasses other than 3P grasses and other weeds % DM yield <80% 5. Crown cover (3P grasses) – at worst, moderate to low density and some plants dead b. Leucaena stem density <250 stems >2m per ha (1 per 40m2) c. Certification from an AQP that rehabilitation is resilient to fire and grazing pressures.	Transitioned from Table E1 of EPML00963013 with modifications to ensure productive and sustainable land use. The resulting milestone criteria are considered best practice and aligned to industry standards.

Milestone Reference	Rehabilitation Milestone	Transitioned and Proposed PMLU Milestone Criteria	Justification for Transition and Proposed PMLU Milestone Criteria
		d. Land suitability class ≤3 or not different from pre-mining if ≥4^ ^Assessment completed in accordance with LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A ruleset for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder.	
RM8	Achievement of woodland habitat PMLU	a. A BioCondition assessment at RA4, RA5 and RA8 and is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's BioCondition Assessment Manual. b. The BioCondition assessment required by RM8(a) at RA5 and RA6 demonstrates achievement of the PRC Plan Benchmark for each assessable attribute for the relevant regional ecosystem as per PRC Plan Schedule Appendix 6: Representative RE benchmark criteria for woodland habitat rehabilitation at RA4 and RA5 c. The BioCondition assessment required by RM8(a) at RA8 demonstrates achievement of the PRC Plan benchmark for each assessable attribute for the relevant regional ecosystem as per PRC Plan Schedule Appendix 6: Representative RE benchmark criteria for woodland habitat rehabilitation at RA8	Transitioned from Table E1 of EPML00963013 with modifications to ensure sustainable land use Incorporation of BioCondition framework is considered best practice and ensures a woodland habitat with sustainable ecological values.
RM9	Achievement of watercourse PMLU	a. Riparian vegetation condition is greater or equal to upstream or downstream values using Riparian Vegetation Index (IDC method)	Transitioned from Table E1 of EPML00963013

3.3.2.1 Rehabilitation Milestone Timeframes

Progressive rehabilitation will continue throughout the life of the mine as soon as practicable after land becomes available. The term 'mined' in this case refers to the meaning under section 6A of the Mineral Resources Act 1989, which refers to mining of a probable or proved ore reserve. Disturbed land is available for rehabilitation (as per section 126D (5) of the EP Act) if the land is not being mined, unless:

- The land is being used for operating infrastructure or machinery for mining.
- The land contains a proved or probable ore reserve that is to be mined within 10 years after the land would otherwise have become available for rehabilitation.
- The land is being used to access active mining areas or proved or probable ore reserves, i.e., haul and pit roads, active mine face access.
- The land contains infrastructure to be handed over to a third-party post mining.

At PTM, there are site specific factors that influence when land is available for rehabilitation including:

- Coal market drivers have major implications for areas of the mine becoming available for rehabilitation due to the need to keep multiple pits 'open' for extended periods of time to provide variable grades of ore to blend to meet customer specifications. For this purpose, and with consideration to the EP Act definition provided above, evidence and experience shows that mine areas typically become available for rehabilitation within 5 years of clearing.
- As recognised in the EP Act definition above, there is a standing requirement to maintain roads accessing mining areas and active mine face offsets in mining areas. For this reason, these areas remain unavailable for rehabilitation until the end of end of mine life to accommodate such operational requirements.

An array of additional infrastructure is required to support mining operations, including communication networks, water, sewage and electrical services, fuel storage, mechanical workshops and more. Following cessation of mining, the schedule for decommissioning, demolition and/or removal of these facilities is unlikely to commence immediately and is dependent on a range of factors:

- The desire for third party land use partners to retain or reuse some assets.
- Many facilities will be required to support closure operations while the mining areas are subject to rehabilitation activities (e.g., requiring fleet) which may take upward of 5-10 years to complete rehabilitation execution works for whole mine areas.

For PRC Plan scheduling purposes, a general allowance of 10 years is provided for most infrastructure to be available for rehabilitation. Naturally, given the opportunity, areas no longer required to support closure activities will be rehabilitated.

In addition to this, there is a subset of buildings and other infrastructure which will not be decommissioned or rehabilitated (therefore not made available for 'rehabilitation'), but rather have potential to be utilised for:

- Post-closure maintenance and monitoring activities; and/or
- Post-closure community benefit and are thus assumed to be made safe and transitioned in a condition agreed with relevant third party(s).

Timeframes associated with the milestones for each RA were developed by considering the requirements of each rehabilitation activity outlined in previous sections and the associated risks identified through the risk assessment (Refer to Section 3.7). The nominated timeframes and respective justifications are detailed in Table 31. These timeframes have been used to develop the milestone schedule in the PRC Plan Schedule.

Table 31 Timeframe Justification for Rehabilitation Milestones

Rehabilitation Milestone	Nominated Timeframe	Justification
RM1 - Infrastructure decommissioning and removal	5 years	A five year timeframe is considered appropriate to ensure that all relevant decommissioning and demolition works can be undertaken safely, considering that there are very few specialist demolition service providers in the market and factoring in the forecasted high demand for demolition services in the next few decades. Given the significant size of the coal processing and load out facilities, make safe activities prior to decommissioning, include de-energisation, structural integrity assessments and HAZMAT investigations, take considerable time given inherent safety risks associated with demolition.
RM2 - Identification and remediation of contaminated land	5 years	A five-year timeframe is considered appropriate to investigate and remediate contamination. This timeframe accounts for the investigation, potential remediation works (typically involving excavators and trucks), engagement of SQPs and site auditor in line with EP Act requirements. Soil remediation projects typically extent for multiple years owing to the iterative nature of confirming that residual contamination meets the intended land use EILs/HILs through validation sampling.
RM3 - Landform establishment	5 years	Five years is justified as a sufficient time to complete this milestone considering that this milestone requires bulk earthworks across domains that are considerably large, factoring in that iterative works may be required to confirm that the landform is behaving as per the design intent and to reduce potential impacts associated with seasonal rainfall.
RM4 – Surface preparation	2 years	As this milestone requires verification from an AQP that growth medium is suitable to sustain vegetation, a 2 year timeframe is considered appropriate to account for investigations and development of appropriate amelioration strategies that require trials over multiple seasons.
RM5 - Revegetation	3 years	To account for further investigations to ensure the vegetation mix can be sustained and factoring in that optimal seed growing seasons may not occur during the nominated period that revegetation is planned, 3 years is deemed appropriate. This nominated timeframe is also justified on the basis of reducing risks associated with seed supply chain issues, that are known to naturally occur (i.e., and late/early seeding and unavailability of seed species to meet the required seed mix).
RM6 - Achievement of stable condition	10 years	Achievement of stable condition relies on extensive monitoring by AQPs that the planning rehabilitation measures are on the trajectory towards successfully sustaining the nominated PMLU. This requires extensive monitoring over large domains whereby frequent sampling is required to be undertaken and in some instances rehabilitation intervention may be required. Ten years is considered an appropriate timeframe to account for natural variation ins water quality and potential recitation works if erosion outside of tolerable limits is occurring.

Rehabilitation Milestone	Nominated Timeframe	Justification
RM7 - Achievement of cattle grazing PMLU	10 years	Achievement of the cattle grazing PMLU relies on certification from the AQP that the land can sustain this use based on achieving certain vegetative conditions to satisfy criteria from FutureBeef. Allowance is made for poor growing seasons and extreme events such as droughts or storms that could negatively impact vegetation establishment, and potential intervention. Given these factors, and considering that only grasses are to be grown, the timeframe assigned is 10 years.
RM8 - Achievement of woodland habitat PMLU	15 years	Achievement of the woodland habitat PMLU relies on certification from the AQP that the land can sustain this use based on achieving certain vegetative conditions to satisfy criteria from the BioCondition Assessment Manual. Allowance is made for poor growing seasons and extreme events such as droughts or storms that could negatively impact vegetation establishment, and potential intervention. Given these factors and considering that the establishment of some species requires years of maturity, the timeframe assigned is 15 years.
RM9 - Achievement of watercourse PMLU	15 years	Achievement of the watercourse PMLU relies on justification from the monitoring undertaken during RM6 that the land can sustain this use based on comparison of riparian condition to surrounding watercourse reaches. Allowance is made for poor growing seasons and extreme events such as droughts or storms that could negatively impact vegetation establishment, and potential intervention. Given these factors and considering that the establishment of some species requires years of maturity, the timeframe assigned is 15 years.

3.3.3 Exploration

In accordance with RM1(g) all exploration drill holes will be rehabilitated in accordance with the eligibility criteria and standard conditions for exploration and mineral development projects – V2 (DEHP, 2016).

3.3.4 Community Consultation

Achievement of the PMLUs of cattle grazing, woodland habitat and watercourse are consistent with LODs, consultation and respective agreements completed to date (refer to Section 3.2).

3.3.5 Consistency with Local, State and Commonwealth Strategies and Plans

All proposed PMLUs have been transitioned from the EA (LOD). The PMLUs at PTM consider the pre-mining land use, adjacent land uses and approved EA conditions. Existing land use in the area is primarily cattle grazing and coal mining.

Under the Isaac Regional Planning Scheme (February 2021), PTM is located within a rural zone, which includes uses such as grazing, farming, forestry, tourism, and extractive industries. Land use performance outcomes for this rural zone include ensuring development:

- Is consistent with the rural character of the locality.
- Supports the primary rural function of the zone.
- Protects rural, natural, and scenic values of the locality.

- Includes boundary realignments where they used to align with mining or petroleum tenements.

Concurrently, the Queensland Government, via its Mackay, Isaac, and Whitsunday Regional Plan (February 2012), maps PTM in a regional landscape and rural production area, which includes land used for agriculture, natural economic resources (including extractive resources), water catchment, traditional uses, conservation areas and native forests.

The defined uses for both regional plans are consistent with the PMLUs proposed for PTM.

3.4 Non-Use Management Areas

Legislative Requirement

In accordance with sections 126C(1)(d), (g) and (h) of the EP Act, for each proposed non-use management area, the rehabilitation planning part of the PRC Plan must:

- state the reasons the applicant considers the area cannot be rehabilitated to a stable condition;
- include copies of reports or other evidence relied on by the applicant for each proposed non-use management area;
- state the extent to which the proposed non-use management area is consistent with the outcome of consultation with the community in developing the plan, and
- state the extent to which the non-use management area is consistent with any strategies or plans for the land of a local government, the State, or the Commonwealth.

PRC Plan Guideline (Section 3.3)

A NUMA is defined in the EP Act as an area of land the subject of a PRC Plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC Plan carried out on the land have ended. Proposed NUMAs must be justified under the criteria set out in section 126D (2) of the EP Act.

The rehabilitation planning part of the PRC Plan must also include:

a. information demonstrating that the proposed footprint of each NUMA is as small as practicable.
b. an assessment of the NUMA location options, having regard to the constraint of the resource location, with an analysis of the potential environmental harm and sensitivity of the surrounding environment of each option.
c. a description of the proposed location of each NUMA and the environmental values of the surrounding environment.
d. evidence showing how the proposed location will prevent or minimise environmental harm.

In accordance with section 126D (1)(c) of the EP Act, the applicant must develop and implement management milestones within the PRC Plan Schedule which achieve best practice management and minimise environmental harm for any NUMAs contained in the proposed PRC Plan. As part of the development of management milestones, the applicant must conduct a NUMA specific risk assessment to identify and quantify risks and associated controls. The risk assessment should have an overarching goal of identifying and controlling any significant risks to the community and the environment.

The proposed PRC Plan must include a detailed description of the nominated NUMA(s) for the site. The description must include, but is not limited to:

- description of the land at surrender;
- any relevant safety features;
- completion criteria for measuring whether the NUMA has achieved sufficient improvement.

Where a NUMA has already been identified in a land outcome document and is able to be transitioned into the PRC Plan Schedule, the applicant is not required to comply with sections 126C (1)(g) or (h) or 126D (2) or (3) of the EP Act. NUMAs transitioned into the PRC Plan Schedule are not required to complete the information requirements under section 126C (1)(j) of the EP Act in this section for those NUMAs. However, the legislative requirements under section 126C (1)(d) of the EP Act still apply.

Where a NUMA has not been pre-approved and is proposed as part of the transition into the PRC Plan, the applicant must include all of the requirements identified in this section.

As outlined in section 754 (3) of the EP Act and section 6.3.2 of the PRC Plan guideline 'a NUMA will be taken to be pre-approved if a land outcome, the same or substantially similar to a NUMA, is contained in a 'land outcome document'. This is the case for PTM due to the residual voids being authorised under Schedule E, Condition E6 and E7 of the EA (Refer to Section 2). As such the EA identifies an approved outcome for the land through these two conditions. The approved outcome is that residual voids are authorised for the land. The proposed NUMA is inclusive of the low wall, high wall, and end walls.

If a NUMA has already been identified in a LOD then per section 754 (3) of the EP Act, the applicant is not required to comply with sections 126C(1)(g) or (h), or section 126D (2) or (3) of the EP Act and is not required to complete the information requirements under section 126C (1)(j) of the EP Act for the transitioned NUMAs. PTM is still required to meet the legislative requirements under section 126C (1)(d) of the EP Act.

Although Sections 126C(1)(g), (h) and (i) and Section 126D(2)(a) of the EP Act are not required to be considered under the transitional provisions, these sections have been addressed in this document to demonstrate the efforts made by the Proponent to avoid environmental harm during the development of the NUMA design. Where these sections of the EP Act have been addressed in this chapter and technical appendices is detailed in Table 32 below.

Because the EA does not state the area or location of the proposed NUMAs, this section will include detail on how the total area of the NUMA will be minimised, and how the location of the proposed NUMA will minimise risk to the environment.

Table 32 Additional NUMA Information

Section	Where in Document Addressed
126C(1)(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)	Section 3.4.2 and 3.6.3.1.3
126C(1)(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	Section 3.4.2, 3.4.3.3, Appendix 3 (Hydrogeology Assessment) and Appendix 8 (Void Closure Plan)
126C(1)(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	Section 3.4.4, 3.6.3.6, and Appendix 8 (Void Closure Plan – Section 8)
126D(2)(a) – The PRCP schedule may state the land is a non-use management area only if carrying out rehabilitation of the land cause a greater risk of environmental harm than not carrying out the rehabilitation	Section 3.4.2

3.4.1 Nominated NUMAs

There is one (1) residual void that will be retained as a NUMA as shown on Figure 23. The NUMA has a total area of 316ha. The NUMA extents and key details are summarised in Table 33

Relevant safety features of the NUMAs are incorporated into the MMs (Section 3.4.3) and include:

- Safety bund is constructed, where required, at the geotechnical set-back distance.
- Fencing erected around perimeter of safety bund, where required.
- Warning signage placed along fence line, where required.

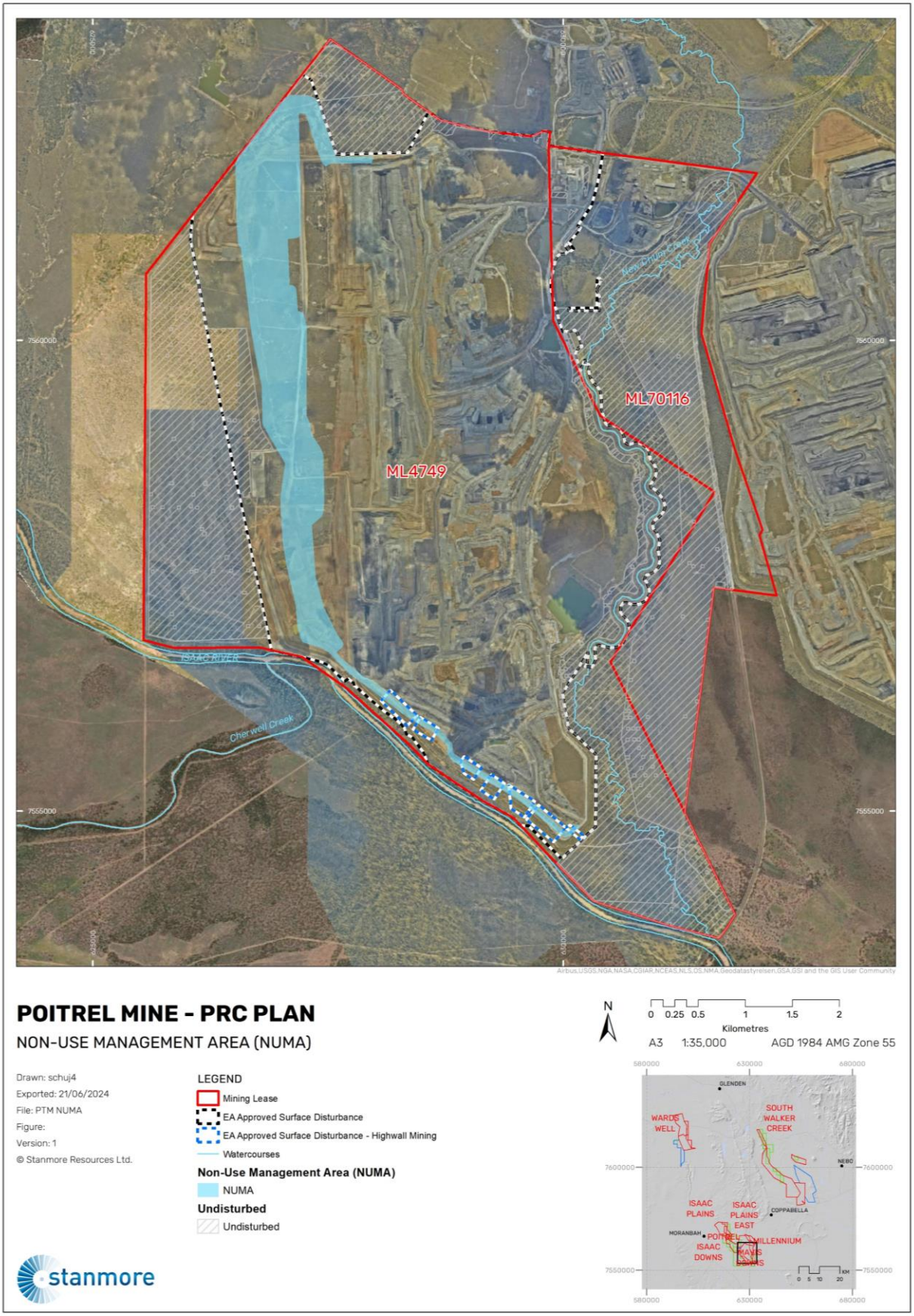


Figure 23 PTM Proposed NUMA

Table 33 PTM Proposed NUMA Details

Proposed NUMA	Mining Tenement	Area (ha)	Factor of Safety (FoS)	Maximum Depth	Maximum Length
IA1	ML 4749	316	Minimum FoS of >1.25 as determined by an AQP	~145m	12km

3.4.2 NUMA Justification

Relevant studies have been undertaken to assess, refine and optimise the PTM residual void location and extent to minimise the potential for environmental harm in its closure state, and to ensure sufficient improvement of the NUMA. These studies resulted in the iterative refinement of the final landform and NUMA extent as documented for the three options NUMA design considered as described in **Section 3.4.3.1**. The preliminary NUMA locations and extent were based on mining the full resource extent of the approved area and were used as the basis for the following void studies:

- Void in a flood plain assessment.
- Rehabilitation flooding assessment.
- Initial void water balance model and assessment.
- Initial void geotechnical stability assessment.

Geochemical water quality assessment. The supporting technical studies appended to this document (Section C) support the proponent's conclusion on NUMA stability and avoidance of risk to environmental harm as identified below and **Section 3.4.3** (NUMA design options analysis).

3.4.2.1 Stable Condition Assessment

Although the NUMA has been approved as transitional in accordance with the PRCP Guideline and EP Act (see Section 2), a general discussion as to why the void cannot be rehabilitated to a stable condition (as per Section 126C(1)(g) of the EP Act) is presented below.

As per the findings presented in **Appendix 3** and **Appendix 8**, the void configuration as proposed will be a groundwater sink. As a groundwater sink, in a net evaporative environment (as is present for the site), water quality (particularly salinity) will continue to degrade over time to the limit of saturation. Therefore, the use of water within the pit cannot be guaranteed post closure and into perpetuity to sustain a PMLU.

The slope of the pit high and low walls in the optimal configurations (considering both operational constraints and best environmental outcomes) also generally precludes their use for grazing activities in the selected configurations as described in detail in **Section 3.6.3.1.3**.

3.4.2.2 Alternative Options Potential for Greater Environmental Harm

Although the NUMA has been approved as transitional in accordance with the PRC Plan Guideline and EP Act (see Section 2), a general discussion as to how the NUMA acquits the requirements of Section 126D(2)(a) is presented below.

During options analysis (**Section 3.4.3.1.1 – 3.4.3.1.3**), it was determined that the void, where backfilled to a certain point, had the potential to become a groundwater source, rather than a sink as described in greater detail in **Section 3.6.3.1.2 and 3.6.3.2**. This presents an increased risk of the mobilisation of contaminants from the residual void into the surrounding groundwater. Therefore, the proposed NUMA in **Table 33** presents the scenario with the minimal potential for impact.

Other configurations of the void where there is an attempt to establish appropriate conditions for a PMLU for the pit walls (high- and low-) is likely to lead to a greater potential for environmental harm. Due to the widening of the void, the catchment of the void increases, creating a more substantial lake, and removing a significant portion of the PMLU area gained by rehabilitation works. In this scenario, rehabilitation already completed on the PTM dumps would be impacted/removed by the layback of pit walls, requiring a repeat of

rehabilitation activities in these areas. Further, undisturbed areas behind high walls will also be impacted, leading to an increase in disturbance footprint and potential impacts to high value vegetation. The increase in catchment area and void lake size also effectively consumes a non-trivial portion of the potential gains in PMLU area. Therefore, the limited NUMA and retention of existing rehabilitated land as presented in the selected NUMA configuration option presents the minimal potential for environmental harm of the viable options. The optimised NUMA design selected through the options assessment discussed in **Section 3.4.3** enables 112 ha of additional PMLU area and one to two percent less NUMA area (detailed in **Table 34**).

3.4.3 Minimising Environmental Impacts

In accordance with Section 6.3.2 of the PRC Plan Guideline, "if the land outcome document(s) does not state the area or the location of the proposed NUMA, the PRC Plan must state how the total area of the land will be minimised, and how the EA holder will ensure the location of the NUMA minimises risks to the environment".

As documented in the Information Sheet – Non-Use Management Areas, Department of Environment and Science 2023 (ESR/2019/4954), rehabilitation and management activities must be implemented for a NUMA to achieve sufficient improvement of the land. Sufficient improvement of a NUMA means the last management milestone for the area has been achieved. On achieving sufficient improvement, the risk of the following has either been prevented or minimised to the greatest extent possible:

- Land collapsing, eroding or subsiding.
- The need to actively manage the area (e.g. to prevent generation, and limit the release of contaminants).
- Access to the area has either been prevented or minimised to the greatest extent possible.

The iterative landform design process has resulted in a mine closure landform which minimises the area of the void and minimises potential environmental harm from the residual void in its closure state by:

- Providing immunity from flooding interactions, up to a PMF event.
- Ensuring the voids acts a sink for groundwater.
- Ensuring the NUMA extent is informed by the area of predicted instability as determined through geotechnical stability modelling, and citing of management measures (safety bund, signage) as defined in the management milestones is outside this area.

Further, void water quality in the proposed closure state is understood, and any limitations for use of this water is considered in the management milestones.

3.4.3.1 Options Assessment for Minimising Final Void

Mining construction and operations at PTM commenced in 2006. PTM targets the coal seams of the Rangal Coal Measures (RCM) via removal and stockpiling of topsoil, drilling, and blasting of overburden/interburden and stripping of overburden/interburden via excavator and truck/shovel to expose the coal seams. The overburden/interburden is placed back into the previously mined voids progressively. There are five mining pits that make up the mining operation - Ramp 10, 20, 30, 40 and 50. At the end of mining, one continuous residual void is proposed.

As detailed in Section 3.1 of this PRC Plan, the residual voids are authorised as NUMAs. A NUMA is an area of land that cannot be rehabilitated to a stable condition after all the relevant activities for the PRC Plan carried out on the land have ended.

As described above, the final landform has been iteratively designed with consideration of relevant technical studies, the mine plan and waste tonnages, and to minimise the extent of the NUMA where feasible. A detailed options assessment has been undertaken to assess the potential to minimise the NUMA extent, and is described below (see **Appendix 8** for further detail).

The options assessment to minimise the extent of the NUMA was conducted with consideration of the broader risks relevant to the closure landform (including contaminant migration), the land collapsing, eroding or subsiding and the need to actively manage the area. There are potential landform design options which may

reduce the size of the residual void, however may result in a landform that would not meet the minimum FoS that has been determined by the AQP.

Not achieving a safe and structurally stable residual void represents an unacceptable environmental outcome and necessitates designing a residual void that is based on practicalities that have been extensively modelled to support this PRC Plan. This context is important when determining the viability of various landform design options. In total three (3) landform design options were considered for PTM that were underpinned by a landform design objective to minimise the extent of the residual void and maintain best practice environmental management. Results of the options assessment is discussed in the sections below.

3.4.3.1.1 Option 1: Base Case No Filling of Void Along Issac River

Previous iterations of the PTM mine plans commenced by BHP in the early 2000s and submitted with the EIS for approvals had no planned partial or full backfill of the final void. The void was anticipated to fill to an equilibrium water level which was not determined in the EIS.

Figure 24 shows the result of scheduling mining to extend down-dip along the entire strike length of the mine. This schedule is the most optimal and value adding case, given it achieves maximum recovery of coal, and provides the shortest haul distances for overburden waste. The section taken across R40 showing extent of the NUMA is provided in Figure 25.

The resultant southern void would lie adjacent to the Isaac River for a length of 2km with a void length of 12km and a total surface area of 405ha which would include fencing and bunding and highwall and low wall setbacks to achieve the target FoS.

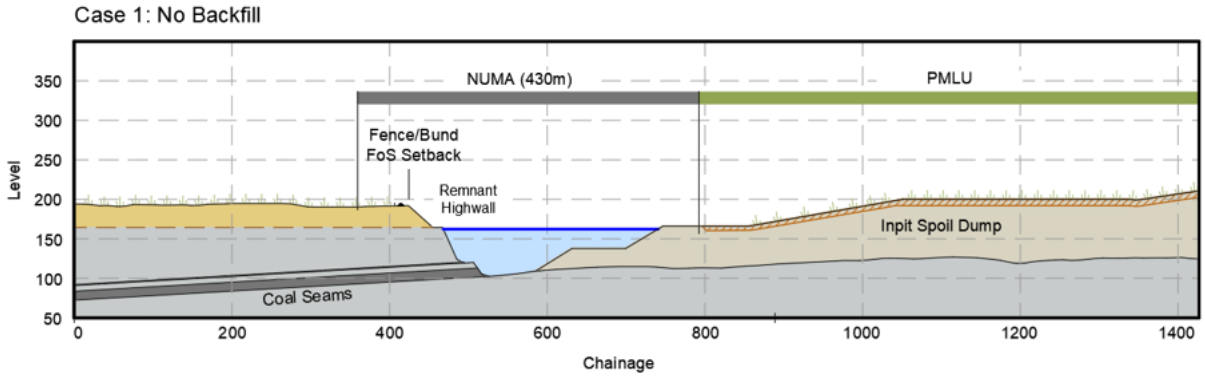


Figure 24 Option 1: Base Case No Filling of Void Section (Minserve)

Although this was originally the preferred option for the PTM final void, the proximity of the proposed NUMA to the Isaac River to the south necessitated further consideration of the void/NUMA configuration.

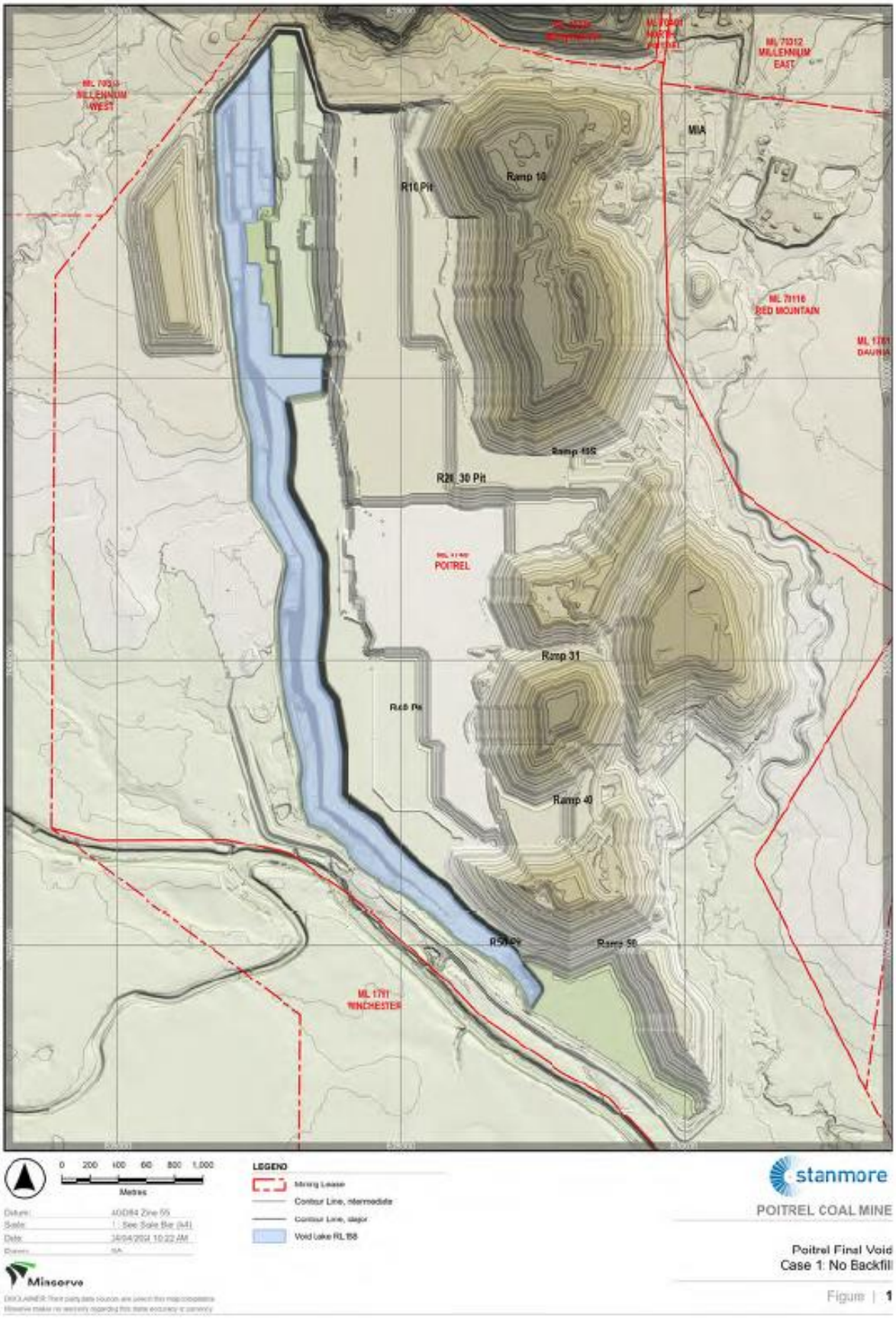


Figure 25 Option 1: Base Case No Filling of Void Plan View (Minserve)

3.4.3.1.2 Option 2 Free Draining Landform Fully Backfilling the Southern Voids

This option provides for fully backfilling the southern voids adjacent to the Isaac River, however as indicated in Figure 27, the residual void size is approximately 428ha as there is less fill material available in the northern section of the void due to the flatness of the mine floor, resulting in a larger void, in contrast to Option 1. The section taken across R40 showing extent of the NUMA is provided in Figure 26 with a total void length of 7km. A significant barrier in achieving this landform is that it requires approximately 59Mm^3 of backfill, with approximately 30Mm^3 not available during remaining operations requiring this material to be rehandled at closure. This also prevents the progressive rehabilitation of the dumps this material would be sourced from until completion of the final backfill.

Of the three landform options considered, this option leaves the largest residual void, requires the most movement and placement of spoil with considerable rehandle at closure, delays progressive rehabilitation of some areas, and is the least financially viable. Consequently, there are few advantages associated with this option and it has been discounted.

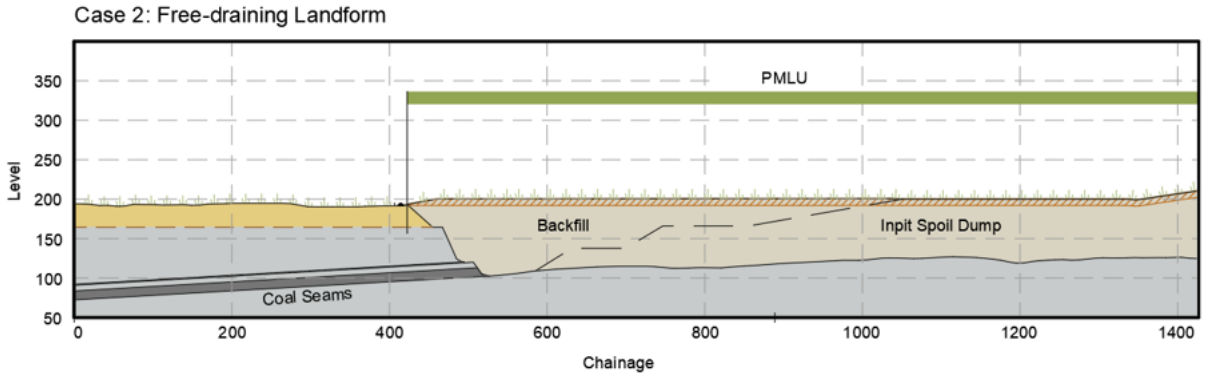


Figure 26 Option 2: Free Draining Landform Section

Due to the topography and altered landscape from mining activities, this landform continued to drain to the remaining residual void to the north. This significantly increased the risk that the void lake would reach levels where there would be interactions between the void lake and groundwater (i.e. the residual void would act as a groundwater source rather than a groundwater sink) with the potential for environmental harm.

This option also resulted in a shortfall of material in the north of the mine, which would necessitate the rehandling of large quantities of waste. Consequently, large sections of waste rock dump under this scenario would remain unavailable for rehabilitation, as the material would be required for future pit backfilling.

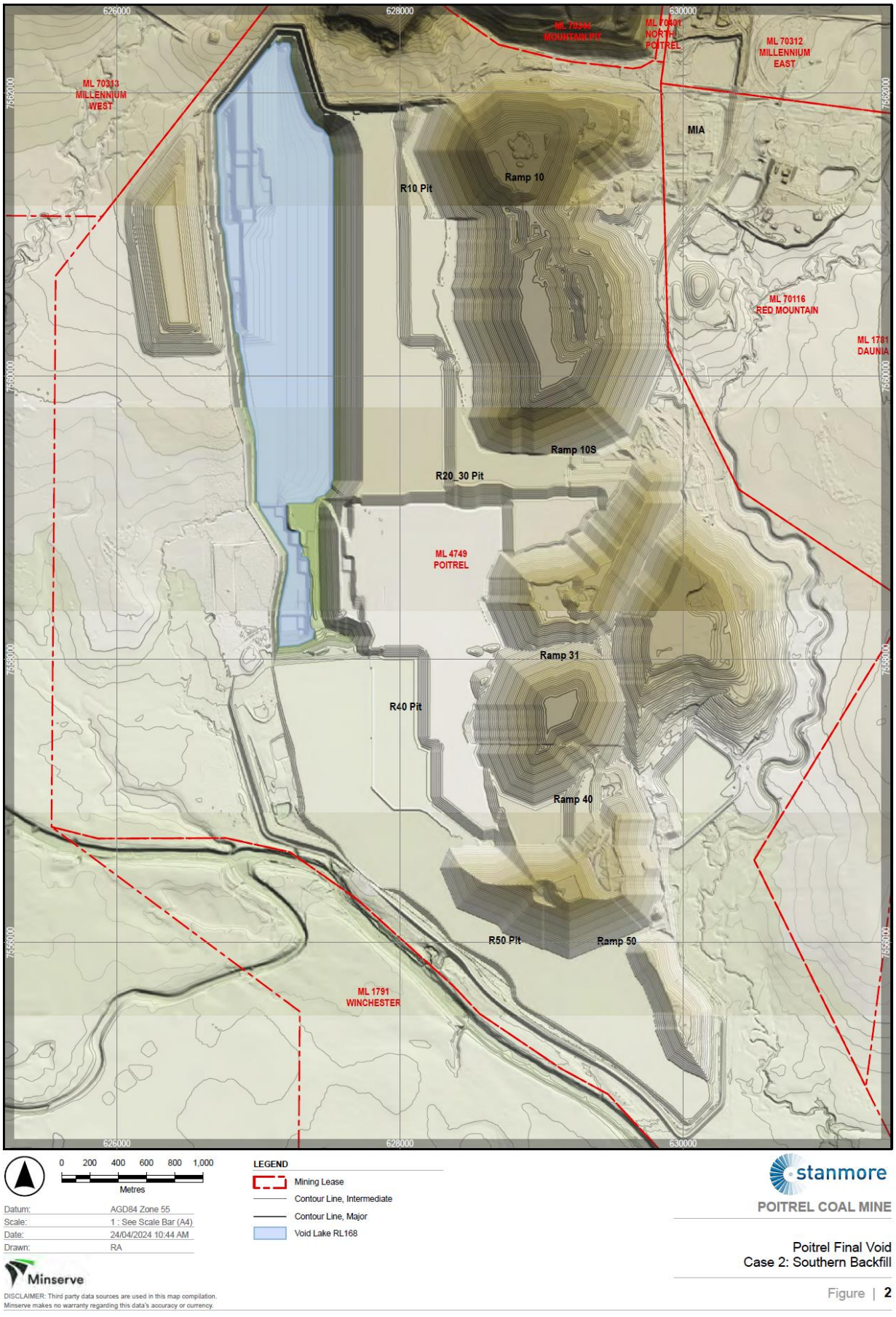


Figure 27 Option 2: Partial Backfill Voids Plan View

3.4.3.1.3 Option 3: Partial Backfill During Operations (Chosen Option)

This option has been determined as being the preferred option to achieve the closure objectives. This option undertakes partial backfill of the southern void adjacent to the Isaac River above the groundwater table. This option utilises available spoil across the remaining life of mine to reduce the residual void size in the south, however there is insufficient spoil material available to completely backfill against the residual highwall as described in Option 2. This option results in substantially minimising the NUMA extent in contrast to Option 1 and achieves a stable landform for the PMLUs in the southern void footprint.

As discussed in Section 3.6.3.3, the residual void is a groundwater sink. The remnant highwall would include fencing and bunding and highwall and low wall factor of safety setbacks. A plan view of the final pit extent is provided in Figure 29.

The length of the residual void is 12km and has a total surface area of 316ha. As indicated in Figure 28, the final surface water elevation in the residual void will not extend to the partially backfilled area in the southern void.

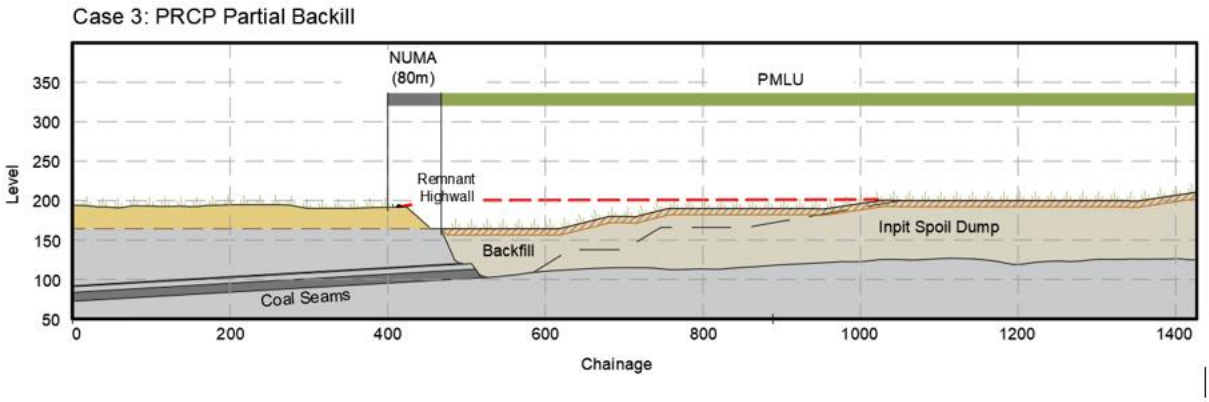


Figure 28 Option 3: Partial Backfill During Operations (Chosen Option) Section

In summary, this option reduces the likelihood of groundwater interactions with backfilled material in the void, and maintains the void's status as a groundwater sink, minimising the potential for the mobilisation of contaminants. Further, the area able to support a PMLU is maximised, while still factoring in slope safety and achievement of other associated milestone criteria for PMLUs adjacent to the high-, end-, and low walls. Potential impacts from and to the Isaac River are also minimised as a result of this landform configuration.

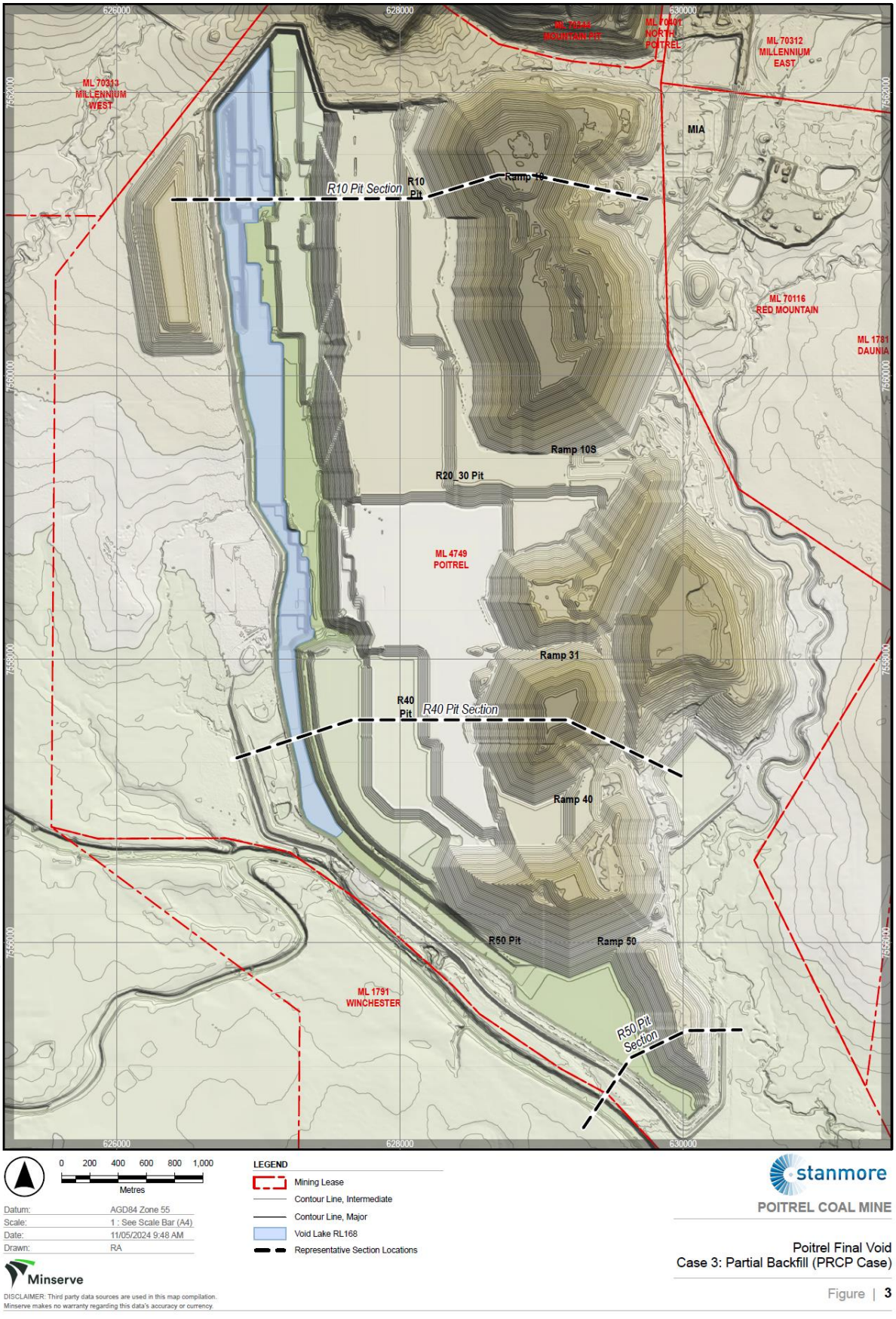


Figure 29 Option 3: Partial Backfill During Operations (Chosen Option) Plan View

3.4.3.1.4 Summary

A summary of the options analysis is it relates to the size of the residual NUMA and PMLUs is shown in Table 34. Option 3 (the chosen option for this PRC Plan application) clearly demonstrates that this option provides for the smallest feasible NUMA extent and consequently provides more available land to sustain a PMLU. Visual representations of the proposed final landform (Option 3) are provided in Figure 30 to Figure 43 below.

Table 34 Options Analysis Outcomes

Category	Option 1	Option 2	Option 3 (Chosen Option)
NUMA (ha)	404	428	316
PMLU (ha)	2137	2113	2225
Undisturbed (ha)	1352	1352	1352
Total	3893	3893	3893
NUMA (% of Disturbance)	**15.9%**	**16.8%**	**12.4%**

The preferred option for the PTM closure landform is Option 3. This is on the basis that:

- This option is feasible in consideration of the material available for backfill across the remainder of the mine plan.
- Allows progressive rehabilitation of areas across the mine in contrast to Option 2.
- Results in the smallest area of NUMA, and residual void extent as shown in Table 34.
- Achieves safe and stable landforms for the proposed PMLU within the southern void footprint.
- Minimises the potential for environmental harm. This landform was used as the basis for the detailed assessments to assess potential environmental risks in closure, with the outcomes of these studies are discussed in detail in the following sections.

Significant re-sequencing of the mine plan has been undertaken by the proponent to incorporate the preferred option into the long term mine plan and schedule.

Figure 30 North End Current Viewpoint

Figure 31 North End Proposed Final Landform

Figure 32 Entire Site Current Disturbance

Figure 33 Entire Site Proposed Final Landform

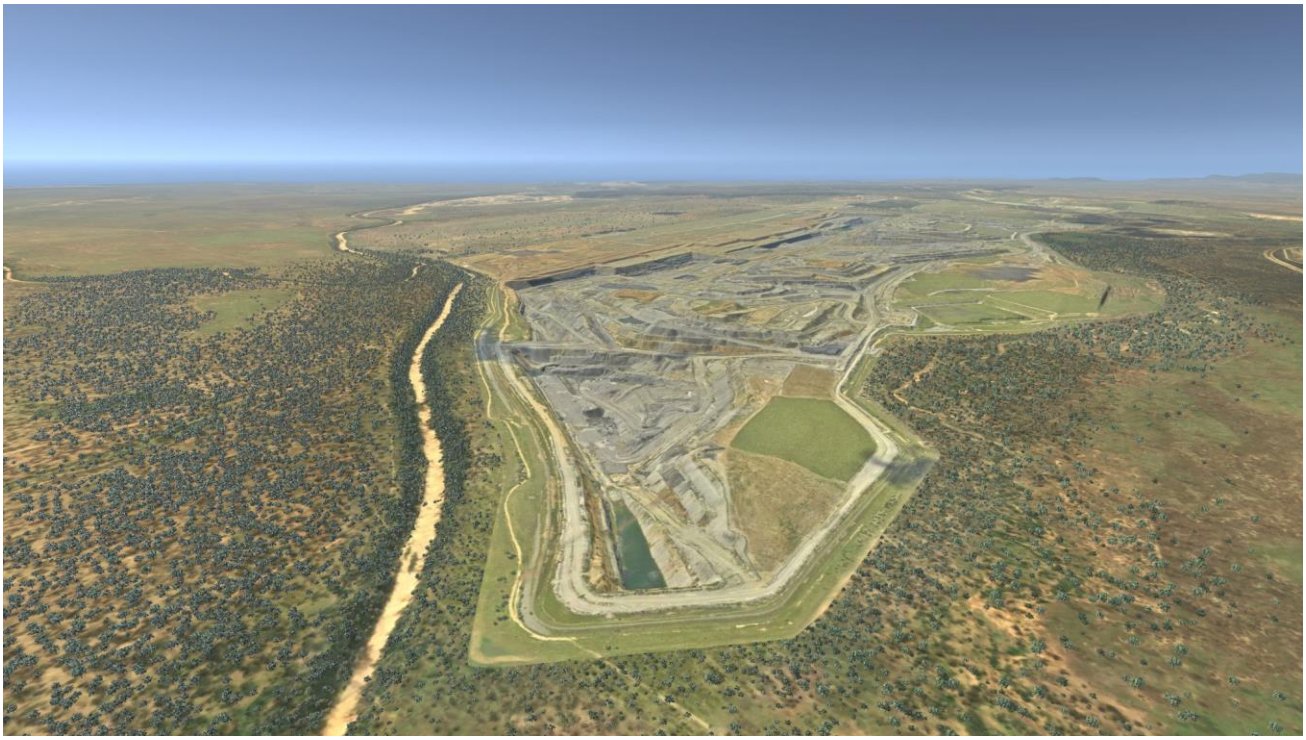


Figure 34 Southern End Current Viewpoint

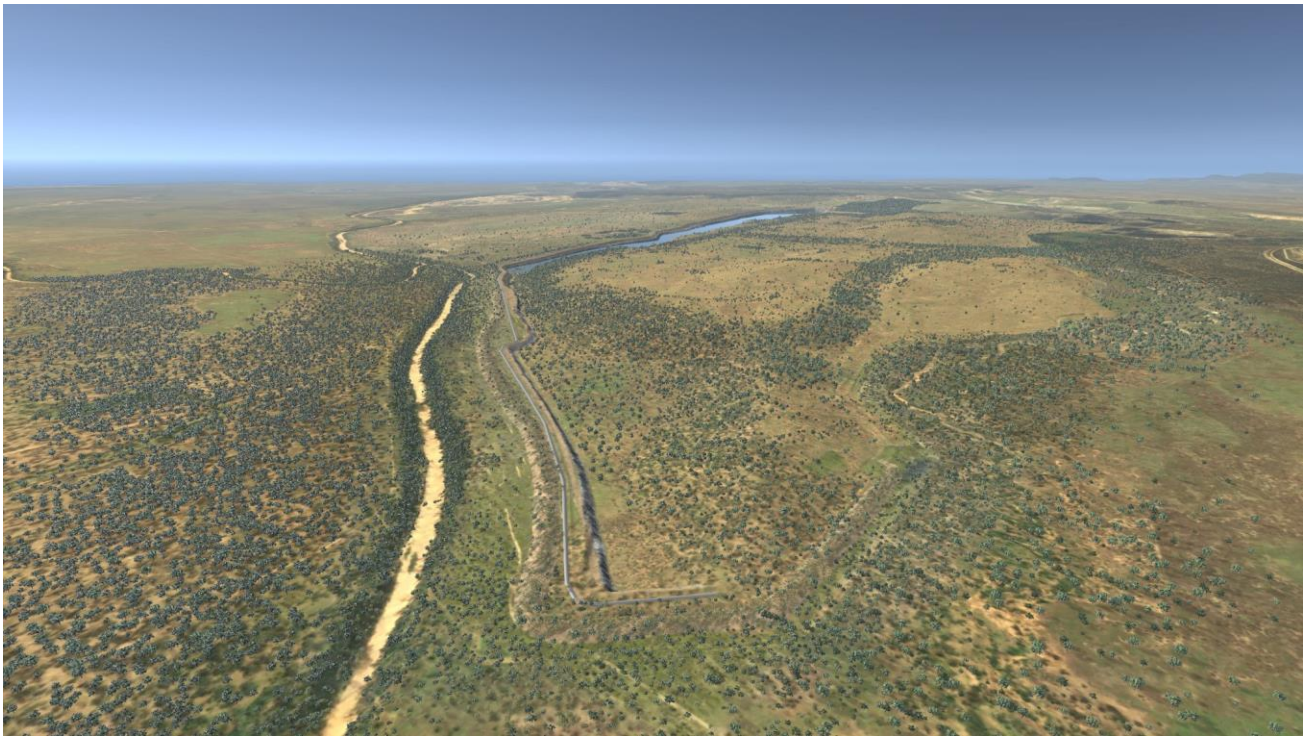


Figure 35 Southern End Proposed Landform

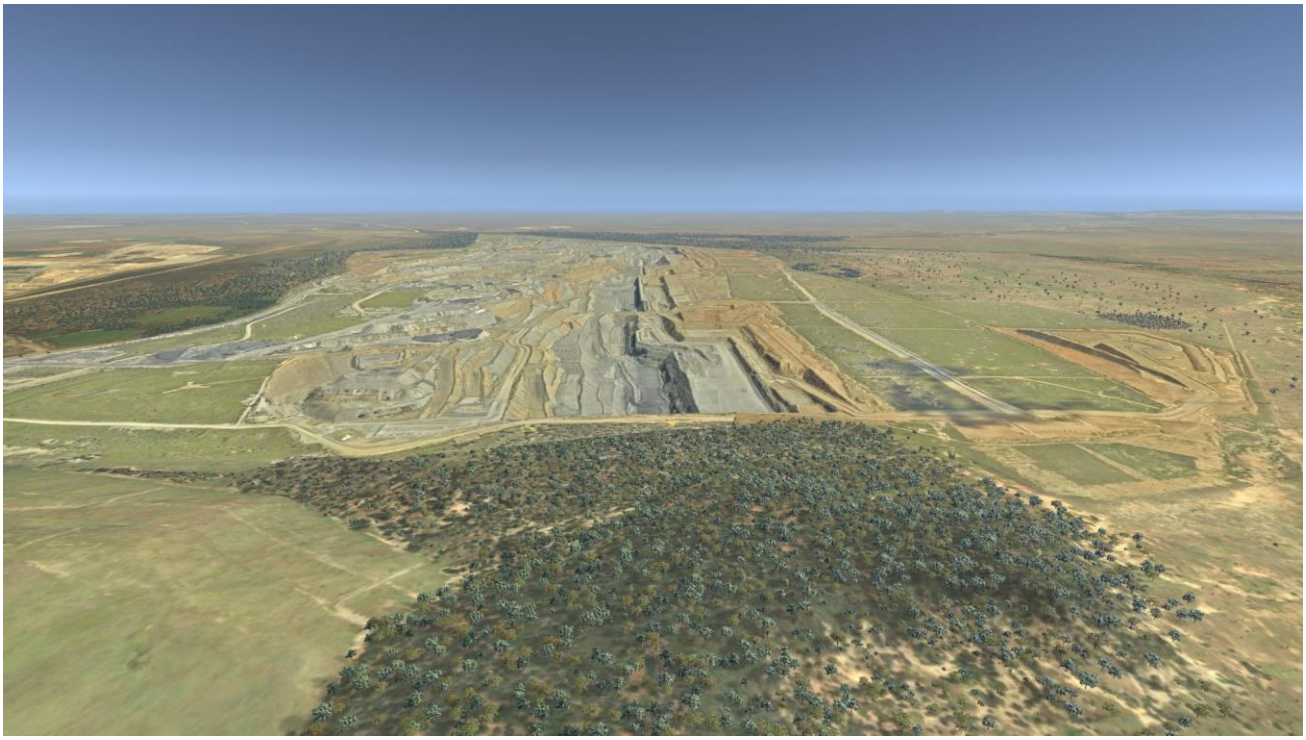


Figure 36 Northern End Current Viewpoint

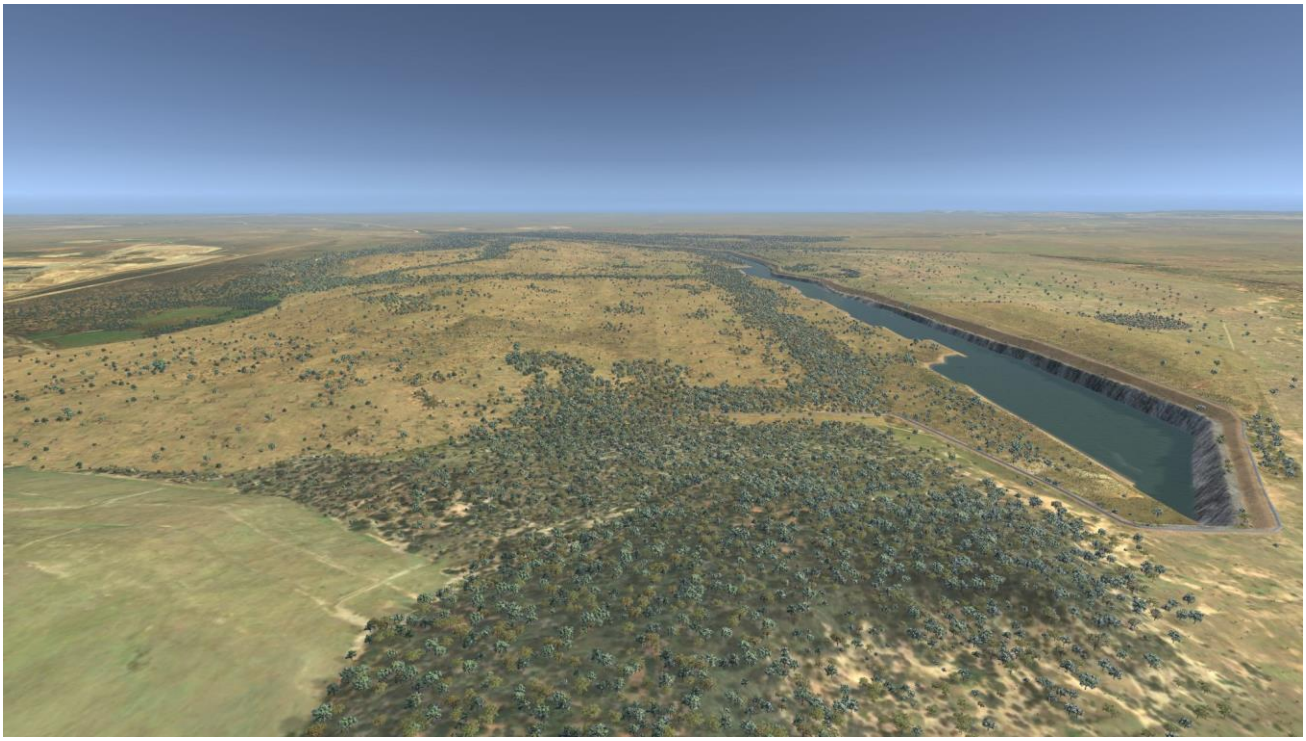


Figure 37 Northern End Future Landform

Figure 38 Current Viewpoint Looking East

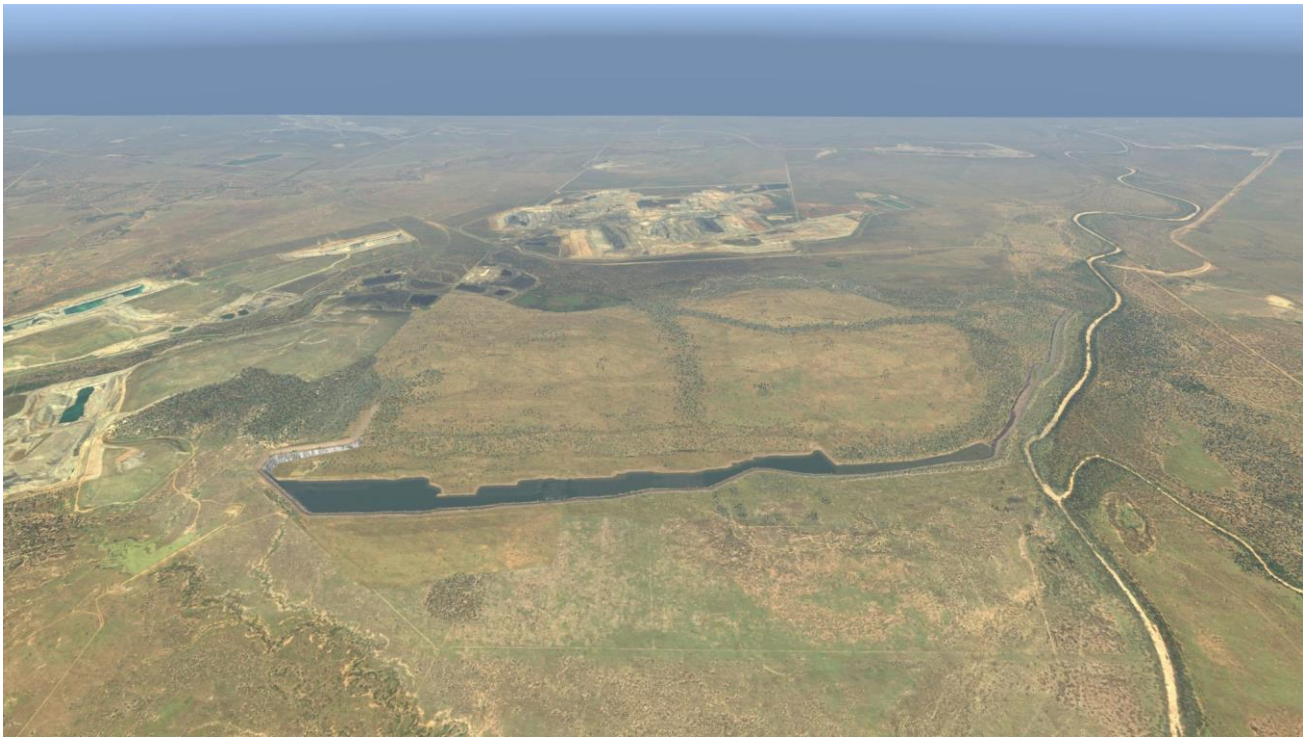


Figure 39 Proposed Final Landform Looking East

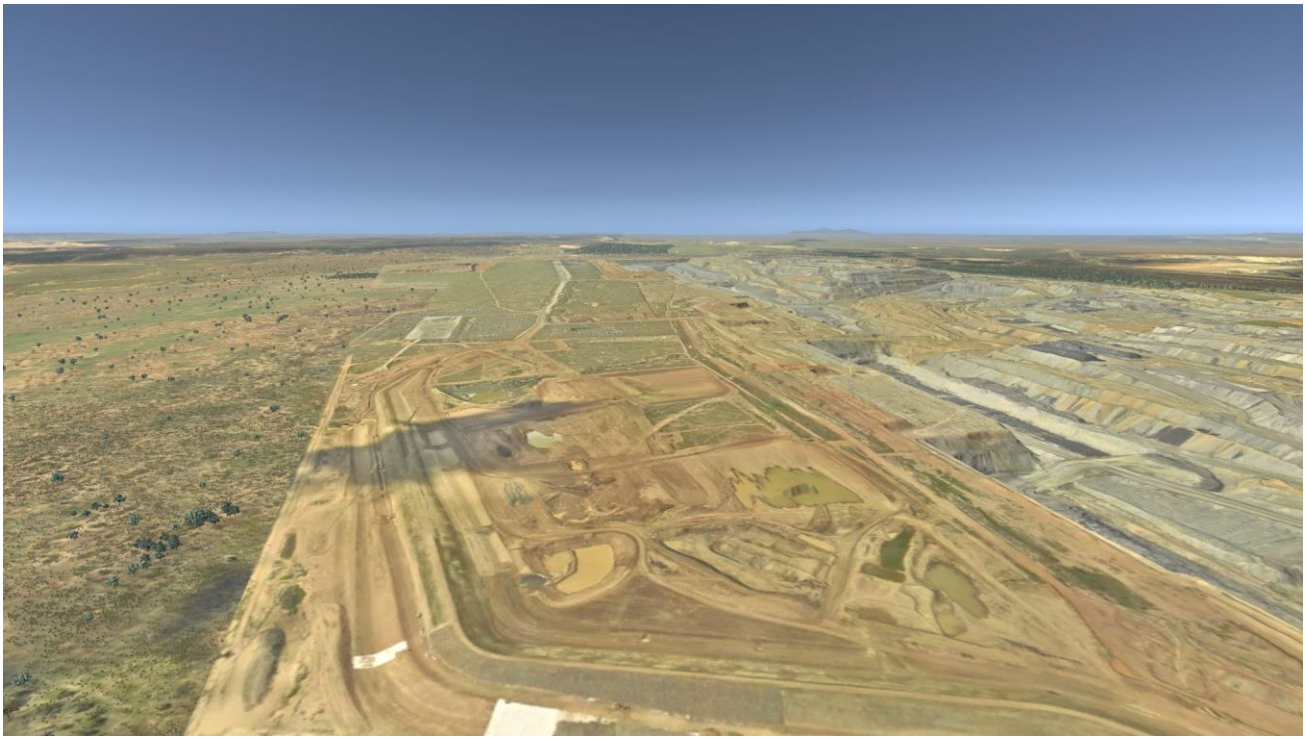


Figure 40 Current Landform Looking North

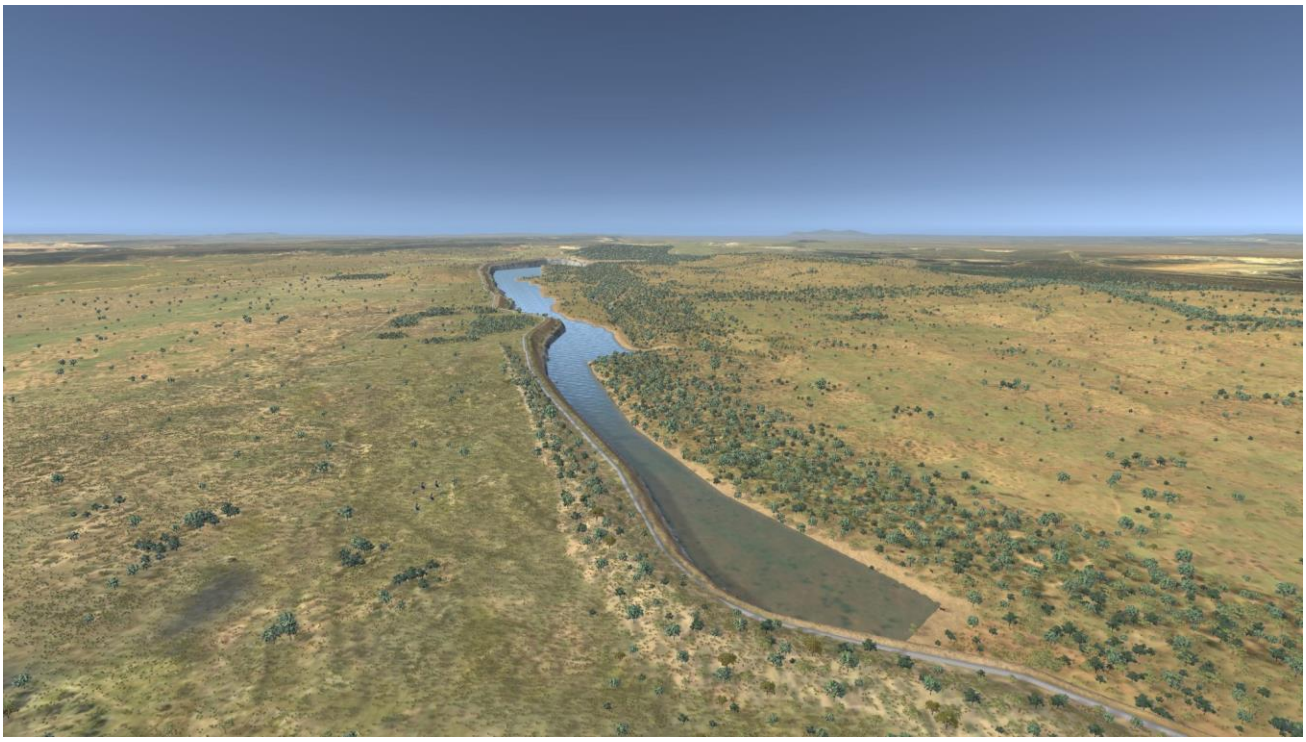


Figure 41 Proposed Final Landform Looking North

Figure 42 Current Drone Imagery Looking South

Figure 43 Proposed Final Landform Looking South

3.4.3.2 Minimising Size and Area

Based on the outputs of the initial PRC Plan studies and options assessment, the NUMA extent has been minimised with the high-wall and end-wall redesigned to increase the distance from the approval boundary and watercourses for the void, with the aim to achieve the minimum geotechnical stability FoS of ≥1.25 within the NUMA extents, and to limit interaction with the floodplain.

The refined NUMA locations and reduced extent, were then used as the basis for the following studies:

- Updated void in a flood plain assessment (Section 3.5).
- Rehabilitation flood modelling (Section 3.6.1.2).
- Updated void water balance modelling (Section 3.6.3).
- Updated void water quality modelling (Section 3.6.3).
- Updated void geotechnical assessment (Section 3.6.3).
- Groundwater modelling (Section 3.6.1.1).

3.4.3.3 Minimising Environmental Harm

The detailed technical studies have been undertaken in an iterative approach as part of the final landform design. These iterations have resulted in a closure landform design that minimises environmental harm and achieves sufficient improvement of the NUMA. The detailed assessments and management milestones are described in the Void Closure Plan (Appendix 8).

The key outcomes of the technical studies relevant to demonstrating prevention or minimising environmental harm from the NUMA include:

- The flood modelling assessed a range of modelled design storm events, being the 1%, 0.1% AEP and PMF flooding simulations. The findings indicate that:
- The final landform embankment between the Isaac River and R40/ R50 Pit provides flood immunity from 1% and 0.1% AEP flood events in the Isaac River.
- The configuration of the final landform and the out of pit dumps located on the eastern side of the site (adjacent to Ramp 10, 10S, 31 and 50) prevents flood waters from entering into the final void from the eastern side.
- No stream velocities in excess of 1.5m/s occurred in flood events up to and including the 0.1% AEP. It is expected that the final landform is likely to have low erosion/scour risk following the establishment of vegetation.
- The mean pit lake water levels at equilibrium stabilise at 169 mAHD and remain below the void spill point (197 mAHD). Therefore, the voids will not overtop and environmental harm beyond that of the void itself is not expected.
- The mean pit lake water levels at equilibrium stabilise at 169 mAHD and remain below the recovered groundwater levels (180 mAHD) for the residual voids ensuring the void will act as long-term groundwater sinks. This reflects an available storage capacity of between 15,871ML and 23,308ML for the void to continue acting as a sink.
- Acidic conditions are unlikely to develop in the residual void lake, with alkaline conditions developing throughout the modelled period. TDS concentrations increase over the model duration but are not predicted to exceed the EA trigger value until after the simulation period (year 2190).
- The void achieved the minimum geotechnical FoS for both the highwall and low walls, with only the northern end of the NUMA extent being increased to account for setback distances from the highwall to achieve the minimum FoS.
- A calibrated numerical groundwater modelling was developed and has been used to assess the proposed final landform and NUMA. The modelling also utilised particle tracking to simulate and assess the movement and fate of water particles through the groundwater system post mining. The model indicates that the residual void will act as a terminal sink for groundwater, with the hydraulic gradient being towards the residual void across the majority of the site:

- The particle movement simulation for particles placed within the residual void indicated that groundwater will remain within the mine closure landform (i.e., rehabilitated in-pit spoil and residual void) in the long-term (SLR, 2024). This includes the modelled fluxes of water from the residual void to the in-pit spoil of the mine closure landform, with these particles returning to the residual void. The simulation also predicted that the void remains as a groundwater sink and the particles would not flow from the residual void off-site to the receiving environment. The particles placed outside of the residual void at the potential contaminant source, the MIA, are all captured within the residual void or remain within the mine closure landform for the duration of the post-mining simulation.
- Predictive hydrographs were derived at the potential GDE sites identified within and adjacent to PTM. The hydrographs indicate that drawdown of the water table in the vicinity of the potential GDEs is predicted to occur prior to the end of mining, with any additional drawdown occurring over the post-mining period predicted to be a result of continuing operational drawdown trends (i.e., a time lag from active mining), rather than new impacts caused by the mine closure landform design.

All NUMAs have management considerations, developed as part of the Void Closure Plan, to further support attainment of NUMA voids that are safe and do not present an unacceptable risk of environmental harm.

MMs have also been developed, refer section below, as part of the PRC Plan Schedule and will require certification from an AQP that residual voids (NUMAs) will not cause environmental harm to land, surface waters or any recognised groundwater aquifer.

3.4.4 Management Milestones

For each NUMA, MMs must be supported by milestone criteria that:

- Are the most appropriate for achieving the milestone.
- Facilitate achieving subsequent management milestones.
- Have regard to the technical knowledge available when the PRC Plan objective assessment is being conducted about managing risks of the NUMA to the environment.
- Achieve the prevention of the production and release of contaminants or, if prevention is not possible, minimise the impact of the release of contaminants.

The PRC Plan Guideline states that management of a NUMA must be done in a way that achieves best practice management of the area and minimises risks to the environment.

The proposed MMs and associated justification are provided in Table 35.

Table 35 Management Milestones for PTM

Milestone Reference	Management Milestone	Milestone Criteria	Justification for Transition and Proposed NUMA Milestone Criteria
MM1	Achievement of structural stability	• Rehabilitation is geotechnically stable and achieves a minimum Factor of Safety of ≥1.25 as determined by an AQP.	• Given the absence of criteria to be transitioned from LODs, an AQP has undertaken an assessment to determine the FoS.
MM2	Achievement of surface requirements	• Safety bund is constructed, where required, at the geotechnical set-back distance. • Fencing erected around perimeter of safety bund, where required. • Warning signage placed along fence line, where required.	• Considered best practice to adequately prevent human and livestock access to voids. • Considered best practice to adequately prevent human and livestock access to voids.

Milestone Reference	Management Milestone	Milestone Criteria	Justification for Transition and Proposed NUMA Milestone Criteria
			• Considered best practice to warn humans of potential risks.
MM3	Achievement of sufficient improvement	• Certification from an AQP that residual voids will not cause environmental harm to land, surface waters or any recognised groundwater aquifer. • Certification from an AQP that the residual voids are safe to humans and livestock.	• Transitioned from Condition E6 of EPML00963013 with the addition of a certification process. • Considered best practice based on outcomes of Void Closure Plan.

3.4.4.1 Management Milestone Timeframes

Given the dynamic nature of life of mine planning there is inherent uncertainty when planning for the achievement of management milestones. Timeframes associated with the milestones for the IA were developed by considering the requirements of each management milestone as outlined in previous sections and the associated risks identified through the risk assessment. The nominated timeframes and respective justifications are detailed in Table 36. These timeframes have been used to develop the milestone schedule in the PRC Plan Schedule.

Table 36 Timeframe Justification for Management Milestones for IA1

Management Milestone	Nominated Timeframe	Justification
MM1 – Achievement of structural stability	5	To validate that stable batters are achieved, geotechnical investigations may be required, and modelling undertaken to quantify stability. Sufficient time has been accounted for these activities, which factor in the availability of geotechnical drill rigs. Considering that this milestone requires validation that the void is performing as per the design intent, five years is considered a sufficient time to complete this milestone.
MM2 - Achievement of surface requirements	5	Considering the large spatial extent of the voids, designing, and constructing the required bunds and fencing, five years is considered a sufficient time to complete this milestone
MM3 - Achievement of sufficient improvement	5	Sufficient time must be factored into this milestone timeframe to allow for detailed analysis of data by an AQP to certify that the residual voids won't cause harm to the environment, humans and livestock. A five year timeframe is considered sufficient to facilitate meaningful trend analysis.

3.4.5 Community Consultation

The final land use encompassing NUMAs is consistent with the outcomes of community consultation as outlined in Section 3.2. As discussed in Section 2.3.5, approval of the EA has considered outcomes of consultation with the community in developing the plan and, as the EA does not limit the number or size of the residual voids, further community consultation is not required to support this PRC Plan Schedule application.

3.4.6 Consistency with Local, State and Commonwealth Strategies and Plans

The extent to which the NUMAs are consistent with Local, State and National strategies and plans is outlined in Table 37 below.

Table 37 Consistency of the NUMA with Local, State, and Commonwealth Strategies and Plans

Strategy or Plan	Purpose	NUMA Consistency
Local / Regional		
Isaac Regional Planning Scheme 2021 (Isaac Regional Council, 2021)	The Isaac Regional Council planning scheme has been prepared in accordance with the Planning Act 2016 as a framework for managing developing in a way that advances the purpose of the Act.	The region has a long history of mining and the Town Plan and urban areas of the Isaac region act as a gateway for supporting major mining activities. Final voids are a common occurrence with open cut mining activities. As such the existing of a final void (i.e., NUMA) is not inconsistent with the planning scheme
Mackay, Isaac, and Whitsunday Regional Plan	The Mackay, Isaac and Whitsunday Regional Plan establishes a vision and direction for the regional to 2031. It provides certainty about where the region is heading and provides a framework to respond to challenges and opportunities that may arise.	Mineral and extractive resource industries are significant components of the region's economy, in particular, coal and coal seam gas, as detailed in the desired regional outcomes in the regional plan. Final voids are a common occurrence with open cut mining activities. As such the existing of a final void (i.e., NUMA) is not inconsistent with the regional plan.
State		
State Planning Policy (SPP) (Department of Local Infrastructure, Local Government and Planning, 2017)	The SPP expresses the states interests in land use planning and development. A state interest is defined under the Planning Act as an interest that the Planning Minister considers affects an economic or environmental interest of the state or a part of the state, or affects the interest of ensuring that the purpose of the Act is achieved. Under the Planning Act, local governments must integrate relevant state interests into the planning scheme for their local government area.	The inclusion of the final void (i.e., NUMA) does not compromise the SPP overlays that apply to PTM: • Bushfire hazard, • Natural environment, • Regional infrastructure.
A Strategic Blueprint for Queensland's Northwest Minerals Province (The Strategic blueprint) (Queensland Government, 2017)	A strategic Blueprint for Queensland's Northwest Minerals Province contains a suite of actions to secure the long term future of Northwest Queensland. It will facilitate a strong and prosperous future by building on existing economic and community strengths in collaboration with industry, business, and community leaders.	The Strategic Blueprint acknowledges that mining industry has been the primary driver for regional employment and economic growth in the province. The Strategic Blueprint also notes that a Northwest Minerals Province Taskforce has been established to identify issues affecting the Province's mining industry and to help plan a strategic way forward. The Queensland Government has also committed, through the blueprint, to facilitating a smooth economic and social transition towards a strong and more

Strategy or Plan	Purpose	NUMA Consistency
		diversified economy, building on existing economic and community strengths, includes mining. A final void is typical for open cut mining operations and therefore a NUMA is not inconsistent with the Strategic Blueprint.
Mackay-Whitsunday Regional Action Plan	As part of the Queensland Budget for 2021 – 2022 a regional action plan for the Mackay Whitsunday area was established. The regional plan outlines how the Queensland Budget will directly support Mackay-Whitsunday.	A new $7 million Resources Centre of Excellence to be built in Mackay. The centre is a one of the kind in Queensland. The Region remains one of the world's best sources of mining expertise and innovation in the mining equipment, technology, and services (METs) sector. The centre features a simulated underground coal mine. A final void is typical for open cut mining operations and therefore a NUMA is not inconsistent with the Mackay-Whitsunday Regional Action Plan.
Commonwealth		
Our North, Our Future: White Paper on Developing Northern Australia (The White Paper) (Australian Government, 2015)	The White Paper sets out how the Commonwealth Government will address challenges to development in northern Australia by: • Making it easier to use natural assets, in close consultation with, and the support of indigenous communities. • Providing a more welcoming investment environment. • Investing in infrastructure to lower business and household costs. • Reducing barriers to employing people. • Improving governance.	The White Paper identified the Australian Government's aspirations for resources as a diverse portfolio of mining across the north including existing large scale resources such as iron ore, base metals and gold, and new mines for strategic minerals such as rare earths. A final void is typical for open cut mining operations and therefore a NUMA is not inconsistent with the White Paper aspirations.

3.5 Voids in Floodplains

Legislative Requirement

In accordance with section 126D (3) of the EP Act, if land the subject of the proposed PRC Plan Schedule will contain a void situated wholly or partly in a flood plain, the schedule must provide for the rehabilitation of the land to a stable condition.

PRC Plan Guideline (Section 3.4)

Section 41C of the EP Regulation states the decision considerations for a void situated wholly or partly in a flood plain. A void is considered to be located in a flood plain if the flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% AEP for a relevant watercourse under the guideline Australian Rainfall and Runoff (2019) (ARR).

Where a land outcome document has a pre-approved land outcome for a void with a location specified, flood plain modelling is not required. If a void has been identified as a NUMA in a land outcome document but the location is not identified, the applicant is required to carry out flood plain modelling in accordance with this section of the guideline. While the provision in the EP Act relating to voids located within a floodplain having to rehabilitate to a stable condition does not apply, the PRC Plan must include how the proposed location of the void minimises risks to the environment. Therefore, the flood plain modelling is required to support the assessment of the proposed location of the void.

If there are no land outcomes identified in a land outcome document, the applicant is required to carry out flood plain modelling in accordance with this section of the guideline.

3.5.1 Background

The PRC Plan Guideline states that "Where a NUMA has already been identified in a land outcome document and is able to be transitioned into the PRC Plan schedule, the applicant is not required to comply with sections 126C(1)(g) or (h) or 126D(2) or (3) of the EP Act. As the NUMA is identified in the EA, under the transitional provisions (section 754(3)) the applicant is not required to comply with section 126D(3) of the EP Act.

The proponent has completed a Voids in Floodplain assessment, included in Appendix 5. The assessment has been undertaken in accordance with the requirements of the Australian Rainfall and Runoff (ARR) 2019 Guideline, and addresses Section 3.4 of the PRC Plan Guideline, and the DES *Information Sheet – Voids in Flood Plains (DESI, 2024)*.

To determine the floodplain extent, the ‘pre-mining’ contour data was processed into a 1 metre spaced DEM and combined with the available Isaac River LiDAR DEM, and publicly available 1 second hydrologically enforced SRTM data. All artificial features (such as pits, waste rock dumps and infrastructure) located on the PTM mining leases were removed, however some features on neighbouring leases were retained (SLR, 2022).

3.5.2 Relevant Watercourses

Under the Voids in Flood Plains Information sheet, a ‘*Relevant Watercourse*’ is defined as:

(a) A watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or

(b) If a watercourse mentioned in paragraph (a) is permanently diverted under—

(i) A condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, Section 98; or

(ii) A water licence or proposed water licence under the Water Act 2000;

the watercourse as permanently diverted.

SLR (2022) identified two relevant watercourses in proximity to PTM:

- Isaac River.

- Cherwell Creek.

3.5.3 Modelling

A hydrological model was developed using the Watershed Bounded Network Model (WBNM), with the Isaac River and Cherwell Creek catchments totalling approximately 8,300km^2. WBNM hydrological inputs were adopted in accordance with the ARR 2019 Guideline. The 0.1% AEP (1000yr) design rainfall depths were sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available from the Bureau of Meteorology (BoM).

The closest stream gauges to the site are located at Goonyella (130414A) and Deverill (130410A). However, these gauges did not have suitable data records to enable calibration of modelled hydrographs. Instead, the 0.1% AEP peak flows were validated using a scaled Flood Frequency Analysis (FFA) using the Water Monitoring Information Portal (WMIP).

The WBNM flow hydrographs were then applied to a two-dimensional hydraulic model (TUFLOW). Results extracted from TUFLOW included peak water surface levels and depths for the 0.1% AEP event. The accuracy of hydraulic model results were limited to the accuracy of the available topographic data sets. Further to this, consideration was given to the groundwater influence on the floodplain extent. However, SLR (2022) determined that groundwater would have no significant impact on the extent of the floodplain.

Further detail on the hydrologic and hydraulic model setup, inputs and assumptions can be found in Appendix 5.

3.5.4 Results

Peak water surface levels and depths for the 0.1% AEP event are illustrated in Figure 44. The results indicate that the southern portion of the final void interacts with the Issac River Floodplain. Given this interaction, the final landform includes a final landform embankment that prevents flood ingress (for events up to, and including the 0.1% AEP) into the final void. Flooding susceptibility and influence on closure landforms, along with mitigation strategies to manage risks presented by floodwaters, is discussed in Section 3.6.1.2.

The proponent has optimised the landform design to reduce the size of the residual NUMAs referenced in Section 3.4.

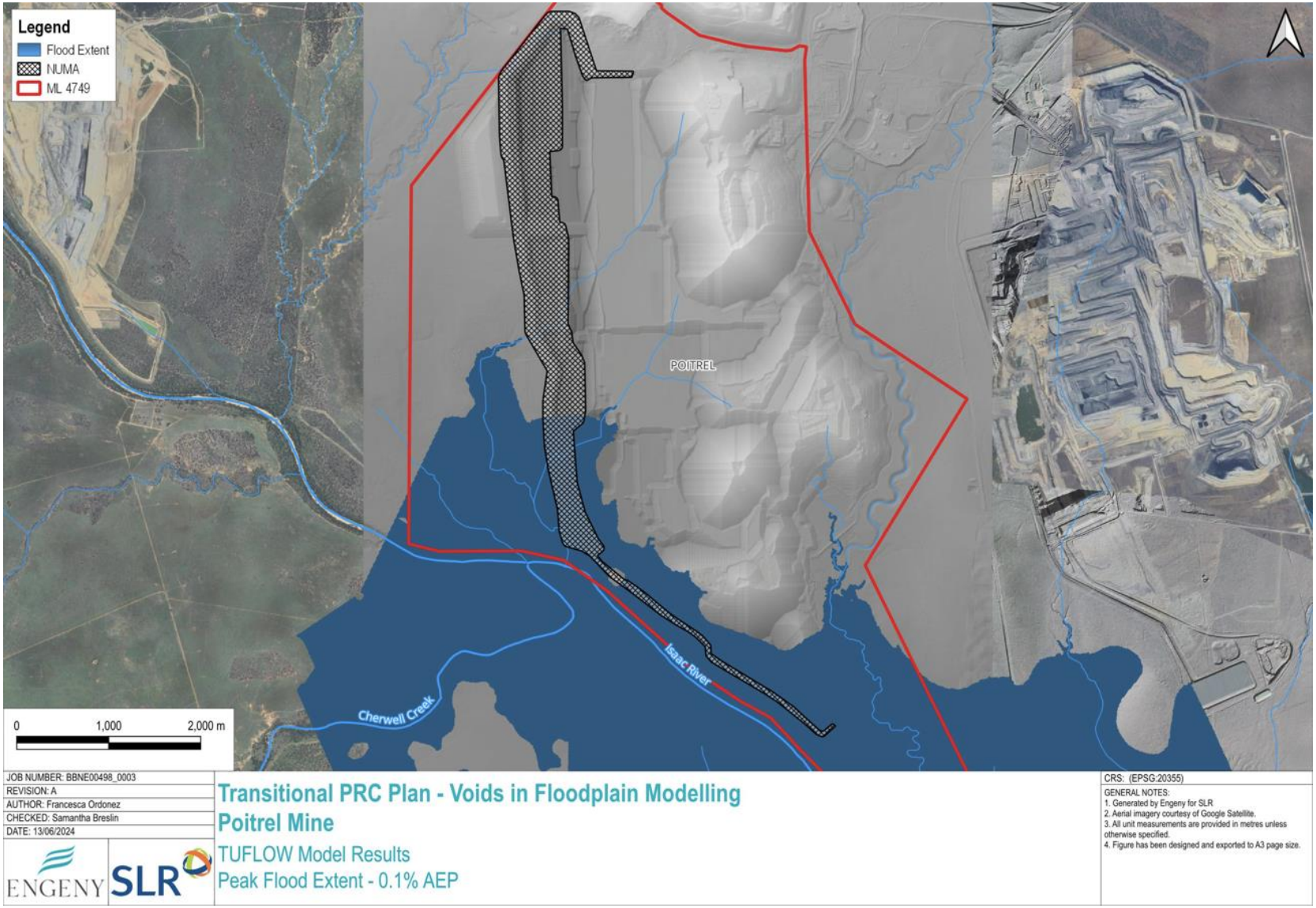


Figure 44 Peak Flood Extent – Voids in Floodplain – 0.1% AEP

3.6 Rehabilitation and Management Methodology

Legislative Requirement

In accordance with section 126C (1)(e) and (i), the rehabilitation planning part of the PRC Plan must:

- For each proposed post-mining land use for land, state the proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRC Plan Schedule.
- For each proposed non-use management area, state the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRC Plan Schedule for the area.

PRC Plan Guideline (Section 3.6)

The proposed rehabilitation or management methodologies will underpin the development of the milestone criteria and support how the proposed PMLU will be achieved, or the NUMA will be managed. As per section 126C(1)(j) of the EP Act, the administering authority requires information describing how the proposed rehabilitation or management methodologies have been developed and will be implemented.

This section identifies a number of studies or reports that must be provided in the proposed PRC Plan. If any of the required information outlined below is not relevant to the specific operation, the applicant must provide justification in the PRC Plan outlining why the information is not required.

3.6.1 General Rehabilitation Practices

PRC Plan Guideline (Section 3.6.1)

This section outlines the range of information that the administering authority considers is necessary to underpin the development of the rehabilitation or management methodologies applicable to new and existing mines for most domains. The applicant must include the information as appendices to the rehabilitation planning part.

A series of technical studies have been completed to both inform final landform design and to address the general rehabilitation practices for PTM. Initial rehabilitation flood modelling, void water balance modelling, hydrogeological assessments and void geotechnical stability assessments were undertaken in an iterative manner to inform final landform design (Refer to Section 3.6.1.5).

The following studies were completed and/or updated based on the final landform:

- Rehabilitation flood modelling (Section 3.6.1.2).
- Void Closure Plan (Section 3.6.3) including:
- Void water balance modelling
- Void water quality modelling
- Void geotechnical assessment
- Groundwater modelling (Section 3.6.1.1)
- Waste and Soils characterisation assessments (Section 3.6.1.3 and 3.6.1.4)
- Revegetation Plan (Section 3.6.1.8)
- Cover design (Section 3.6.1.6)

3.6.1.1 Hydrogeology

PRC Plan Guideline (Section 3.6.1)

Assess the hydrogeology of the site and all connected strata and develop a conceptual model of the mine site's groundwater systems. This information must be integrated into the design of rehabilitation strategies and choice of PMLU or NUMA.

A hydrogeological assessment has been undertaken to support the development of this PRC Plan. The detailed report – Hydrogeology Assessment: Poitrel Mine is provided in Appendix 3. PTM conducts monthly groundwater monitoring in accordance with EA condition I3 and EA Tables I1 and I2 to assess groundwater trigger levels. Additionally, an annual groundwater monitoring data review is conducted by a hydrogeologist (EA condition I5). The review includes the assessment of the groundwater levels and water quality data, and the suitability of the monitoring network. The review is a detailed report that assesses the impacts of mining on groundwater.

3.6.1.1.1 Hydrogeological Setting

The geological composition within PTM encompasses the Permian Rangal Coal Measures underlying the Triassic Rewan Group, with Quaternary alluvium deposits adjacent to the Isaac River. Key hydrostratigraphic units comprise of Cainozoic Sediments, the Triassic Rewan Group, and the Permian Coal Measures.

Groundwater movement primarily occurs within the Permian Coal Measures, mainly through interconnected cleats and fractures within coal seams, which act as the primary regional aquifer. However, the presence of low permeability overburden and interburden confines the flow. Notably, extensive deformation, including folding and faulting, has occurred within the Permian coal measures, leading to compartmentalization of groundwater systems, particularly due to northwest-southeast trending faults like the Isaac Thrust Fault and New Chum Fault.

The Cainozoic Sediments, including Quaternary alluvium and weathered regolith, form an interconnected hydrogeologic unit with significant lithological and stratigraphic heterogeneity. Groundwater within this unit generally flows towards the PTM mining area, influenced by topographic gradients, with potential losing conditions from the Isaac River to the underlying alluvium during flow periods.

The Triassic Rewan Group, acting as a regional aquitard, presents limited hydraulic connectivity with surrounding units due to its fined-grained nature, though some saturated horizons exist. Recharge predominantly occurs via leakage from overlying units, with low recharge rates due to low hydraulic conductivity.

Water quality varies across these units, ranging from moderately saline to highly saline, rendering it generally unsuitable for drinking purposes but potentially applicable for irrigation or stock use. Groundwater discharge primarily happens through evaporation from pit faces in mining operations.

3.6.1.1.2 Groundwater Recharge and Discharge

Recharge to the alluvium primarily occurs through stream flow and flooding, with rainfall directly infiltrating where clay barriers are absent. Alluvial groundwater levels correlate with rainfall, and discharge happens through evapotranspiration from riparian vegetation along the Isaac River, as well as baseflow contributions post-rainfall and floods. Private bores also contribute to groundwater discharge. Low hydraulic conductivity strata underlie the alluvium, limiting downward leakage. Perched water tables are observed where clay layers impede surface water percolation.

Recharge to non-alluvial Tertiary sediments and weathered strata is limited by low hydraulic conductivity material, hindering rainfall infiltration. Groundwater discharge from these strata occurs mainly through evapotranspiration, with some short-term baseflow to streams after wet periods. Vertical seepage is restricted by the presence of low hydraulic conductivity materials.

3.6.1.1.3 Groundwater Quality

Proportions of major anions and cations were analysed to determine the hydrochemical facies of PTM groundwaters. Durov diagrams (Figure 45 to Figure 47) showcase the anion-cation balance, pH, and EC from historical monitoring bore data, divided by aquifer.

In the Cainozoic Sediments (Figure 45), groundwater exhibits a Na-Cl type with a pH range from weakly acidic to weakly alkaline and an EC range from 13,800 to 29,800µS/cm.

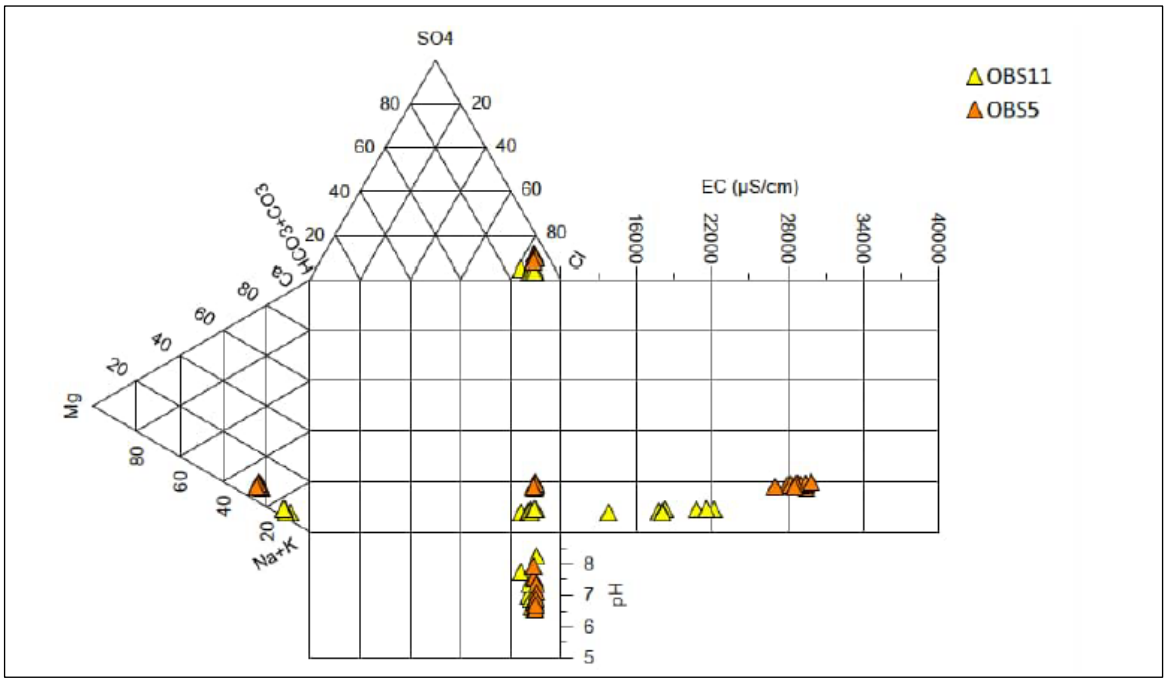


Figure 45 Durov Diagram – Cainozoic Sediments

Groundwater quality from two bores screened in the Rewan Group shows a Na-Cl groundwater type with pH range from weakly acidic to weakly alkaline and an EC range from 8,500 to 12,800µS/cm (Figure 46).

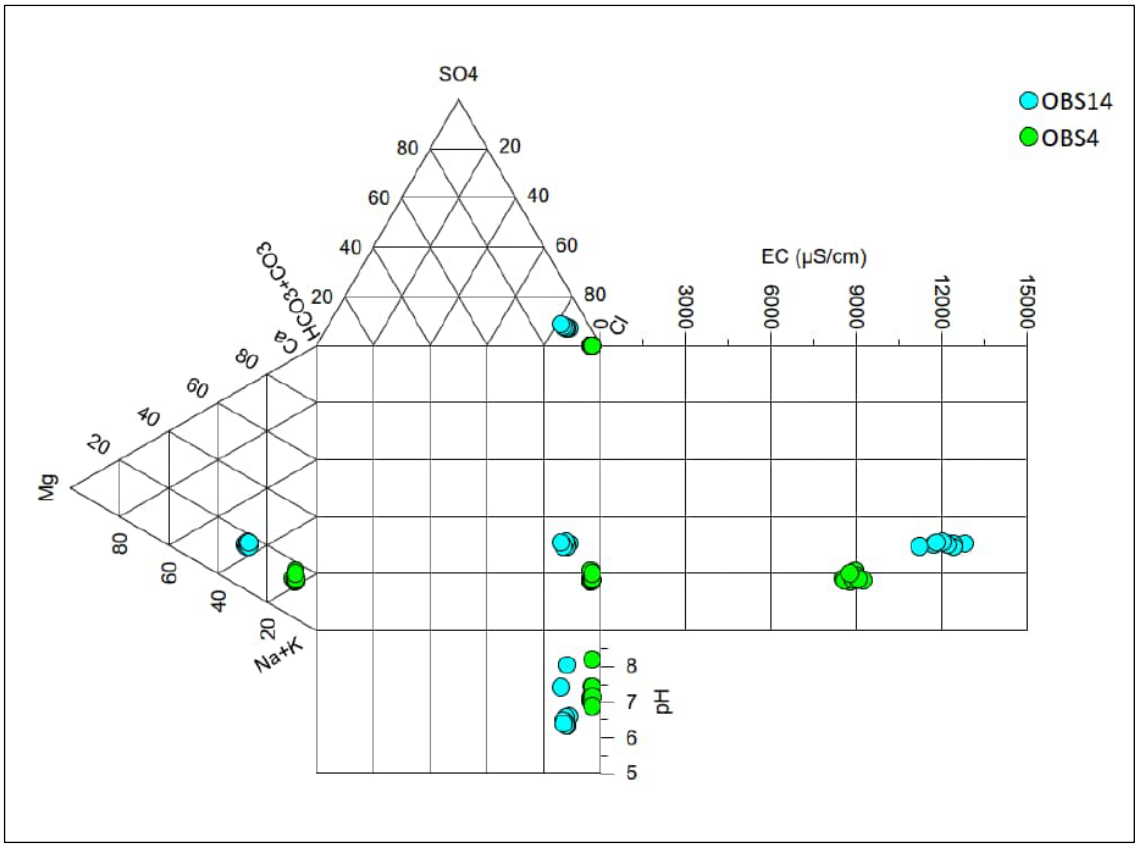


Figure 46 Durov Diagram – Rewan Group

Groundwater from Permian Coal Measures generally exhibits a Na-Cl type, aligning with findings from Cainozoic Sediments and Rewan Group bores. Exceptions include OBS2 and OBS10, displaying Na-HCO3 type, possibly indicating recharge. pH ranges from weakly acidic to alkaline, while EC ranges from 830 to 30,500µS/cm (Figure 47).

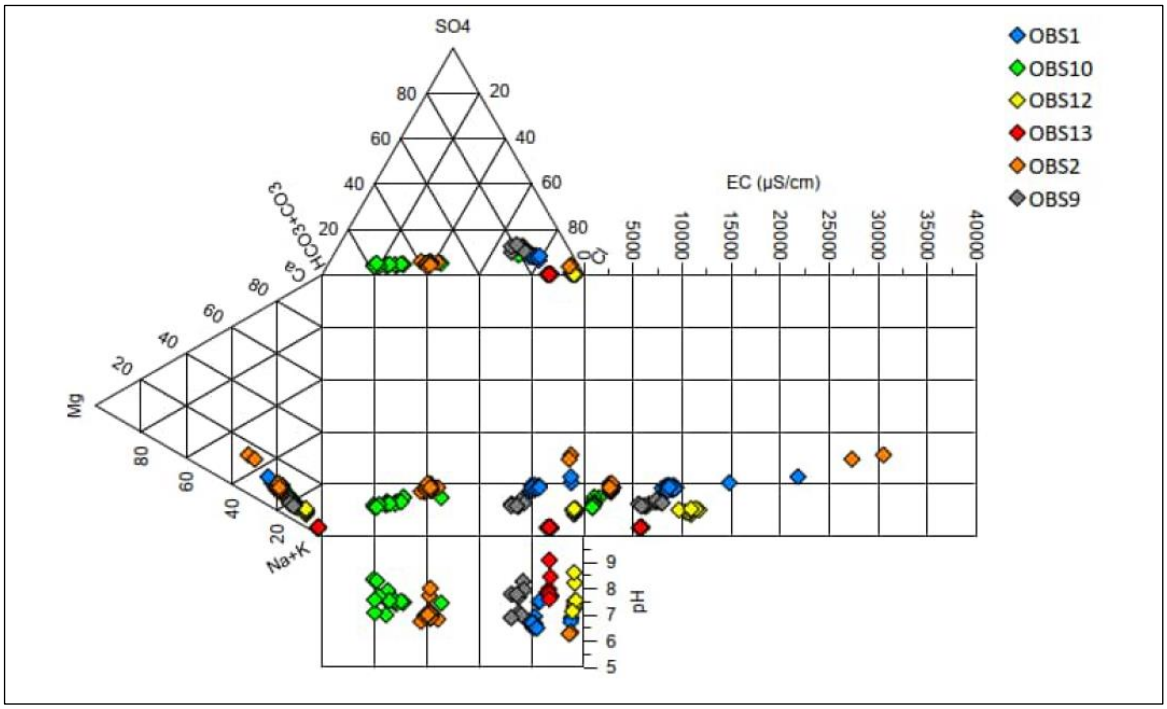


Figure 47 Durov Diagram – Permian Coal Measures

Salinity

Salinity, described by TDS concentrations, is crucial for water management. Figure 48 presents TDS data from monitoring bores across hydrostratigraphic units:

- Cainozoic Sediments: TDS ranges from saline to highly saline, averaging 16,961mg/L with a range of 7,550 to 26,500mg/L.
- Rewan Group: TDS varies from moderately saline to highly saline, averaging 6,725mg/L with a range of 4,910 to 20,400mg/L.
- Permian Coal Measures: TDS ranges from brackish to saline, averaging 6,687mg/L with a range of 506 to 7,210mg/L for Leichhardt and Vermont Seams. Interburden groundwater ranges from moderately saline to highly saline, averaging 3,984mg/L with a range of 1,570 to 21,400mg/L.

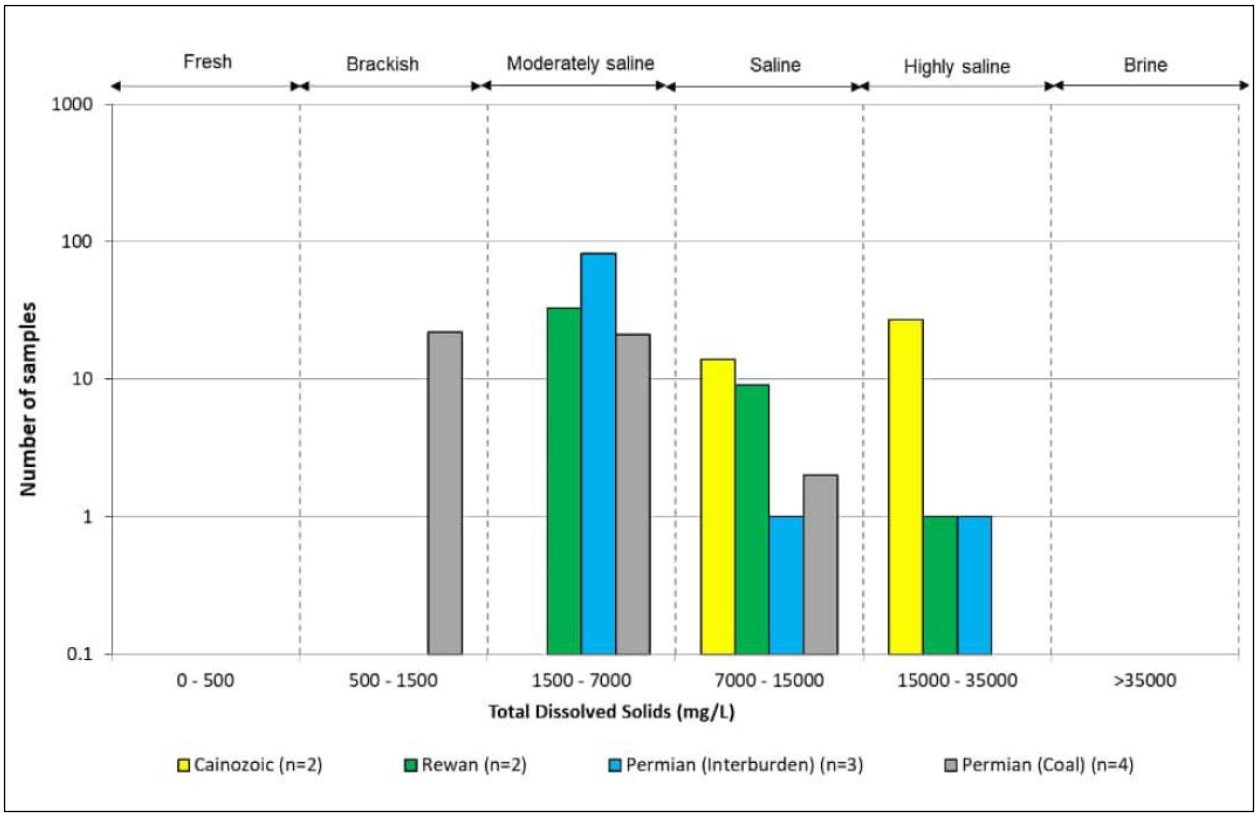


Figure 48 Salinity Ranking by Hydrostratigraphic Unit (Note: n = number of bores)

3.6.1.1.4 Groundwater Flow (Groundwater flow direction and velocity 4.2)

At PTM, the unconsolidated alluvial sediments of the Isaac River, along with other Cainozoic sediments (e.g., Tertiary sediments), and weathered regolith, form a single interconnected hydrogeologic unit, albeit with notable lithological and stratigraphic distinctions within.

Limited historic groundwater monitoring data is available from the Cainozoic sediments at PTM due to sporadic saturation occurrences. Five current and historic monitoring bores are installed into these sediments, with records prior to 2024. Four of these bores (OBS5, OBS7, OBS8, and SP_Levee_3) are installed into the unco of the Isaac River, while OBS11 is installed into the sediments of New Chum Creek. Historic water level monitoring data from these bores is depicted in Figure 49. Additionally, three recently installed EA monitoring bores along the southern boundary of PTM (SLR, 2024) provide groundwater level data, ranging between 184.2 mAHD (OBS17) and 182.1 mAHD (OBS15), with OBS19 reported as 'dry'.

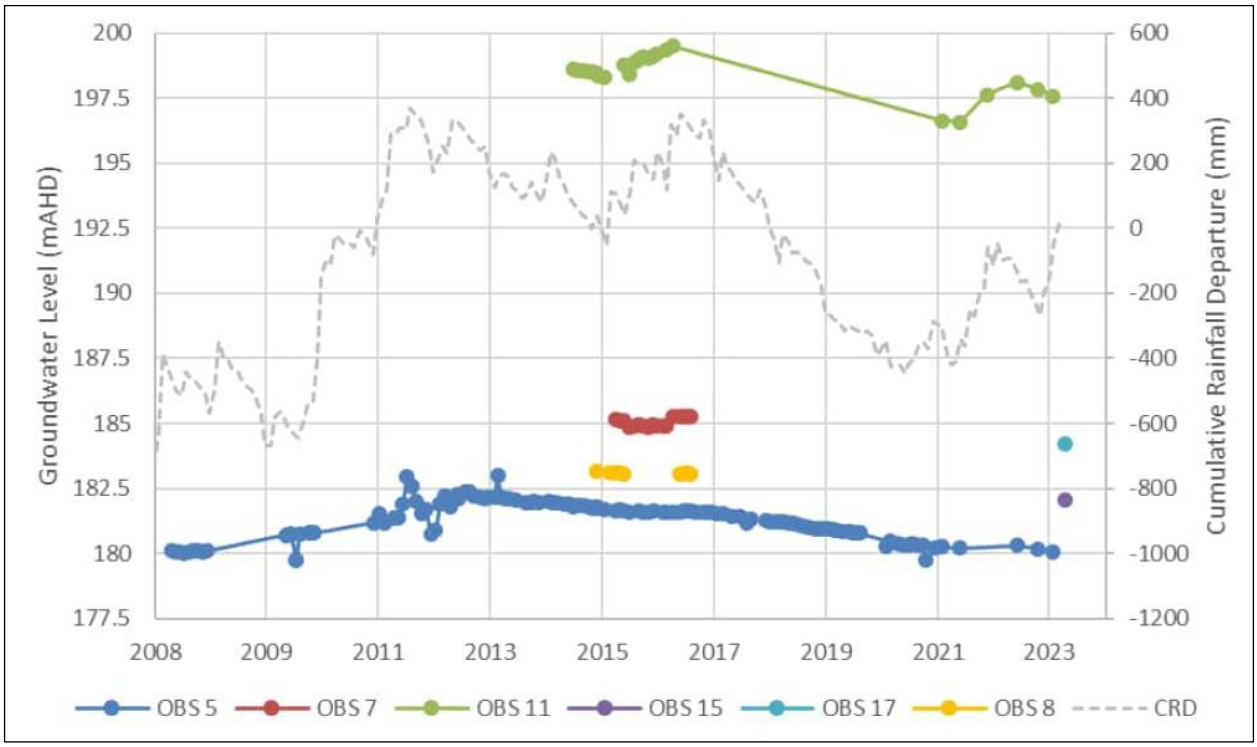


Figure 49 PTM Monitoring Bore Hydrograph – Cainozoic Sediment Aquifer

SLR (2020) analysed data from three bores installed into the Isaac River alluvium downstream of PTM, with groundwater elevations ranging from approximately 171 to 179 mAHD (14 to 16mBGL). Higher elevations were recorded in bores further upstream, indicating limited saturation, consistent with sporadically dry drillholes historically intersecting the alluvium in the PTM area. SLR (2020) also noted that the regolith is largely unsaturated, with saturation mainly confined to lower elevations along the Isaac River and its tributaries, where flow direction reflects topography, moving towards nearby drainage lines.

3.6.1.1.5 Groundwater Modelling

To support the assessment of potential groundwater impacts, numerical groundwater modelling was undertaken. Full details of this numerical model are included within the PTM Hydrogeology Assessment technical report (SLR, 2024) (Appendix 3). The groundwater modelling has been undertaken in a manner consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) and in accordance with the IESC explanatory notes on uncertainty analysis (Middlemis & Peeters, 2018). The objectives of the modelling were to:

- Identify areas of potential risk, such as private supply bores or GDEs, where groundwater impact mitigation/control measures may be necessary post-closure and.
- Simulate the level and rate of recovery of the residual void lake, and the level and rate of mining-related groundwater drawdown recovery in the groundwater system surrounding the residual void.
- Assess groundwater inflow to the final landform's residual void.

The PTM numerical groundwater model was developed to assess the potential impacts on the groundwater system from operational changes. This model was utilised in this assessment with some adjustments required to assess the post-closure conditions. The post-closure condition considers the approved area, the accumulation of water within the residual voids and the rebound of the regional groundwater level.

Potentiometric Surface Mapping

Groundwater levels in the Cainozoic (Alluvium) sediments (represented by OBS5) show a marginal long-term declining trend since 2014, likely influenced by mining activities. Groundwater in the Cainozoic (Tertiary Unconsolidated Sand) sediments (represented by OBS7 and OBS8) demonstrate relatively stable water levels, with monitoring ceasing when they became 'dry' in 2017. OBS11 (also in the Cainozoic (Unconsolidated Sand) sediments shows a response to rainfall trends. Groundwater flow direction in the

Cainozoic sediments appears consistent with that of the Isaac River, while OBS11 suggests a north to south flow direction towards OBS8, consistent with New Chum Creek's surface water flow direction.

SLR (2020) developed a potentiometric surface for the Isaac River alluvium near PTM downstream, utilizing data from Winchester South, Moorvale South, and Olive Downs Projects. AGE (2019) provided a surface for upstream. Groundwater modelling by SLR (2020 and 2021) also contributed to potentiometric surfaces. An updated surface incorporating PTM monitoring bore data and SLR information shows a southeasterly groundwater flow direction, mirroring the Isaac River. Elevations range from around 185 mAHD in the southwest PTM corner to approximately 180 mAHD downstream. Local modifications are observed near existing PTM operations, supported by SLR's modelling, indicating PTM's influence on the alluvial groundwater system. Comparison with geologic thickness suggests limited alluvial saturation and indicates hydraulic connectivity between alluvium and underlying Tertiary/weathered units. AGE (2019) noted similar flow patterns west of PTM, suggesting local changes in permeability and recharge.

3.6.1.1.6 Hydraulic Testing

Site-Specific Hydraulic Conductivity Data

Advisian (2018) highlighted the absence of site-specific aquifer hydraulic testing at PTM until GHD (2020) conducted tests. GHD's testing involved one bore in the weathered Rewan Group (MB20PTM04T, now OBS14) and two in the Permian strata (MB20PTM02P and MB20PTM03P, now OBS12 and OBS13), revealing very low formation hydraulic conductivity.

Slug testing by SLR (2023a) followed, encompassing 15 bores: 11 in the Permian Coal Measures, two in the weathered Rewan Group, and two in the Cainozoic Sediments. Attempts on two additional Permian bores failed due to extremely low hydraulic conductivities. See Table 38for a summary of results.

Table 38 Summary of Hydraulic Conductivity Estimates from Site-Specific Testing

Hydrogeologic Unit	Number of Bores Tested	Minimum Hydraulic Conductivity (m/day)	Maximum Hydraulic Conductivity (m/day)	Average Hydraulic Conductivity (m/day)
Cainozoic	2	0.003	0.007	0.006
Rewan	2	0.001	5.03	3.24
Permian	11	0.001	2.80	0.33

The results show a wide range of hydraulic conductivity, with the limited number of Cainozoic Sediments bores showing relatively low hydraulic conductivities typical of clay dominated sediments. Results for the Permian Coal Measures show a three orders of magnitude spread of hydraulic conductivity. Results for the Rewan Group also show a large range, indicative of a higher hydraulic conductivity for the weathered part of the formation.

Regional Hydraulic Conductivity Ranges

A significant record of aquifer hydraulic testing data from neighbouring mines and projects with similar hydrogeologic units as PTM provides valuable insights. This data is deemed representative of PTM's unit hydraulic properties due to similar geologies.

Figure 50 illustrates a histogram of horizontal hydraulic conductivity spread from field testing at adjacent/nearby sites like Daunia Mine, Winchester South Project, Olive Downs Project, and Moorvale South Project, compared to documented values in literature. Results show that PTM's hydrogeologic units fall within the range of data collected across the Bowen Basin. Additionally, the site-specific testing results (Table 38 above) align with regional and literature values in Figure 50, indicating consistency between site-specific and regional datasets.

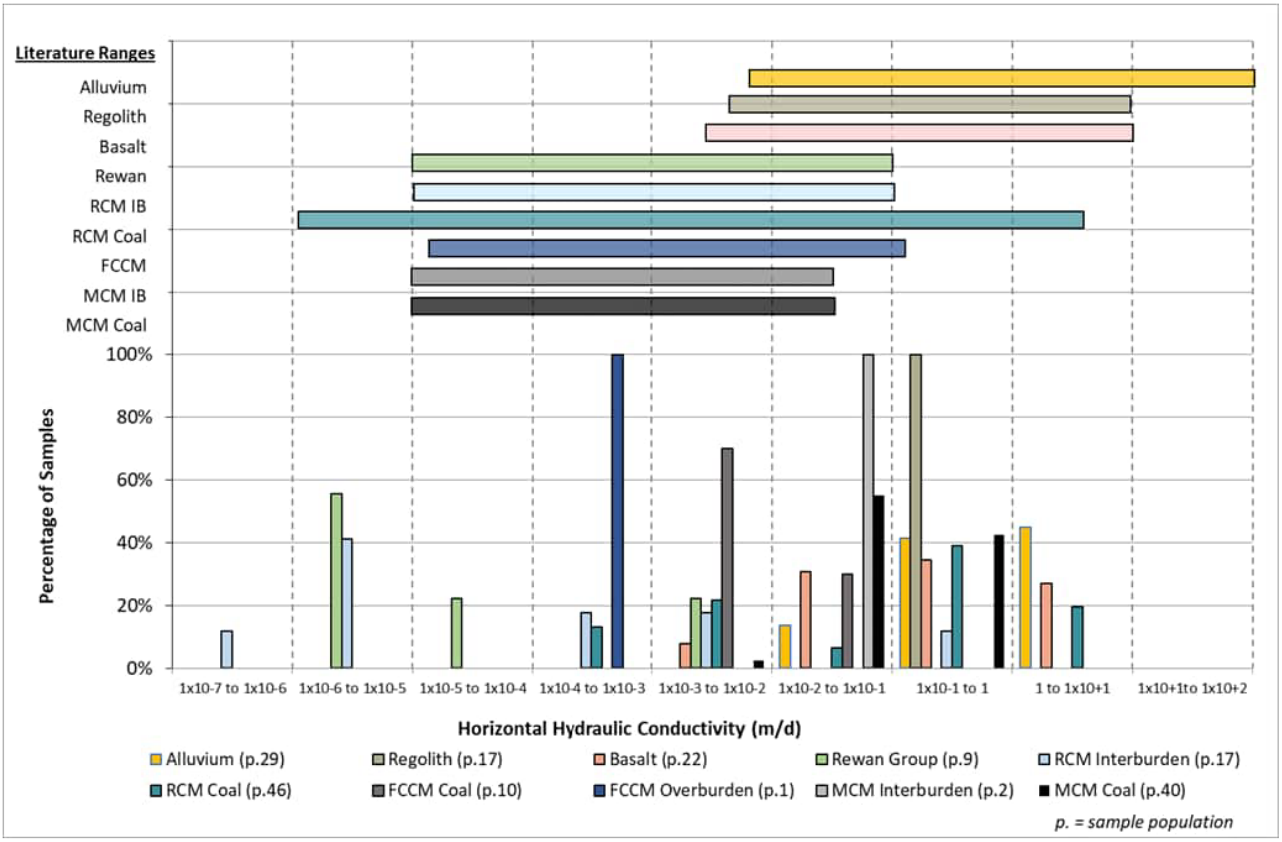


Figure 50 Horizontal Hydraulic Conductivity Ranges

3.6.1.1.7 Predicted Groundwater Levels

Groundwater levels around the final void are influenced by predicted void lake levels (Refer to Section 3.6.3), regulated by evaporation balancing surface and some groundwater inflows, including from spoil and natural formations. This relationship indicating that groundwater levels correspond to lake levels, primarily controlled by surface water fluxes and evaporation.

The water table near the residual void is expected to remain low over time due to continuous groundwater discharge to the void lake, governed by its elevation. This maintains inward groundwater flow gradients post-mining. There's a steep gradient from natural formations, while the gradient from spoil is relatively flat. This difference is partly due to a greater residual head gap between groundwater in natural formations and the void lake, compared to that of spoil, along with lower hydraulic conductivities in the natural geology.

The Alluvium and Regolith are expected to remain mostly dry throughout the PTM Area, with some saturation in specific southern and eastern regions, respectively. Groundwater levels in the Leichhardt and Vermont Seams are forecasted to remain low in the long term due to continuous groundwater discharge towards the void lake, regulated by its elevation.

Predictive hydrographs of groundwater can be found in Section 6.2.5 of Appendix 3 and demonstrate groundwater level changes over time for Leichhardt and Vermont Seams of the Permian Coal Measures, just outside (west) of the residual void due to the void's significant strike length. Additionally, the hydrographs indicate the following:

For the area west of the northern end of the void:

- At hydrograph site Permian1, lake levels are predicted to recover to within about 6m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
- At hydrograph site Permian2, lake levels are predicted to recover to within about 2m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.

For the western area of the central void:

- At hydrograph site Permian3, lake levels are expected to recover to about 11m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.

- At hydrograph site Permian4, lake levels are forecasted to recover to approximately 11m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.

For the western area of the southern void:

- At hydrograph site Permian5, lake levels are anticipated to recover to about 13m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
- At hydrograph site Permian6, lake levels are projected to recover to approximately 11m of the Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.

The hydrograph findings for the Leichhardt and Vermont Seams reveal that while model predictions indicate persistent inward flow gradients towards the residual void over the long term, the differences between predicted void lake levels and groundwater levels in seams immediately adjacent to the void are relatively minor in certain instances, notably in Permian1 and Permian2 hydrographs located at the northern end of the void. It's important to note the absence of identified groundwater environmental receptors in these seams, minimizing environmental risk from any void outflow. Moreover, the net flux over the post-mining period remains inward for the void, indicating that any outward flux is eventually recaptured by the void.

To increase the head gradient towards the residual void lakes from the surrounding groundwater system, reducing predicted void lake levels by deepening the void or limiting surface water inputs is suggested. However, since surface water inputs contribute around 97% of the total volumetric inflow to the void, groundwater inflow has a relatively minor impact on void lake formation. Further backfilling of the void could elevate the void lake level and increase the potential for outflow to the groundwater system, leading to unfavourable environmental outcomes, particularly if beneficial evaporative control of groundwater gradients is compromised.

3.6.1.1.8 Particle Tracking

To assess the fate and movement of water particles within the mine closure landform, including the residual voids, particle tracking using mod-PATH3DU was undertaken. Particle tracking simulates the potential pathways and destinations of water and any contaminants that may be carried by the source water during the post-closure simulation period.

Initially, particles are positioned on the final landform surface and within the residual void, and then released at the onset of the post-mining simulation. Notably, the mod-PATH3DU code automatically moves particles from the surface to the shallowest saturated layer at the simulation's outset. In many instances, this corresponds to the Leichhardt seam due to the unsaturated nature of shallow layers (Layers 1 and 2) across much of the area initially.

The analysis reveals that particles initially situated within shallower saturated layers tend to migrate progressively towards deeper layers representing the Leichhardt and Vermont Seams or backfilled spoil over the post-mining period. Most particles converge towards the void lake, with many being captured within it. Additionally, particles originating from the void, or the Mine Infrastructure Area (MIA) are also depicted as being retained within the void.

Overall, the simulation suggests that groundwater, including that within backfilled spoil and the void, remains within the final landform over the long term, with no significant flow observed towards the receiving environment. However, it's noted that while particle paths generally align with predicted head gradients, there are instances where particle directions seem contrary to the head contours/gradients. This divergence may be attributed to transient head changes occurring during the recovery simulation, as the recovery process progresses over the 2309-year period.

3.6.1.1.9 Residual Void Groundwater Flow

The final predicted groundwater inflows to the residual void are depicted in Figure 51. These inflows are divided between those entering through spoil and those entering through natural geological formations. In the first 50 years post-mining, groundwater levels are expected to remain suppressed, especially in the spoil yet to saturate significantly. During this period, fluxes to the void are mainly influenced by:

- The day-on-day climatic simulation within the WSP (2024) water balance model.
- How the daily timestep water balance results are translated to the groundwater model’s more simplified stress period setup.

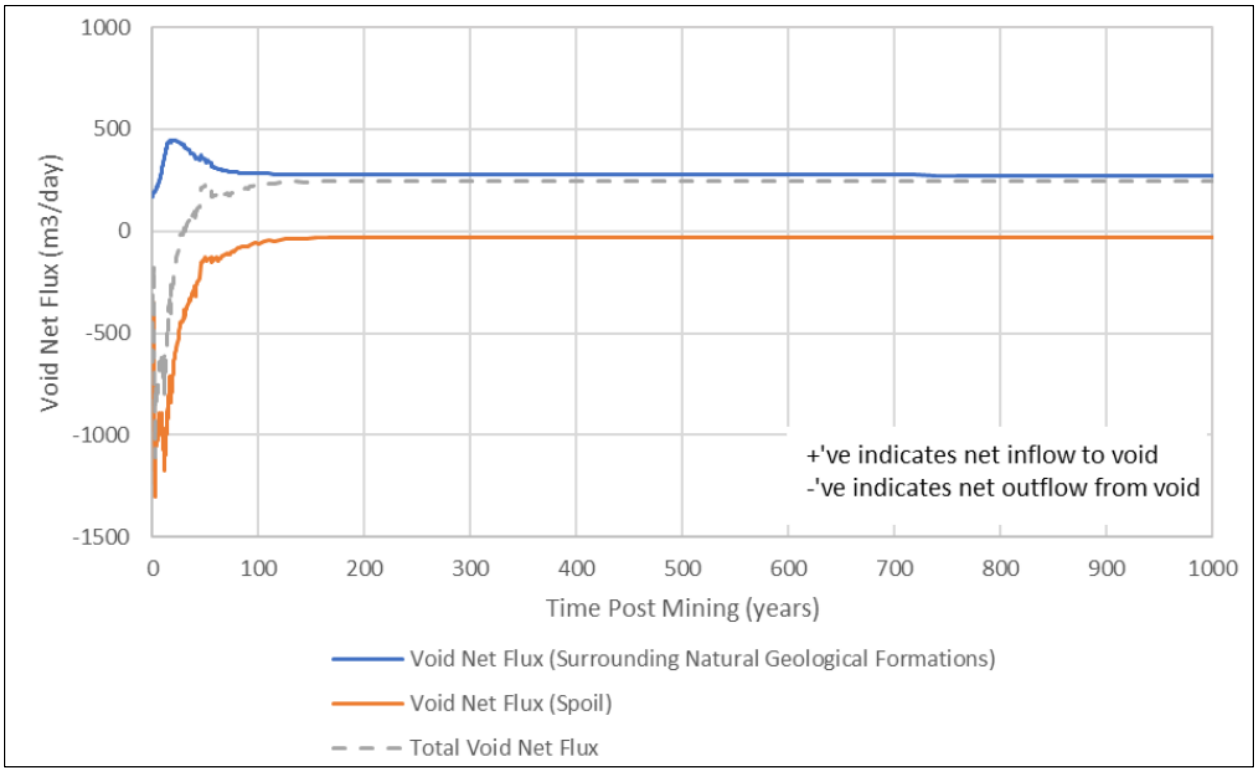


Figure 51 Predicted Void Groundwater Inflows – Ramp 10/20/30/40/50 Residual Void

The groundwater model predicts variable outflows from the void to the spoil and inflows from natural geological formations. During these periods, surface water from rainfall captured in the residual void per the WSP water balance model (Refer Section 3.6.3) is expected to seep into the spoil as groundwater levels slowly recover. All outflows from the void during this time are predicted to be directed to the spoil, with no outflow to natural geological formations. Further backfilling of the void above the groundwater level is cautioned against, as it may worsen environmental outcomes by creating a hydraulic gradient towards the surrounding groundwater system, facilitating discharge. Predicted equilibrium groundwater fluxes to the void are minimal compared to surface water contributions, representing approximately 3% of the total volumetric inflow to the void's water balance.

3.6.1.1.10 Post-mining - Conceptual Site Model Summary

A conceptual hydrogeological model (CHM) has been established for the PTM Area depicting the groundwater interactions with the mine closure landform including the residual void. The CHM key findings, relevant to post-mining groundwater impacts from the closure state landform, are as follows (SLR, 2024):

- Formation of a residual void lake was predicted, with lake water levels stabilising below both pre-mining groundwater elevations and shallow post-Permian strata including the base of surficial weathering and shallow hydrostratigraphic units (i.e., alluvium, Tertiary units and weathered regolith).
- Inward hydraulic flow gradients towards the residual void will be maintained within the RCM upon stabilisation of groundwater and residual void lake levels. This is driven by evaporative losses from the void lake, with no outflows of water to the surrounding hydrostratigraphic units predicted to occur.
- Infiltration of rainfall through in-pit spoil emplacements will continue to be captured in the residual void or remain within the spoil.
- There will be little to no impact on surficial aquifers, including alluvial aquifers beyond what has already been predicted at the time when mining is anticipated to end.
- There will be little to no impact on environmental or anthropogenic receptors.

See Figure 52 for a visual representation of the model.

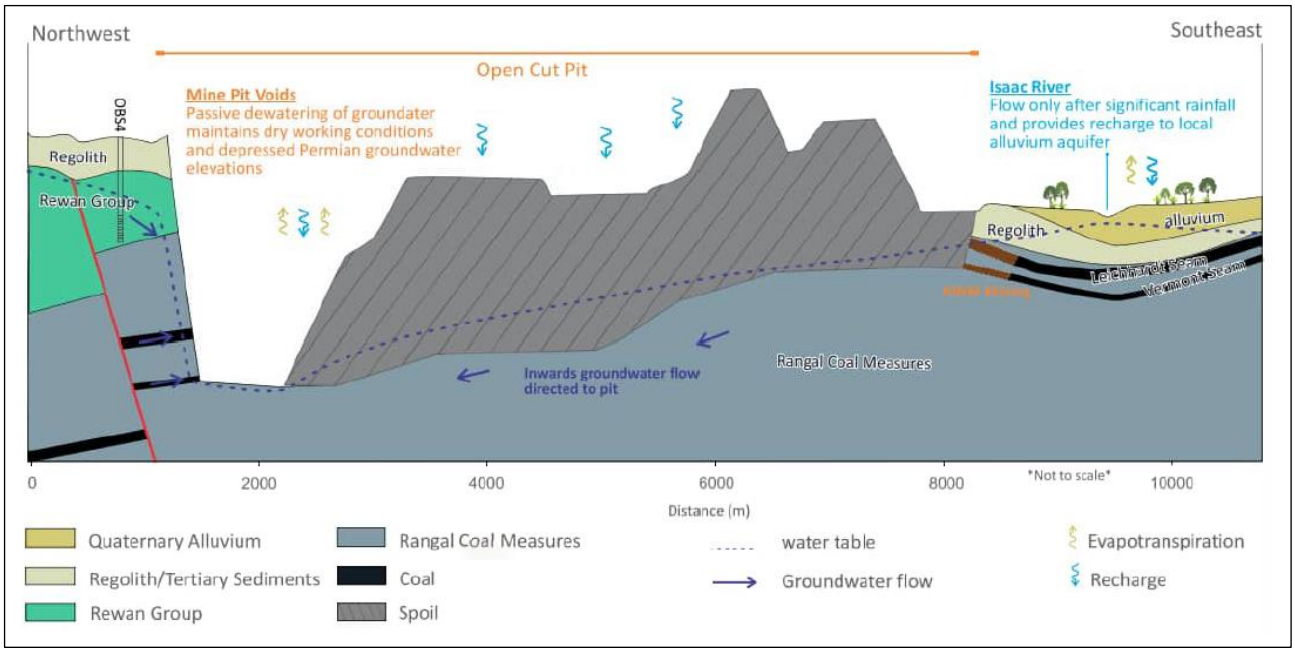


Figure 52 Conceptual Hydrogeological Model of PTM Groundwater System – (End of Mining)

3.6.1.2 Flooding Assessment

PRC Plan Guideline (Section 3.6.1)

Section 3.4 of this guideline requires flood plain modelling for the purpose of voids located within a flood plain being rehabilitated to a stable condition. In addition to this, the applicant must also assess the flooding susceptibility and influence across the site. If flooding is a consideration, develop a hydrologic model of the catchment and a hydraulic model of the proposed mining area. Knowledge of flooding is integral to the rehabilitation planning process, including the placement and design of mine domain.

A Rehabilitation Flood Assessment has been undertaken to support the development of this PRC Plan and is included in Appendix 10. As per Section 3.6.1 of the PRC Plan Guideline, a hydrologic model of the catchment and a hydraulic model of the proposed mining area was developed to address the following requirements:

- The location of domains in relation to potential flood levels for the 1%, 0.1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF).
- Alteration of flow upstream and downstream.
- Model flood levels (including probable maximum flood levels) for a range of design storm events.
- Develop a flooding risk profile.

3.6.1.2.1 Flood Behaviour and Rehabilitation Areas

The flood modelling results have been used to identify locations where floodwaters from 1% AEP, 0.1% AEP and PMF events in the Isaac River, New Chum and Cherwell Creek catchments interact with the final landform (refer Appendix 10).

The final landform embankment (RA4) between the Isaac River and R40/R50 Pit provides flood immunity from 1% and 0.1% AEP flood events. However, floodwaters from a PMF event overtop the embankment and enter the R40 Pit portion of the residual void (refer Figure 54).

Some ponding occurs at the toe of Ramp 10S, 31 and 40 final landforms. This is considered temporary and would only occur during and immediately after rainfall events. It may also be the result of poor integration of conceptual final landform design surfaces with existing LiDAR within the TUFLOW model. During landform establishment (RM3), detailed engineering design will eliminate the potential for ponding, by rendering the areas free-draining. The instances of ponding are located in topographically favourable areas, whereby minor landform reshaping / grading toward existing watercourses will eliminate the ponding. The risk of long-term or permanent ponding is low.

No stream velocities in excess of 1.5m/s occur against or on reshaped final landforms in events up to and including the 0.1% AEP. Subsequently, the risk of erosion via floodwaters is low. Stream velocities in excess of 1.5m/s are confined within the modelled undisturbed watercourse channels, and within the New Chum Creek diversion channel, and ultimately aid in maintaining a sediment regime consistent with watercourses in the region. As discussed in Section 3.6.1.7.3, the New Chum Creek Diversion is permanent, with ongoing monitoring demonstrating that the diversion is trending towards achieving the water license outcomes, specifically Outcome 3, that the *hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.* These outcomes will be achieved and confirmed through RM6, where an AQP will provide certification confirming that RA7 and RA9 is performing in accordance with the DNRME *Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599).

The flooding assessment did not identify any risks related to surface water on reshaped landforms. For waste rock dumps and topsoil dumps (RA5 and RA6), engineering design of the landforms will ensure that surface water is managed in a way that limits erosion and allows establishment of vegetation. Section 3.6.1.5 describes this approach in more detail, with erosion protection measures proposed for any areas of concentrated surface water flow or gradient transition points. Surface water from landforms will be directed either to the void, or existing watercourses.

3.6.1.2.2 Alteration of Flows

Hydraulic modelling undertaken has considered flows prior to the establishment of PTM, against the post-mining final rehabilitation landform. Final landform flood modelling has included the embankments and diversion that are intended to remain in the final landform concept design. This model was developed as a two-dimensional TUFLOW model and demonstrates the following peak flow results for 1% AEP, 0.1% AEP, and PMF flow events. The model boundary was large enough to capture potential alteration of upstream and downstream flows.

Consideration has been given to pre-mining and post-mining flood scenario peak flows; however, since two separate flood models were used for both pre- and post-mining, there are limitations with explicitly comparing quantitative results.

No stream velocities in excess of 1.5m/s (initial risk-based indicator for erosion/scour potential against final landforms) occur in flood events up to and including the 0.1% AEP against the built final landform. It is expected that the final landform is likely to have low erosion/scour risk following establishment of vegetation.

Stream velocities exceed 1.5m/s in the PMF event against the final landform embankment. The final landform embankment adjacent to the Isaac River has been divided into two portions for the purposes of the flooding assessment. A northern section which protects the R40 Pit void that will remain as part of the final landform and a southern embankment which protects the R50 pit void that will remain as part of the final landform as per Figure 53.

3.6.1.2.3 Flooding Risk Profile

1% AEP. 0.1% AEP, and PMF flood events have been assessed to determine the flood risk profile for the final landform. The following outcomes are noted:

- The final landform embankment between Isaac River and R40/ R50 Pit provides flood immunity for 1% and 0.1% AEP flood events in the Isaac River.
- The configuration of the final landform and the out of pit dumps located on the eastern side of the site (adjacent to Ramp 10, 10S, 31 and 50) prevents flood ingress to the final void from events up to and including the PMF.
- Some ponding occurs adjacent final landforms, though it is expected that this would be temporary during, and immediately after rainfall events. Following removal of infrastructure (RM1), and landform reshaping (RM3) these areas will be rendered free draining.
- No stream velocities greater than 1.5m/s occurred against landforms in flood events up to and including the 0.1% AEP. It is expected that the final landform is likely to have low erosion/scour risk following implementation of erosion controls and the establishment of vegetation.
- Stream velocities exceed 1.5m/s in the PMF event against the final landform embankment. Events less frequent but of greater magnitude (i.e. rarer than the 0.1% AEP) may therefore present an erosion/sour risk to the embankment.

Monitoring of the landform embankment (RA4) prior to and during closure will assist in identifying protection methods to reduce the erosion/scour risk.

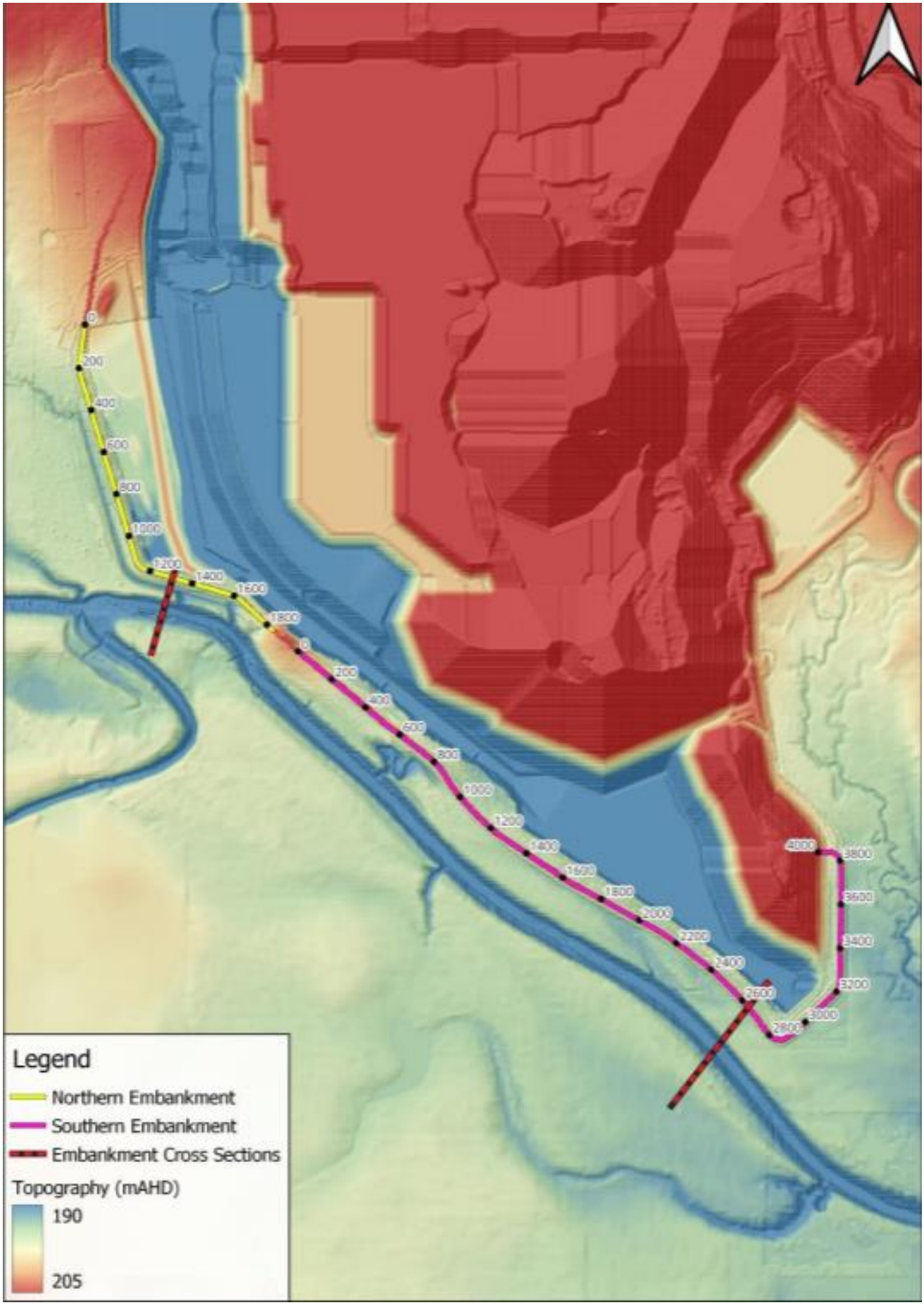


Figure 53 Landform Embankment Sections

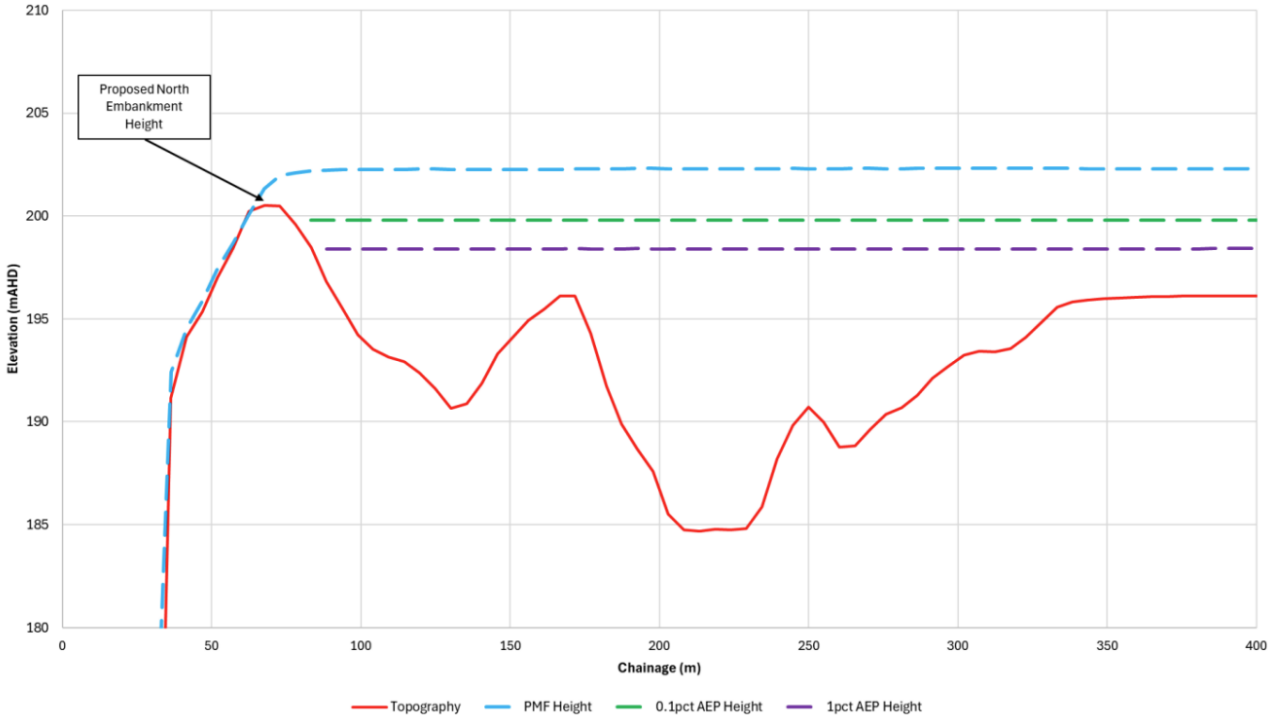


Figure 54 Northern Embankment - Cross Section at Chainage 1300 along Final Landform Embankment

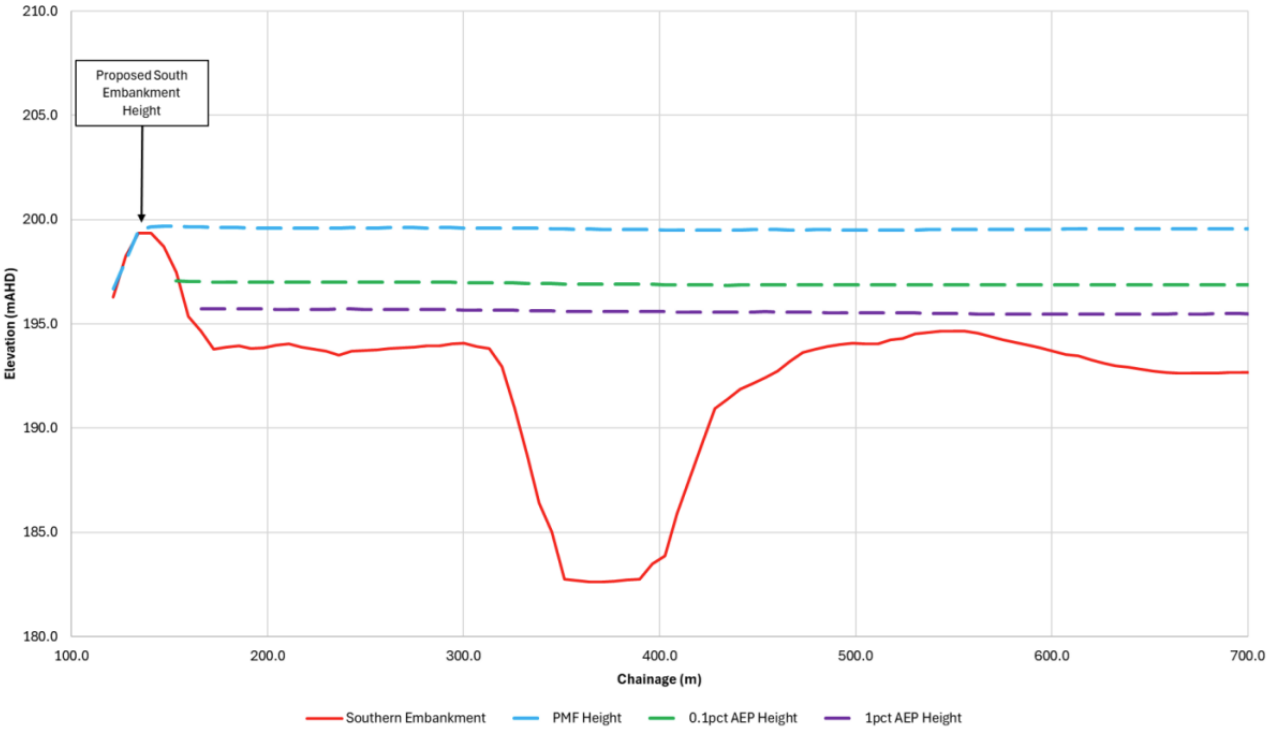


Figure 55 Southern Embankment - Cross Section at Chainage 2600 along Final Landform Embankment

3.6.1.3 Waste Characterisation

PRC Plan Guideline (Section 3.6.1)

Characterise mine wastes in a report that describes the likely physical behaviour and chemical reactivity of the waste materials under the conditions in which they would be stored. The report must address the constituent elements present, and their likely future speciation and mobility.

All mined material should be classified on its propensity to be potentially acid or non-acid forming, to generate neutral metalliferous or saline drainage, and its susceptibility to weathering.

A Mine Waste Characterisation Report (MWCR) (RGS, 2024) has been developed which summarises the chemical and physical properties of the mined material at PTM, and describes relevant management measures, and to inform rehabilitation strategies relevant to the proposed PMLUs. The MWCR is attached to this PRC Plan as Appendix 6.

All mined material has been classified based on its propensity to be potentially acid or non-acid forming, to generate neutral metalliferous or saline drainage and its susceptibility to weathering.

The deposit at PTM occurs in the Late Permian Rangal Coal Measures in a drag syncline within the Burton Range fault system. PTM has three separate rock units: Permian rocks, Tertiary sediments, and post-Tertiary sediments. The regional geology is a basin-like structure with seams dipping gently to the west. Two major coal seams have been identified, the Leichhardt and the Vermont seams.

Overburden consists of silty claystones and clayey to silty sandstones of low to medium strength along occasional thin bands of siderite-cemented siltstone and sandstone. The depth of weathering is typically 15 to 20m, often demarcated by contact with a coal seam or ply. Weathered coal measures are usually leached and oxidised. In spoil dumps, coal measures rock fragments typically weather to sandy and cobbly clay

The following section summarises the characterisation of the materials, the detailed analysis is included in the MWCR (Appendix 6).

3.6.1.3.1 Geochemical Classification of Spoil

The sampling of representative spoil materials (consisting of overburden, interburden, and partings) was conducted by collecting drill core materials. The first drilling program where spoil materials were characterised included 21 holes that were drilled as a requirement for the 2005 EIS. A more recent drilling campaign (2022) comprised 3 new drill holes and 244 samples. The drill hole locations of both the historical and recent drilling campaigns are shown in Figure 56.

Figure 56: Historical (2005) and FY22 drill hole locations (2022)

Geochemical assessment of the 2005 drill hole samples comprised soil quality testing and multi-element assays. The geochemical analyses performed on the 2022 drill hole samples is discussed in the following sections.

Acid Base Accounting

pH: The $pH_{1:5}$ values for the overburden, interburden, and partings samples (n=244) are variable and range from 4.5 to 9.5, with a median value of 9.4 (Figure 57). Five samples (or 2 %) from drill hole 171870 are below pH 7.0, although this seems to be localised to a relative level (RL) between 135 and 145m and is associated with Leichhardt coal plies (L3 and L4). The remaining samples (98 %) are typically above pH 7.0 and are expected to add some alkalinity to contact water.

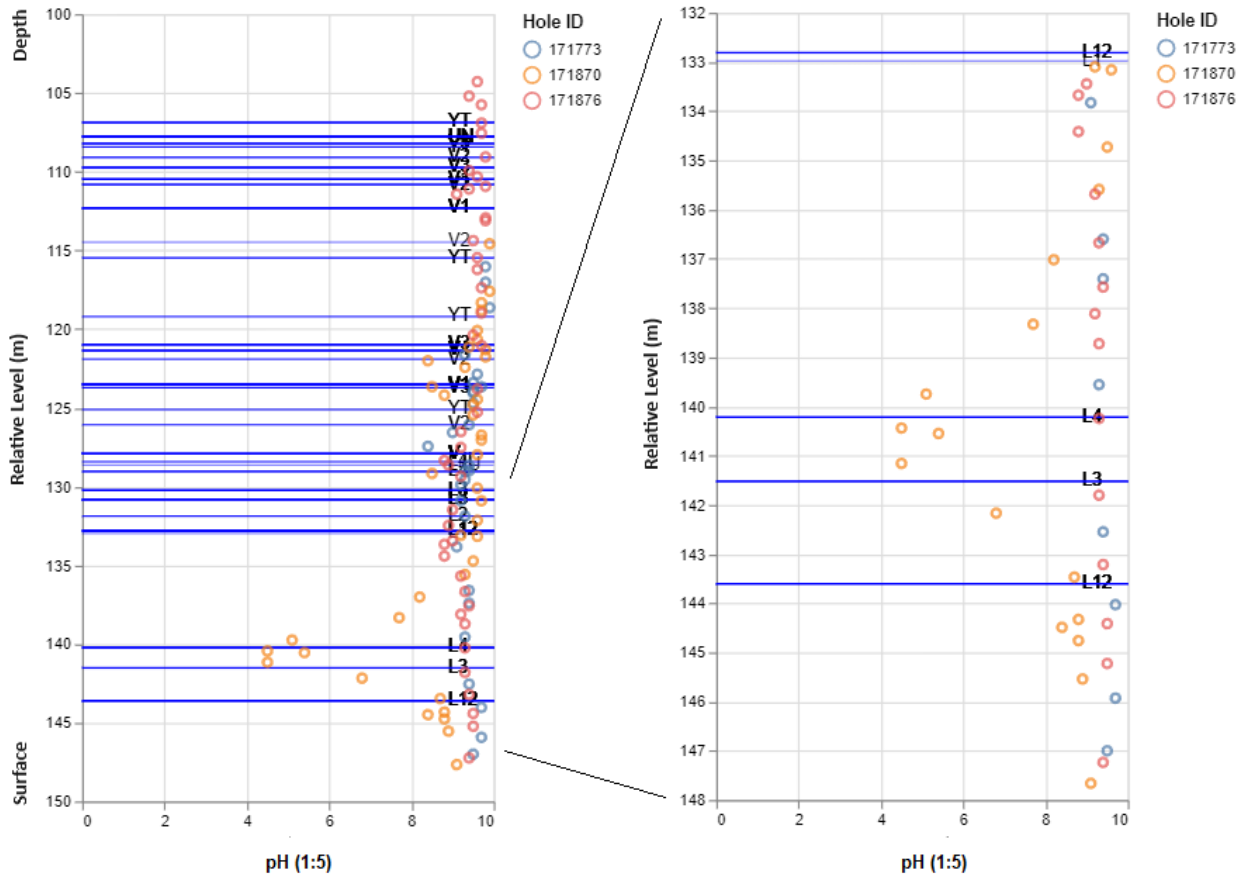


Figure 57: pH results for overburden, interburden, and partings

EC: The electrical conductivity ($EC_{1:5}$) values for the overburden, interburden, and partings samples are variable, range from 34 to 625µS/cm and are typically low (median 264 µS/cm) (Figure 58). Slightly higher EC values (>400µS/cm) are associated with the Yarrabee Tuff (YT) between RL 114 to 121m. Materials near coal seams typically have low EC (<400µS/cm), with the exception of one sample with 625µS/cm near L3.

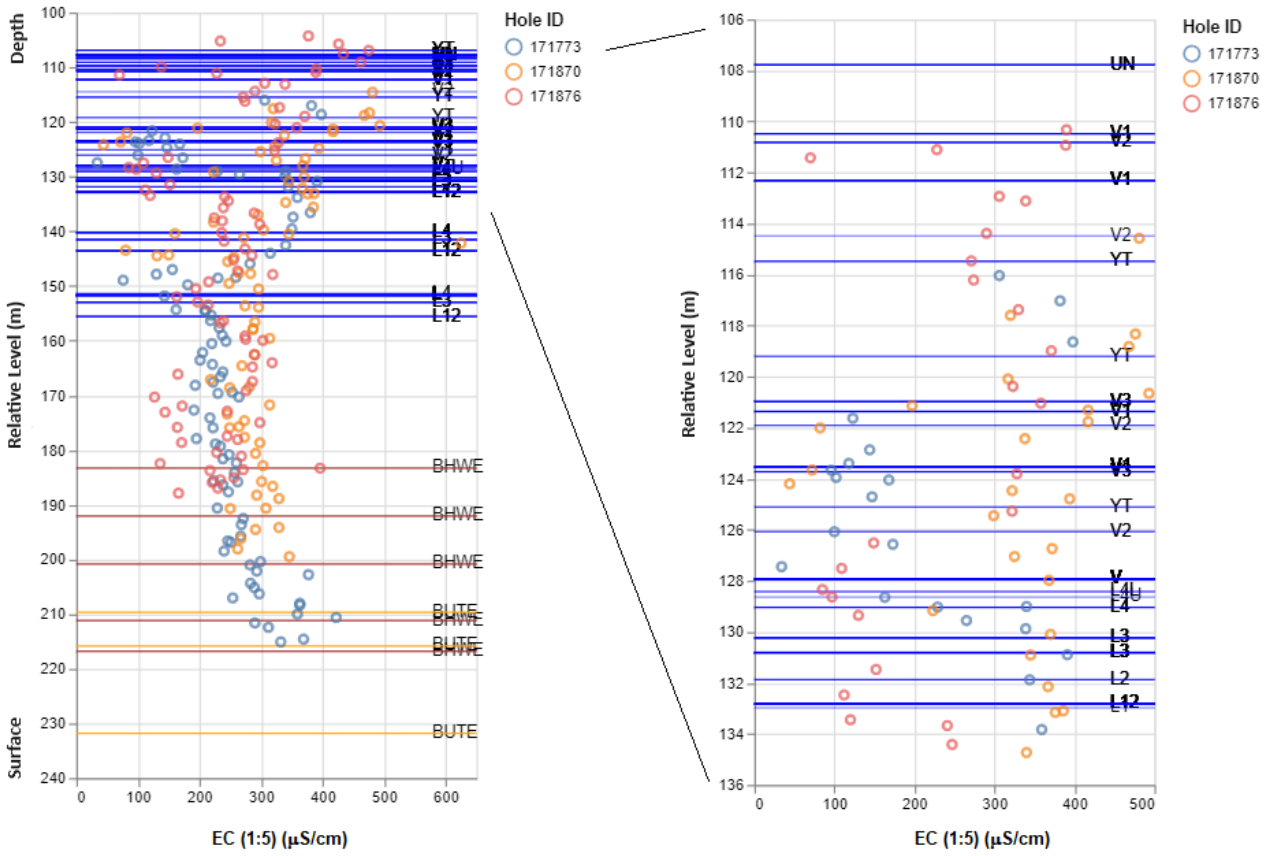


Figure 58: EC results for overburden, interburden, and partings

Total S: The total sulfur content of overburden, interburden, and partings samples ranges from <0.01 to 0.45 %S (median 0.01 %S) and is generally very low as shown in Figure 59. Materials with a total sulfur content less than or equal to 0.1 %S are considered barren of sulfur and have negligible capacity to generate acidity[2] through sulfide oxidation when exposed to oxidising conditions. Only 24 samples (or 10 %) have >0.1 %S, indicating that the overwhelming majority of samples (90 %) are barren of sulfur.

Results in Figure 59 demonstrate that higher total sulfur values (0.1 to 0.45 %S) are typically associated with materials situated near the Leichhardt and Vermont coal seams. This trend between total S and proximity to coal seams is consistent across all three drill holes

Sulfide S: The sulfide sulfur content of overburden, interburden, and partings samples was verified using the chromium reducible sulfur (S_{CR}) test. Samples with a total sulfur content greater than or equal to 0.1 %S (n=35) were selected for further testing using the S_{CR} method. The S_{CR} content of the 35 selected samples ranged from 0.006 to 0.501 %S_{CR}. Only 2 samples (or 1 %) had >0.1 %S_{CR}, which confirms the majority of total sulfur is likely to be present as non-acid generating forms of sulfur, such as sulfate or organic sulfur.

[2] The median crustal abundance of sulfur is 0.07 %S (Bowen 1979; INAP, 2023), which has been rounded.to 0.1 % S.

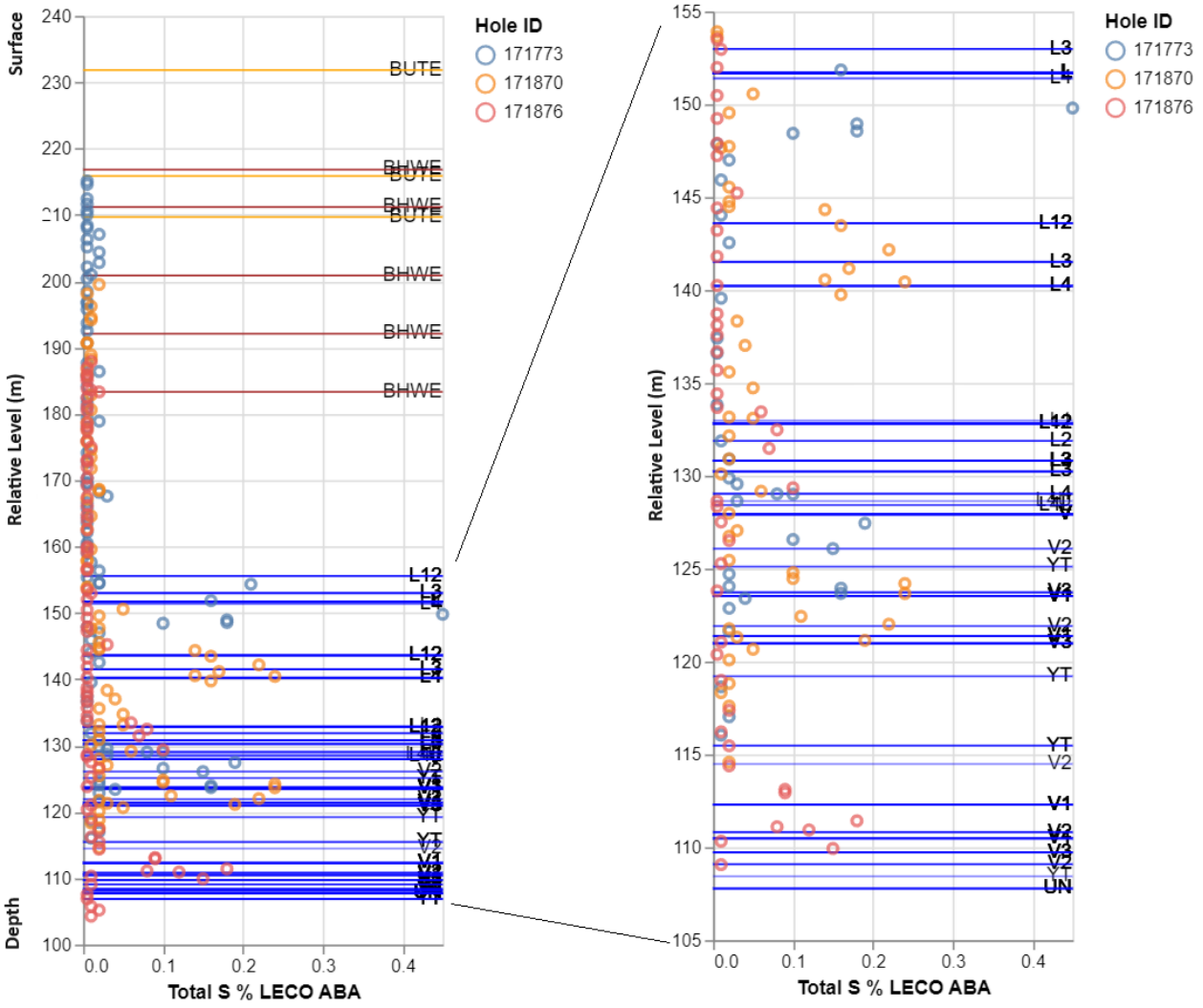


Figure 59: Total S results for overburden, interburden, and partings

MPA: Based on the total sulfur content, the Maximum Potential Acidity (MPA) that could be generated by the 244 samples of spoil materials has been calculated. The MPA ranges from 0.15 to 13.8 kg H_2SO_4/t; and has a low median value of 0.3 kg H_2SO_4/t. This indicates that the majority of samples have a low theoretical potential to produce acidity.

ANC: The Acid Neutralising Capacity (ANC) measures the amount of acid (as kg H_2SO_4 /t) that could be neutralised by acid neutralising minerals present in the sample materials. The ANC for the samples ranges from 1.8 to 492 kg H_2SO_4/t and has a median value of 28 kg H_2SO_4/t.

NAPP: The NAPP for the 244 samples has been calculated by subtracting the ANC from the MPA. Strongly positive NAPP values generally indicate some risk of acid production and that a material is classified as PAF. Strongly negative NAPP values generally indicate that a material is NAF or Acid Consuming (AC). NAPP values close to zero (i.e., between -5 and +5 kg H_2SO_4/t) have some inherent uncertainty in terms of material classification, although materials represented by these samples are expected to have a low risk and elevated factor of safety with respect to potential capacity to generate acid.

The NAPP value for the overburden, interburden, and partings samples ranges from -490 to +4.0 kg H_2SO_4/t (median -27.0 H_2SO_4/t) and is negative for all but 4 samples. Positive NAPP values are associated with materials close to coal seams and typically have relatively high total S and low ANC. The overwhelming majority of samples (98 %) have a negative NAPP value.

ANC:MPA Ratio: The ANC:MPA ratio measures the proportion of ANC present in the sample compared to the MPA. If the ANC:MPA = 3 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[3]; COA, 2016). If the ANC:MPA ratio is less than 1, 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 risk of generating acid.

The ANC:MPA ratio for the 244 spoil material samples ranges from 0.3 to 3,043 and has a median value of 119. The majority of samples (95 %) have an ANC:MPA ratio of 3 or greater and are considered to have a negligible risk of AMD. From the remaining samples, 3 % have an ANC:MPA ratio between 2 and 3 (indicating low risk), and only 2 % have an ANC:MPA ratio of less than 2 (indicating possible or increased risk).

Geochemical Classification:

Table 39 provides a summary of the geochemical classification criteria used to classify the acid forming potential of the 244 overburden, interburden, and partings samples from drill core subjected to static geochemical testing. The results demonstrate that 220 of the 244 samples (90 %) are classified as NAF (Barren) as they have a low total sulfur content (≤ 0.1 %S). Some samples (19 out of 244 or 9 %) have marginally elevated sulfur content (compared to background concentrations) but also have sufficient ANC to be classified as NAF. Two (2) samples are classified as Uncertain, both are coal.

Overall, most materials represented by the samples tested are expected to have a very low risk and increased factor of safety with respect to potential acid generation.

Table 39: Geochemical classification criteria for spoil materials

Geochemical Classification	Total Sulfur (%)	ANC: MPA Ratio	NAPP (kg H2SO4/t)	Number of Samples (n=244)	% Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	220	90 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	22	9 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	2	1 %
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

Multi-Element Concentration

Multi-element analyses were completed on 93 selected individual samples from the 2005 drill holes and 63 selected individual samples from the 2022 drill holes.

The multi-element results were compared to the median background concentration (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. The GAI quantifies an assay result for a particular element in terms of the median crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times median crustal abundance, as shown in Table 40.

Table 40: Geochemical Abundance Index enrichment factors

GAI	Enrichment Factor	GAI	Enrichment Factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment

[3] INAP considers that mine materials with an ANC/MPA ratio greater than 2 are likely to be NAF unless significant preferential exposure of sulfides along fracture planes occurs in combination with insufficiently reactive ANC.

GAI	Enrichment Factor	GAI	Enrichment Factor
3	12 – 24 fold enrichment		

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important 'trace' elements more so than with major rock-forming elements.

The GAI results indicate that most of the metals and metalloids tested in the samples have GAI values less than 3 and are therefore not enriched compared to unmineralised soils (Bowen, 1979; CRC, 2000; INAP, 2024). The only minor exception is calcium (Ca), which has a GAI value of 3 in a medium sandstone sample from drill hole 171773. Calcite cement is noted in the geological logs of other samples in this drill hole and may also be present here.

Soluble Water Quality Testing

The multi-element results in water extracts from 63 selected individual samples of mine materials were assessed against Australian guideline values for freshwater aquatic ecosystems (95 % species protection level) and livestock drinking water (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge.

Acidity in the water extracts from the samples ranges from <1 to 617mg/L (as CaCO3 equivalent) and is highest in the coal samples from drill hole 171870. The total alkalinity in the water extracts is variable and ranges from 23 to 44,200 mg CaCO3/L. The majority of the alkalinity in the samples is in the form of bicarbonate (HCO3), although some materials also contain carbonate. The net alkalinity values for the samples are positive apart from 3 samples comprised of coal sample in drill hole 171870, and the units either side of this sample. This indicates that most sample materials have excess acid buffering capacity in the unlikely event that any acidity is generated by a mine material.

The concentrations of dissolved trace metals/metalloids tested in water extracts from the samples of mine materials are typically low and predominantly below the laboratory limit of reporting. Most dissolved metal/metalloid concentrations are below the applied water quality guideline criteria. The exceptions are aluminium (93 % of samples), arsenic (44 % of samples), which can have concentrations marginally greater than the applied freshwater aquatic ecosystem water quality guideline values for 95% species protection. Occasional concentrations of molybdenum (8 % of samples) and selenium (16 % of samples) can exceed the applied guideline values for livestock drinking water (ANZG, 2018), although the majority of samples have dissolved concentrations well below these values.

Kinetic Leach Testing

Kinetic leach column testing has been undertaken to assess the reaction kinetics and geochemical properties of co-disposed mixed plant reject (MPR) and mine spoil from various operations including PTM, Daunia, and South Walker Creek Mines.

Kinetic leach testing was undertaken on the columns over a 12-month period. Results from the kinetic testing demonstrate that leachate samples were neutral to slightly alkaline with median pH values ranging from approximately pH 7.5 to 8.5. Total alkalinity results for leach extracts suggest the spoil portion of the KLCs is likely to be providing the bulk of the alkalinity observed. EC values of leach extracts generally stabilised around 1,000µS/cm after the first twelve weeks of leaching. Major ion concentrations (Ca, Mg, K, Na, Cl, SO4) decreased over the first 12 weeks of the testing program then generally stabilised or continued to decrease over subsequent leach events.

Concentrations of metals and metalloids in leach extracts were generally low, with most results below the laboratory limits of detection. As with major ion concentrations, detectable metal and metalloid concentrations declined over the leach events of the initial 12 weeks. Most metal and metalloid concentrations stabilised.

3.6.1.3.2 Geochemical Classification of Coarse and Fine Rejects

Coarse and fine rejects from the adjacent CHPP were sampled in three separate sample programs in 2017-2018, 2020, and 2021-2022. The frequency of sampling was fortnightly over a four- month period. Eighty-

seven (87) samples were collected in total, including mid and coarse reject, thickener underflow fine rejects, and dry fine rejects.

Acid Base Accounting

pH: The pH1:5 value for the coarse rejects and fine rejects samples (n=87) is typically alkaline and ranges from 7.5 to 10.1, with a median value of 9.0 for coarse rejects and 8.8 for fine rejects. All samples are above pH 7.0 and are expected to add some alkalinity to contact water.

EC: The electrical conductivity (EC1:5) value for the coarse rejects and fine rejects samples ranges from 100 to 1,420µS/cm and are typically low (median 247µS/cm for coarse rejects and 305µS/cm for fine rejects).

Total S: The total sulfur content of coarse and fine reject samples ranges from 0.11 to 2.61 %S (median 0.28 %S for coal rejects and 0.52 %S for fine rejects). The total S is generally low although the materials are not barren of sulfur. All of the 87 samples have >0.1 %S.

Sulfide S: The sulfide sulfur content of coarse and fine reject samples was verified using the chromium reducible sulfur (SCR) test. The SCR content of the 87 samples ranged from 0.018 to 2.38 %SCR. Most samples (75 %) had >0.1 %SCR, which confirms that some of the of total sulfur is sulfide sulfur and the remainder is likely to be present as non-acid generating forms of sulfur, such as sulfate or organic sulfur.

MPA: Based on the SCR content, the MPA that could be generated by the 87 samples of coarse rejects and fine rejects has been calculated. The MPA ranges from 0.55 to 72.9kg H_2SO_4/t; and has a low median value of 3.6kg H_2SO_4/t for coarse rejects and 10.5kg H_2SO_4/t for fine rejects.

ANC: The ANC for the samples ranges from 11 to 172kg H_2SO_4/t and has a median value of 57kg H_2SO_4/t for coarse rejects and 70kg H_2SO_4/t for fine rejects, which is considered low to moderate.

NAPP: The NAPP for the 87 coarse rejects and fine rejects samples has been calculated by subtracting the ANC from the MPA. The NAPP value for the coarse and fine reject samples ranges from -149 to 0kg H_2SO_4/t (median -54.0 H_2SO_4/t for coarse rejects and -60.0 H_2SO_4/t for fine rejects) and is negative for all but one sample.

ANC:MPA Ratio: The ANC:MPA ratio for the 87 coarse and fine reject samples ranges from 1.0 to 129 and has a median value of 14 for coarse rejects and 7 for fine rejects. The majority of samples (94 %) have an ANC:MPA ratio of 3 or greater and are considered to have a negligible risk of AMD. From the remaining samples, 3 % have an ANC:MPA ratio between 2 and 3 (indicating low risk), and 3 % have an ANC:MPA ratio of less than 2.

Geochemical Classification: Table 41provides a summary of the geochemical classification of the acid forming nature of the 87 coarse and fine reject samples subjected to static geochemical testing. The results demonstrate that 22 of the 87 samples (25 %) are classified as NAF (Barren) and have a low sulfide sulfur content (≤ 0.1 %S). Most samples (62 out of 87, or 71 %) have marginally elevated sulfide content (compared to background concentrations) but also sufficient ANC to be classified as NAF. Three (3) samples (or 3 %) are classified as Uncertain. The Uncertain samples are coarse reject (1 sample) collected April – June 2019 and fine reject (2 samples) collected April – June 2019 and 13 Oct 2020. Overall, materials represented by the coarse and fine reject samples tested are expected to have a very low risk and increased factor of safety with respect to potential acid generation.

Table 41: Geochemical classification criteria for course and fine rejects

Geochemical Classification	Total Sulfur (%)	ANC: MPA Ratio	NAPP (kg H_2SO_4/t)	Number of Samples (n=87)	% Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	22	25 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	62	71 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	3	3 %

Geochemical Classification	Total Sulfur (%)	ANC: MPA Ratio	NAPP (kg H2SO4/t)	Number of Samples (n=87)	% Samples
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

Multi Element Concentrations

Multi-element analyses were completed on 18 selected individual coarse rejects and fine rejects samples. The multi-element results were compared to the median background concentration (median crustal abundance) of those elements in unmineralised soils (Bowen, 1979, CRC, 2000 and INAP, 2024). From this comparison, a GAI was calculated (Table 40).

The GAI results indicate that most of the metals and metalloids tested in the coarse and fine reject samples have GAI values less than 3 and are therefore not enriched compared to unmineralised soils (Bowen, 1979; CRC, 2000; INAP, 2024). The only minor exceptions are molybdenum (Mo), which has a GAI value of 3 in a fine rejects sample and sulfur (S), which has GAI values of 4 and 3 in two fine rejects sample.

Soluble Water Quality Testing

Multi-element results in water extracts from 18 selected individual samples of coarse and fine reject have been assessed against the Australian guideline values for freshwater aquatic ecosystems (95 % species protection level) and livestock drinking water (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as “maximum permissible levels” for site water storage or discharge.

Acidity in the water extracts from the samples ranges from <1 to 18mg/L (as CaCO3 equivalent) and is generally very low. The total alkalinity in the water extracts is variable and ranges from 62 to 8,030mg CaCO3/L. The majority of the alkalinity in the samples is in the form of bicarbonate (HCO3), although some materials also contain carbonate. The net alkalinity values for the col reject and fine rejects samples are all positive, indicating the materials have excess acid buffering capacity in the unlikely event that any acidity is generated.

The concentrations of dissolved trace metals/metalloids tested in water extracts are typically low and predominantly below the laboratory limit of reporting. Most dissolved metal/metalloid concentrations are below the applied water quality guideline criteria. The exceptions are aluminum (22 % of samples), arsenic (17 % of samples), selenium (6 % of samples), and zinc (6 % of samples) which have concentrations marginally greater than the applied freshwater aquatic ecosystem water quality guideline values for 95% species protection. All of the metals/metalloid concentrations in the coarse and fine reject samples are below the applied guideline values for livestock drinking water (ANZG, 2018).

Kinetic Leach Testing

Static and kinetic characterisation of a single (1) fine rejects sample was undertaken over a 25-day period. The aim of this assessment was to understand the geochemical behavior of the materials over time if subjected to subaerial deposition within mine spoil stockpile.

The assessment determined the fine reject sample was unlikely to generate acid and had a low risk for saline drainage. However, there was some potential for generating neutral metalliferous drainage over time based on slightly elevated concentrations of SO4, Mn, Cu, Ni, and Zn.

Physical Characterisation

Golder (2020) investigated the geotechnical properties of fine rejects sample as part of a study of the fluidity of fine rejects prior to dewatering.

The main findings of the geotechnical investigation program, were the following:

- The fine rejects can be classified as low to medium plasticity Silts and Clays.
- The fine rejects are potentially susceptible to “classic” liquefaction if the moisture content of the soil is >85% of the Liquid Limit.
- The degree of saturation for fine rejects is in the range of 79 to 100 % confirming the majority, but not all, fine rejects to be fully saturated.

- The degree of saturation estimated for the adjacent spoil material varies from 20 to 75 %.

A summary of the fine reject sample properties is provided in Table 42..

Table 42: Geotechnical properties of a typical freshly placed fine rejects sample

Property	Value
Average Dry Density (t/m^3)	1.04
Solids Density (t/m^3)	1.85
Degree of Saturation	1.00
Porosity	0.44
Void Ratio	0.77
Solids Concentration by Mass (%)	70.5
Solids Concentration by Volume (%)	56.4
Bulk Density (t/m^3)	1.48

3.6.1.3.3 Management and Rehabilitation Measures

Spoil

The management of spoil materials will be consistent with the current approved mine waste management strategy, that is, in-pit disposal within waste dumps, then progressively rehabilitating with landform shaping directing run-off to the void.

No specific management measures are proposed or required for the spoil to manage risk of AMD, SD or ND.

Where highly sodic and/or dispersive spoil is identified it should, wherever practicable, not be placed at the surface of final landform (within 2m of the surface) and should not be used in construction activities.

However, it may not be practical to selectively handle and preferentially place highly sodic and dispersive spoil during operation. Therefore, in the absence of such selective handling, spoil landforms will be constructed to ensure they are stable, and progressively rehabilitated to minimise erosion, as per the Stanmore Landform Design Guideline (SMR, 2024).

Where rock is used for construction activities, this should be limited (as much as practical) to unweathered Permian sandstone, as this material has been found (generally) to be more suitable for construction and for use as embankment covering on final landform surfaces. Regardless of the rock type, especially where engineering or geotechnical stability is required, laboratory testing and rehabilitation field trials should be undertaken to determine the propensity for dispersion and erosion of spoil landforms.

Surface water run-off and seepage from waste rock emplacements, including any rehabilitated areas, should be monitored for water quality parameters.

Rejects

Reject materials generated as part of PTM operations will continue to be managed in accordance with the current approved coal reject management strategy - comprising the disposal (burial) of dewatered rejects within low-wall spoil at designated disposal areas. Coal reject areas will also undergo monitoring for AMD and related environmental impacts.

The concentration of total metals in coarse and fine reject materials is typically below applied guideline criteria for soils. Surface runoff and seepage from NAF materials left exposed to oxidising conditions is likely to be slightly alkaline, with low levels of salinity. The concentration of soluble trace metals and major ions in runoff and seepage from coarse rejects and fine rejects is also expected to be low.

Based on the current assessment, reject materials are regarded as posing a low AMD hazard with respect to generation of acidity and/or sulfate. However, to further reduce AMD risks and to assist rehabilitation, rejects

will be disposed into low-wall spoil piles and be buried by at least 2m of spoil. Seepage would be confined within, and drain to, the footprint of residual voids.

Monitoring of Mineral Waste Characteristics

Ongoing analysis of mineral samples throughout mining will continue as detailed in the MWCR (Appendix 6). Progressive sampling would, at minimum, comprise a broad suite of environmental geochemical parameters, such as pH, EC (salinity), static geochemical suites and total and soluble metals/metalloids. This data will be recorded and managed within the site's environmental management system and integrated into the mine planning process for appropriate management commensurate with the risk presented. Waste placement and management strategies will continue to be refined as mining progresses.

3.6.1.4 Soil and Capping Material

PRC Plan Guideline (Section 3.6.1)

The rehabilitation and management methodology should include that soil assessment activities are supplemented by additional surveys conducted at appropriate intervals to assess soil resources in planned disturbance areas. In addition to the assessment of soils, the proposed rehabilitation methodologies in the rehabilitation planning part must also address topsoil management. Topsoil management must ensure sufficient topsoil quantity and quality is available in those instances that waste rock or tailings cannot support the proposed PMLU. Integrated soil and waste rock characterisation and mapping should form the foundation of the rehabilitation strategies. The available soil resources and capping material should be assessed prior to the commencement of operations.

A materials characterisation study has been conducted for PTM to assess the quality and quantity of soil and capping material available for rehabilitation (Appendix 4). The objectives of the study included:

- Develop an inventory of materials available for rehabilitation and assess the suitability of materials as growth media in rehabilitation.
- Interpret available data to characterise materials for use as growth media to support vegetation required to meet the PMLU.
- Assess the volume of materials available for use in rehabilitation activities.

Both soils and spoils were assessed for use as growth media for PTM rehabilitation activities. The soil assessment included field surveys and testing on stockpiled topsoil at PTM. Characterisation of spoils were undertaken as part of assessments for landform design (Section 3.6.1.5), and waste characterisation (Section 3.6.1.3) in addition to the existing spoil data from previous assessments. The materials were categorised into two management groups and two sub-groups below:

Topsoil:

- Red/Brown clays.
- Red/ Grey loams.

Spoil Material:

- Permian spoil (overburden).
- Weathered sediments and clay spoil (interburden).

The results of the study and suitability of these material groups for use in rehabilitation at PTM is described below.

3.6.1.4.1 Quality and Quantity of Available Resource

Topsoil Resources

Topsoil stockpiles across PTM were categorised into two groups, red/brown clays and red/grey loams. A total of 84 samples were collected across 21 stockpile sites representing these two groups, the results of which are summarised in Table 43.

Table 43 Summary of Key Chemical and Physical Properties for Topsoil at PTM (Landloch, 2022)

Analysis	Red / Brown Clay	Red / Gray Loams
Chemical Properties		
$pH_{1:5}$ (H_2O)*	Neutral to strongly alkaline (7.1 to 8.5)	Neutral to strongly alkaline (7.1 to 8.5)
$EC_{1:5}$ (dS/m)	Low to moderate (0.9 – 0.28)	Low (0.12 – 0.14)
ESP (%)	Non-sodic (1.2 – 4.9)	Non-sodic (2.8 to 3.5)
Total N (mg/kg)	Low the moderate (270 – 1384)	Low (396 to 471)
Available P (mg/kg)	Low (4 – 16)	Low (4 to 14)

Analysis	Red / Brown Clay	Red / Gray Loams
Available K (mg/kg)	Low the moderate (76 – 364)	Low the moderate (124 to 222)
Organic Carbon (%)	Low to moderate (0.57 – 1.82)	Low (0.29 – 0.83)
CEC (meg/100g)	Low to moderate (5.5 – 24.6)	Low (5.8 – 8)
Ca/Mg (ratio)	Low Ca to balanced (2.7 – 8)	Low Ca to balanced (3 – 5.2)
Physical Properties		
Clay content (%)	>30	<30
Rock content (%)	<20	10-20
Dispersion (EAT)	Slightly dispersive to stable (3b – 7)	Slightly dispersive to slaking (3b – 5)
Permeability*	Low	Moderate
Erodibility*	Low to Moderate	Moderate
Associated regional soil	MM7	Ro9
Associated SMU	A3, B1, B3, B3v, B4, B4v and B5 (B2 where gravel content is >10%)	A2, E1 and E3 (E2 where gravel content is >20%)

Table Notes: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed.

*Based on measured erodibility parameters (Landloch Pty Ltd, 2017).

Red/brown clays are the dominant topsoil at PTM , consisting of dark brown, brown, or reddish brown with texture of clay loam to medium clay. Typical gravel content was found to be less than 10%, though in some stockpiles, gravel content of up to 20% is present. All red/brown clays were non-sodic and generally stable.

Less than 15% of the samples collected represented the Red/grey loams. Gravel content was found to vary between 10-20%. This material is pale red, pale grey, or grey with the texture of a sandy loam to sandy clay loam. The material was found to be non-sodic, but susceptible to slaking and dispersion, with some risk of erosion.

Topsoil proposed for use on rehabilitation areas should be sampled and characterised prior to use, with amelioration requirements applied as recommended by a suitably qualified person. Landloch (2022) summarised that the key limitation of these topsoil materials for use in rehabilitation is low fertility. A balanced NPK fertiliser or compost could be applied during rehabilitation to provide a starter source of nutrients for initial vegetation growth.

Spoil Resources

Overburden

Overburden spoil at PTM consists of grey or pale brown Permian material, comprised of rocky sandstone, siltstone, and claystone. The material was found to have clay content below 25%, resulting in low water holding capacity. Permian characteristics were found to vary slightly, depending the strata location, degree of weathering and degree of carbonaceous inclusions, but were concluded to be sodic and dispersive. A summary of key chemical and physical properties is presented in Table 44.

Table 44 Summary of Key Chemical and Physical Properties for Permian Overburden Material at PTM

Analysis	Permian Overburden
Chemical Properties	
$pH_{1:5}$ (H_2O)	Moderate to strongly alkaline (8 – 9.5)
$EC_{1:5}$ (uS/cm)	Low to moderate (180 – 820)
ANC (H_2SO_4/t) *	High (20 – 30)
PAF	No

Analysis	Permian Overburden
CEC (meg/100g) *	Moderate to high (14 – 32)
ESP (%) *	Non-sodic to strongly sodic (5 – 27)
Metals	Comparable to background levels
Physical Properties**	
Clay content (%)	<25
Rock content (%)	>30
Slake durability (5)	Moderate (50 – 75)
Permeability	Very high
EAT*	Dispersive (Class 2)
Dispersion Risk	Moderate

*Chemical properties are based on average values for all spoil samples analysed

**Taken from erodibility testing results for similar spoil at Daunia mine (Landloch Pty Ltd, 2017).

Landloch (2022) considered fresh Permian the most suitable option as a growth medium, advising that fresh recently stripped Permian material, that has not be exposed to extended periods of weathering, should be used in the upper growth media profile to greatly increase batter slope resistance to erosion while vegetation establishes.

Slake durability data indicated that only 25% of Permian samples have a slake durability higher than 70% (Landloch, 2017). If this material could be isolated, it may be useful to rock armour and stabilise steeper areas. Additional studies and testing for rock properties such as hardness (consolidation and cementation), mineralogy (susceptibility to weathering of the component minerals) and permeability would be useful to locate additional competent rock material.

Weathered Permian material may provide suitable growth media for establishment of woodland vegetation on lower slopes, given the material has only minor chemical limitations and is unlikely to significantly reduce growth of most plant species used in rehabilitation.

Interburden

Interburden at PTM comprises of weathered sediments and clay, containing portions of fragile rock, with a clay content of >35% resulting in moderate to high water holding capacity. It is typically pale orange to brown in colour. The materials were found to be strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hard setting and tunnel and gully erosion (Landloch, 2022). Key chemical and physical properties are summarised in Table 45.

Table 45 Summary of Key Chemical and Physical Properties for Interburden Material at PTM

Analysis	Permian Interburden
Chemical Properties	
$pH_{1:5}$ (H_2O)	Neutral to strongly alkaline (7 – 9)
$EC_{1:5}$ (uS/cm)	Moderate to high (510 – 1200)
ANC (H_2SO_4/t) *	High (20 – 50)
PAF	No
CEC (meg/100g) *	Moderate to high (14 – 36)
ESP (%) *	Sodic to strongly sodic (6 – 24)
Metals	Comparable to background levels
Physical Properties**	
Clay content (%)	>35

Analysis	Permian Interburden
Rock content (%)	<20
Slake durability (5)	Low (<50)
Permeability	Low to moderate
EAT*	Dispersive (Class 2)
Dispersion Risk	Moderate

*Chemical properties are based on average values for all spoil samples analysed

**Taken from erodibility testing results for similar spoil at Daunia mine (Landloch Pty Ltd, 2017).

Landloch (2022) advised that placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended, due to its high potential for erodibility. Use as a secondary growth medium on flat or very low gradient areas could be considered, if the intended material has no chemical limitations to vegetation growth.

3.6.1.4.2 Amelioration and Surface Treatment

Fertiliser and amendment rates for soil materials are dependent on the intended PMLU for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus-based amendments would be recommended for these areas. As a guide, soil amendment should aim to provide:

- Phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40mg/kg.
- An appreciable source of starter nitrogen.
- Adequate macro and micronutrients.
- Reduced potential for dispersion.

For material at PTM, the materials were classified according to their ability to support plant growth, as either primary or secondary growth media. Primary growth media infers the materials have the ability to be used as a topsoil or alternative growth media. Secondary growth media infers the ability of materials to be used as a substrate and may consist of waste/spoil material that is then capped with the primary growth medium.

In addition to primary and secondary classification, materials at PTM were further classified into classes A to D by Landloch (2022), to assess suitability as a growth medium, and provide a guide for amendment requirements (Refer to Table 46).

Table 46 Material Suitability Classification

Class	Description
A	Good Quality - Nil to low levels of amendment will be required
B	Fair Quality - Low to moderate levels of amendment may will be required.
C	Marginal Quality - Moderate to high levels of amendment may be required to improve material quality to support plant growth.
D	Not Suitable - generally be uneconomic or unviable to amend these materials to the degree needed to support plant growth

Suitability of PTM topsoil and spoil material as primary or secondary growth media, along with amendment recommendations, is presented with Table 47.

Table 47 Potential Limitations of Topsoil and Spoil at PTM

Material	Potential Limitations	Amendments	Growth Media Suitability Classes	
			Primary (1)	Secondary (2)
Red/brown clay topsoil	• Sometimes strongly alkaline. • Often low N, P, K, and TOC.	• Fertiliser and/or compost rates are to be determined by a suitably qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Red/grey loam topsoil	• Sometimes strongly alkaline. • Often low N, P, K, and TOC.	• Fertiliser and/or compost rates are to be determined by a suitably qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Permian spoil (overburden)	• Strongly alkaline. • Sodic to strongly sodic and dispersive. • Rock content up to 50%.	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. • If to be used as a primary growth media, then further assessment is required.	1B/C	2B
Weathered sediments and clay spoil (interburden)	• Often strongly alkaline. • Can have elevated salinity. • Often sodic to strongly sodic and dispersive. • Slake durability.	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. • Bury all saline material to a depth greater than 2m below the surface.	1D	2C

Notes:

Class A – Good Quality: **Negligible** limitations to plant growth.

Class B – Fair Quality: **Minor** limitations to plant growth.

Class C – Marginal Quality: **Moderate** limitations to plant growth.

Class D – Not Suitable: **Severe** limitations to plant growth.

3.6.1.4.3 Quantity of Available Resources

The volume of existing stockpiles of topsoil was estimated to be approximately 2,793,354m^3 (Landloch, 2022). The volume of fresh Permian spoil, suitable for use as a primary growth media (with moderate amendment) is estimated at 396,600,000m^3.

Growth media is proposed to be applied to a minimum depth of 100mm on all rehabilitation areas overlying a 1.9m layer of fresh Permian. Considering this approach, the estimated required volume of growth media to complete rehabilitation activities is presented in Table 48..

Table 48 Material Balance

RA/IA	PMLU	Area (Ha)	Growth Media Depth (m)	Growth Media Volume (m^3)
IA1	N/A	316.07	0	-
RA1	Cattle Grazing	203.12	0	-
RA2	Cattle Grazing	203.0	0.1	203,000
RA3	Cattle Grazing	42.38	0.1	42,380
RA4	Woodland Habitat	35.5	0.1	35,500
RA5	Woodland Habitat	569.45	0.1	569,450
RA6	Cattle Grazing	1,055.83	0.1	1,055,830
RA7	Watercourse	44.65	0	-
RA8	Woodland Habitat	68.0	0.1	68,000
RA9	Watercourse	2.61	0.1	2,610
	Total			**1,976,770**

3.6.1.4.4 Location and Accessibility

The location of stockpiles topsoil resources at PTM are shown in Figure 60. These stockpiles are maintained in close proximity to each disturbance area to limit haul distances to approximately 1-5km during progressive rehabilitation.

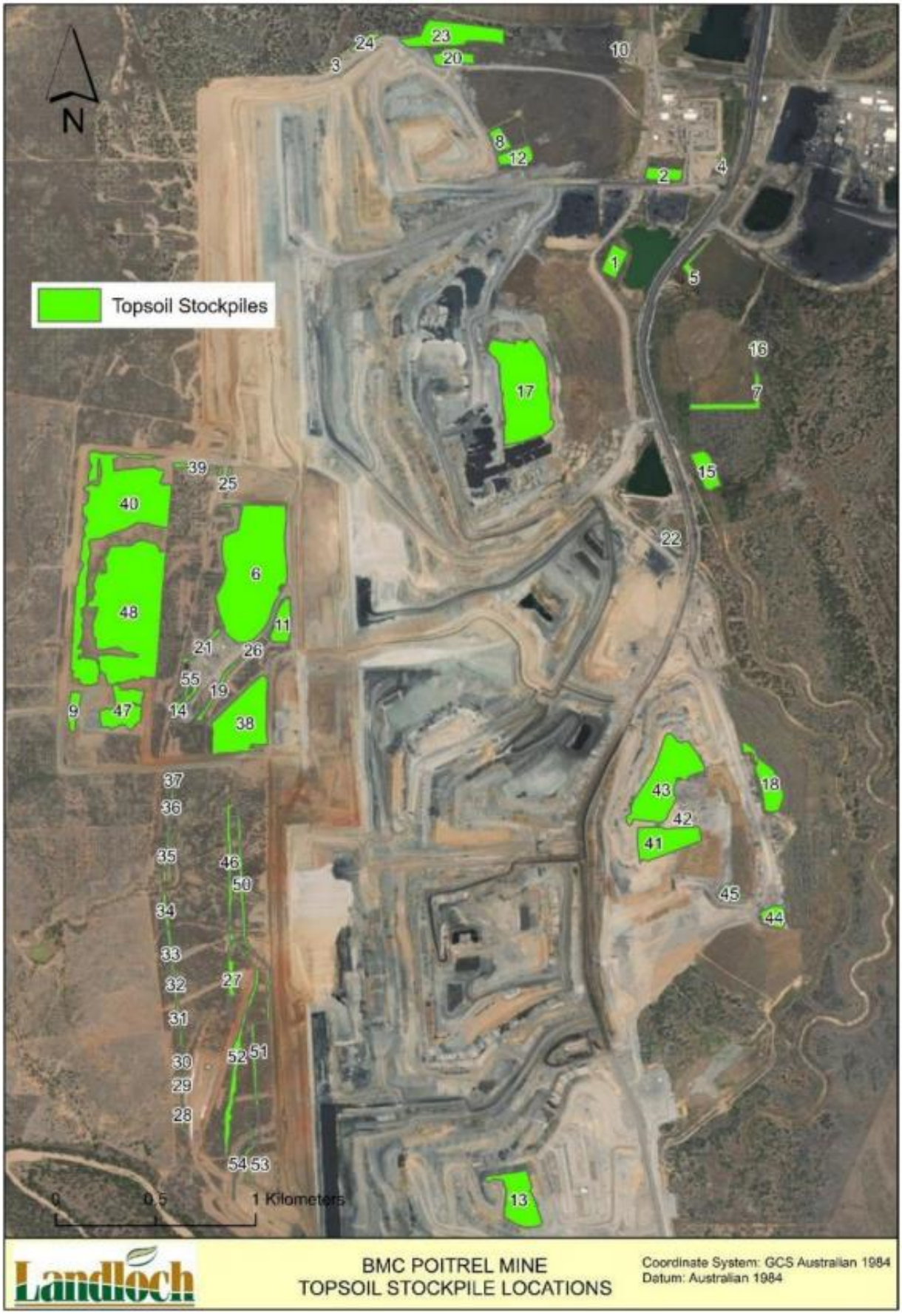


Figure 60 Topsoil Stockpile Locations (Landloch, 2022)

3.6.1.4.5 Surface Treatment

Prior to growth media application, reshaped landforms will be ripped to a depth of approximately 0.5m to reduce compaction and allow adequate water and root penetration. Following this, the growth media will be ripped, across slope, no deeper than 0.3m. This will reduce machinery compaction, remove track marks that are not on contour, and assist in incorporating any soil ameliorants and fertiliser to encourage vegetation growth.

3.6.1.4.6 Relationship between Soils and Vegetation Ecosystems for the PMLU

Target growth media properties for target PMLU vegetation species are presented in Section 3.6.1.8.4. These target parameters are based on representative soil parameters provided in the QLD Department of Primary Industries (DPI) Land Management Manual – Understanding and Managing Soils in the Central Highlands (Bourne & Tuck, 1993), with consideration of the likely compromised condition of stockpiled topsoil and other rehabilitation materials at PTM. Given these target properties are based on substrates formed from natural processes over time, they are considered as a guide for amelioration, to render the material more suitable and supportive of vegetation growth. It is likely that some soil properties might fall outside of these ranges, hence the need to engage a SQP to assess proposed growth media (and recommend ameliorants) prior to applying to rehabilitation areas.

3.6.1.5 Landform Design

PRC Plan Guideline (Section 3.6.1)
The final landform design must be based on the proposed PMLUs and NUMAs and demonstrate that the land will be safe and structurally stable

The final landform design considers the landform development and associated reshaping of all relevant areas within the mining lease after the removal of infrastructure. The integrated landform has been refined based on the outcomes of relevant technical studies to support the PRC Plan. These studies include a Landform Design study attached as Appendix 7 and detail the relevant considerations for design of the final landform at PTM, including demonstrating that that it predicted to be safe, stable, non-polluting and able to sustain the required PMLUs.

The landform design has considered the relevant NUMAs and PMLUs that apply to the rehabilitation areas and has ensured that the geotechnical stability of the residual voids is achieved (Section 3.6.3.1.2), and that they are mitigated against flood impacts (Section 3.6.1.2).

3.6.1.5.1 Method of Determining Landform Design

The final landform design at PTM has considered the relevant design objectives outlined in Table 49. The design objectives have been established to facilitate an optimised cut/fill balance with slope gradient, slope stability and groundcover criteria defined to achieve a safe, stable, non-polluting landform that sustains the required PMLUs.

Table 49 Landform Design Objectives and Criteria

Post Mining Land Use	Rehabilitation Area	Landform Design Objectives	Design Criteria
Cattle grazing	RA1 RA2 RA3 RA6	• Landforms with gradients of <15% or less shall have clay or loam soils applied as growth media. • For waste landforms, at least 1.9m of NAF fresh or weathered Permian waste shall be present below the growth media.	• Landforms with gradients of <15% achieve 80% groundcover. • Landform obtains geotechnical FoS ≥1.5 (unless an alternative is justified by an AQP) • Set-back of high-wall and end-wall achieves stability FoS within NUMA extents • Flood mitigation provided for residual voids above the 0.1% AEP flood levels.
Woodland habitat	RA4 RA5 RA8	• Waste landforms reshaped to be free draining • For waste landforms, at least 1.9m of NAF fresh or weathered Permian waste shall be present below the growth media	• Landform FoS ≥1.5 unless an alternative is justified by an AQP • Slopes >15% to a maximum 25% achieve 30% groundcover • Set-back of high-wall and end-wall achieves stability FoS within NUMA extents • Flood mitigation provided for residual voids above the 0.1% AEP flood levels

Post Mining Land Use	Rehabilitation Area	Landform Design Objectives	Design Criteria
Watercourse	RA7 RA9	• For RA9 only, banks to be reshaped following removal of rock	• Riparian vegetation and geomorphic index is greater or equal to upstream or downstream values.

3.6.1.5.2 3D Design

3D imagery depicting the post-mining topography of the central-south and northern pits is presented in Figure 61, with the final eastward perspective of the post-mining landform illustrated in Figure 62.

The 3D design of the final landform configuration at PTM is also shown in Figure 29 (Section 3.4.3) and has been developed to a conceptual level based on a dozer push plan to achieve final slope profiles. As such, the design is not representative of a final design in that there are sections that will require iterative refinement as design maturity increases (e.g., lift heights, detailed surface water management). The final landform will be water shedding and given the waste material properties, no liner is proposed.

Key specifications for the final landform are outlined in Table 50 below.

Table 50 3D Final Landform Key Characteristics

Component	Specification	Unit of Measure
Footprint area (total)	2,225	ha
Landform height (maximum)	140	m
Maximum landform slope angle (grazing)	15	%
Maximum landform slope angle (woodland)	25	%

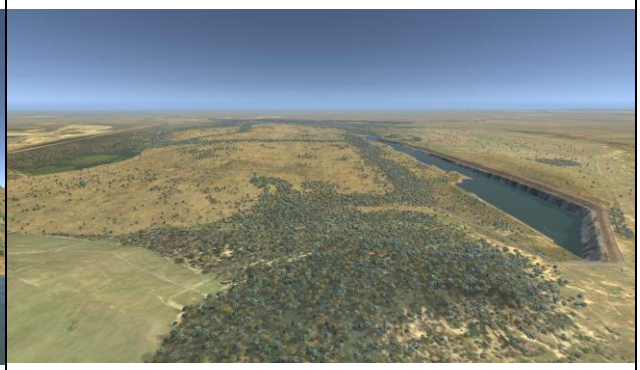
South-Central

Southern Final Pit

Central Final Pit

North

North Void Final



Woodlands Final

Figure 61 3D Post Mining Landform Design – Images (Minserve)

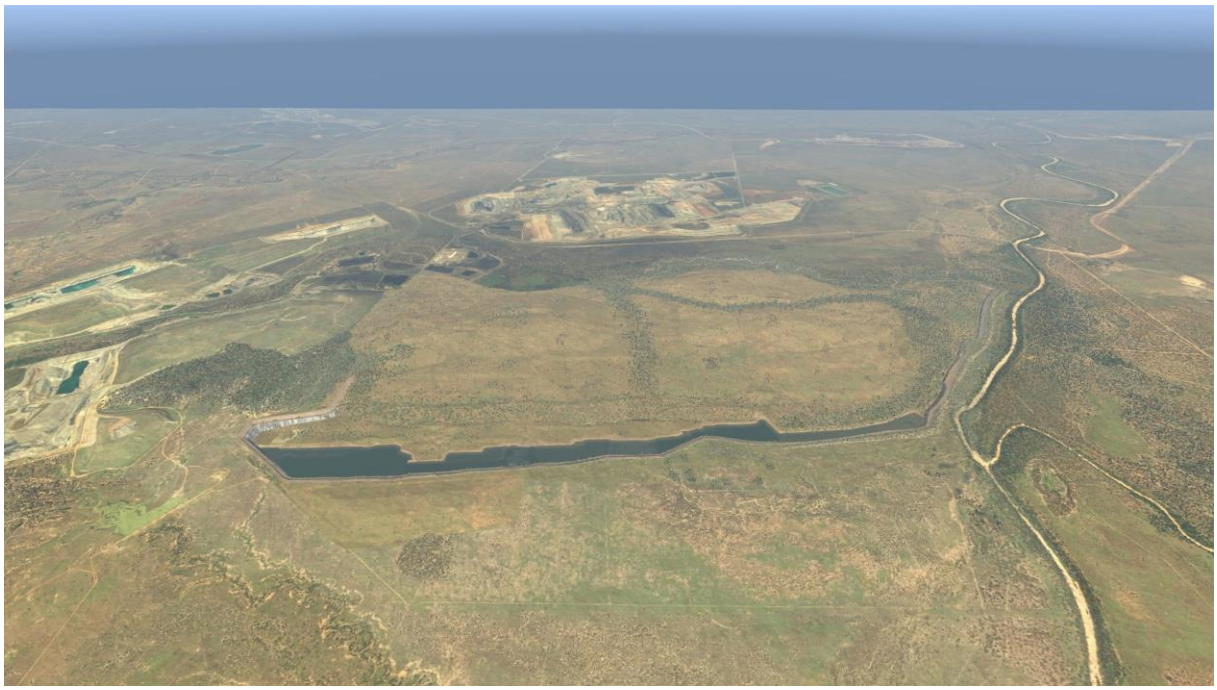


Figure 62 3D Post Mining Landform Design – Final Look East (Minserve)

3.6.1.5.3 Materials Availability

The materials available onsite for use in rehabilitation and closure consist of topsoils and overburden spoils (Landloch, 2024). Rejects are not considered a rehabilitation resource given their material properties and are considered bulk fill only.

Stockpiled topsoil materials have been categorised into two management groups:

- Clay textured topsoils are the dominant soil stockpiled at PTM. It occurs at approximately 85% of the sample sites.
- Loam soils account for approximately 15% of stockpiled topsoils at PTM.

Spoils are categorised into two management groups:

- Permian spoil.
- Weathered sediments and clay spoil.

A summary of key chemical and physical properties for growth media to support rehabilitation activities is provided in Section 3.6.1.4.

The following materials are proposed for use within the upper 2m of final landforms:

- Fresh Permian (1.9m).
- Clay topsoil (0.1, Grazing PMLU).
- Clay topsoil mixed into Fresh Permian rock (0.1, Woodland PMLU).

Topsoil materials will be stockpiled and used as growth media to facilitate vegetation growth and support rehabilitation of PTM landforms to achieve the approved PMLUs. Where required to increase the erosional resistance of landforms (where slopes > 15%), rock that is available onsite may be incorporated to increase erosional stability.

Rehabilitation materials available onsite under the current LoA plan has been indicated in Table 51below, with overall materials balance provided in Section 3.6.1.4 (noting that materials import is a function of soil/capping

requirements as the final landform will target a neutral cut/fill balance). The predicted total Permian requirements are approximately 41.4Mm^3 with sufficient quantities present under the current LoA plan.

Table 51 Materials Availability

Material	Available (m^3)	Notes
Topsoil	2,793,354	Based on current stockpile estimates. Prior to recovery and stockpiling, materials will be characterised to develop an approach that limits the recovery and use of potentially acidic, sodic or saline materials in rehabilitation.
Fresh Permian	396,600,000	Based on LoA plan. Consideration may be required in waste management and scheduling to enable material to be incorporated into the upper 1.9m layers of the final design for grazing and woodland PMLUs. Some grading/selection may be required to achieve an appropriate rock mix for the upper 0.1m growth medium layer for the Woodland PLMU

3.6.1.5.4 Hydrological and Hydrogeological Assessments

Except for the localised catchment into the residual void, the final landform will predominately be water shedding. Specific surface water management measures that will be implemented are as follows:

- Reshaping of the spoil dumps to be free-draining and to tie-in with natural contours.
- Surface water to be directed towards natural water courses, with no permanent water management structures on slopes.
- Implementation of erosion protection measures in areas of concentrated flow or gradient transition points to mitigate risk of increased flow velocities on final landforms.
- Flood mitigation to prevent the risk of flooding into the residual voids up to the 0.1% AEP flood level.
- Implementation of landform structures to prevent flood and void interactions.
- Removal of road culverts and fill material from within the watercourse extents.

A flood assessment, including hydrologic and hydraulic modelling was completed for the PTM final landform (Refer to Section 3.6.1.2). It was shown that the final landform embankment between the Isaac River and R40/R50 pit (RA4) provides flood immunity from 1% and 0.1% AEP flood events.

A hydrogeological assessment (Section 3.6.3.2), including numerical modelling, and pit lake water balance modelling (Section 3.6.3.1) identified the residual void, once stabilised, will through evaporative losses continue to act as a sink. Therefore, groundwater gradients in the proximity of the residual voids will maintain flows towards the pit lakes and retain any contaminants within the residual voids.

As the current landform design is at a conceptual level, detailed profiling of the free-draining surface (including associated surface water control aspects) will be completed leading into and as part of RM3.

3.6.1.5.5 Erosional Stability

Landloch (2024) undertook assessments to determine acceptable rates of soil loss and subsequently assess long-term erosional stability of rehabilitated landforms at PTM. A reference target soil loss was determined by assessing the erosion potential of areas surrounding PTM using the Revised Universal Soil Loss Equation (RUSLE). Based on this assessment, the long-term erosion for vegetated surfaces range from 0.3—7t/ha/y, with an average of 2t/ha/y and uncertainty of 0.3t/ha/y. For 50% cover, the average predicted long-term erosion for the same area is 12t/ha/y.

A key priority in setting a tolerable erosion target is the prevention of significant rill or gully development. On that basis, for slopes where long-term erosion risk (for a range of reasons) is considered high, then a maximum rate of erosion of 5t/ha/y at any point on the batter slopes being modelled has commonly been applied by Landloch on the basis that - at that value - rilling is largely if not completely absent. Accordingly, the

5t/ha/yr value was adopted for the purposes of Landform evolution modelling (LEM) for shallower grazing slopes. For the woodland PMLU, 7t/ha/yr was selected to align with RUSLE values given the steeper slope profiles.

LEM was completed for up to 300 years on the final landform DEM, with simulations of runoff and erosion for a range of a range of landform slope and vegetation cover configurations completed initially using the Water Erosion Prediction Program (WEPP) to allow derivation of parameters for the SIBERIA LEM

WEPP simulations were carried out for:

- Batter slopes 140m high, at 15-25% gradients, surfaced with clay soil with vegetation cover levels 50-90% (Grazing PMLU) (Figure 63 and Figure 64)
- Batter slopes 140 high, at 15-25% gradients, surfaced with a 4:1 blend of Fresh Permian waste and clay soil with 0-50% vegetation cover (Woodland PMLU) (Figure 65 to Figure 67)

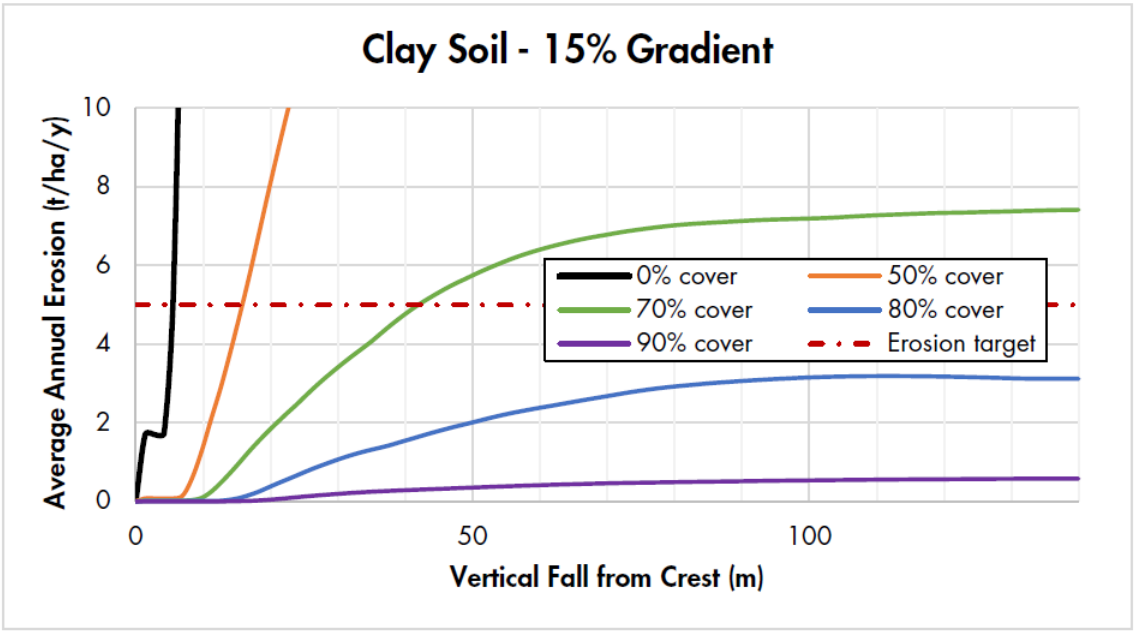


Figure 63 Predicted erosion rates along 15% gradient batter slopes with clay soil surface and 50%, 70%, 80%, and 90% vegetation cover

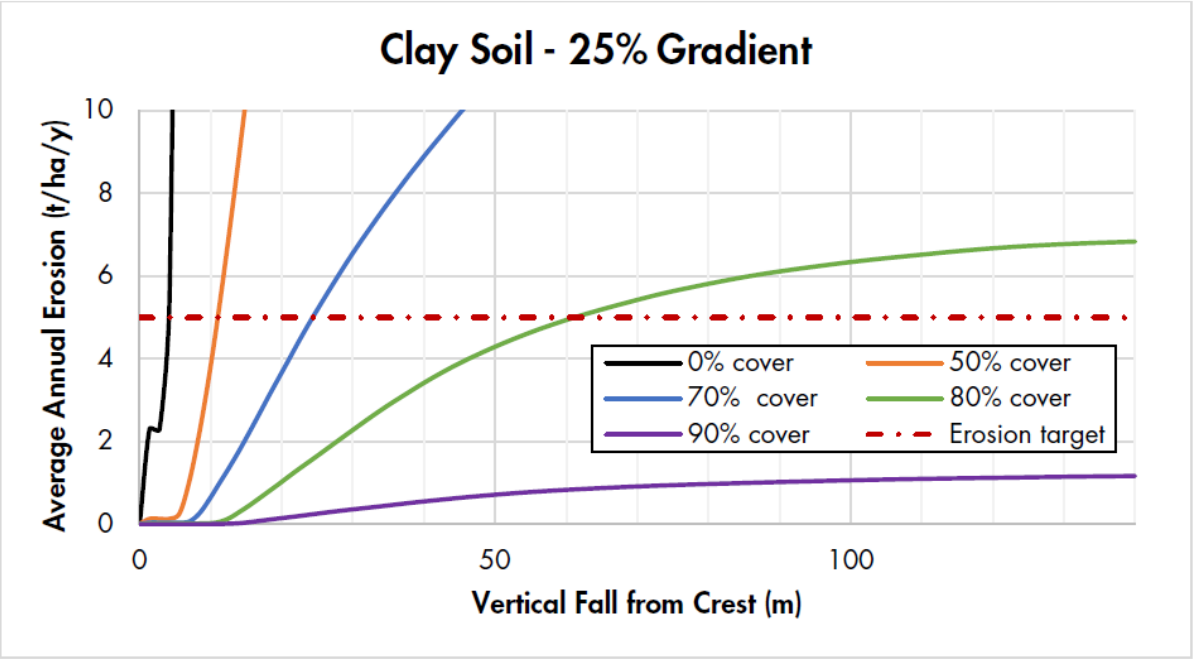


Figure 64 Predicted erosion rates along 25% gradient batter slopes with clay soil surface and 50%, 70%, 80%, and 90% vegetation cover

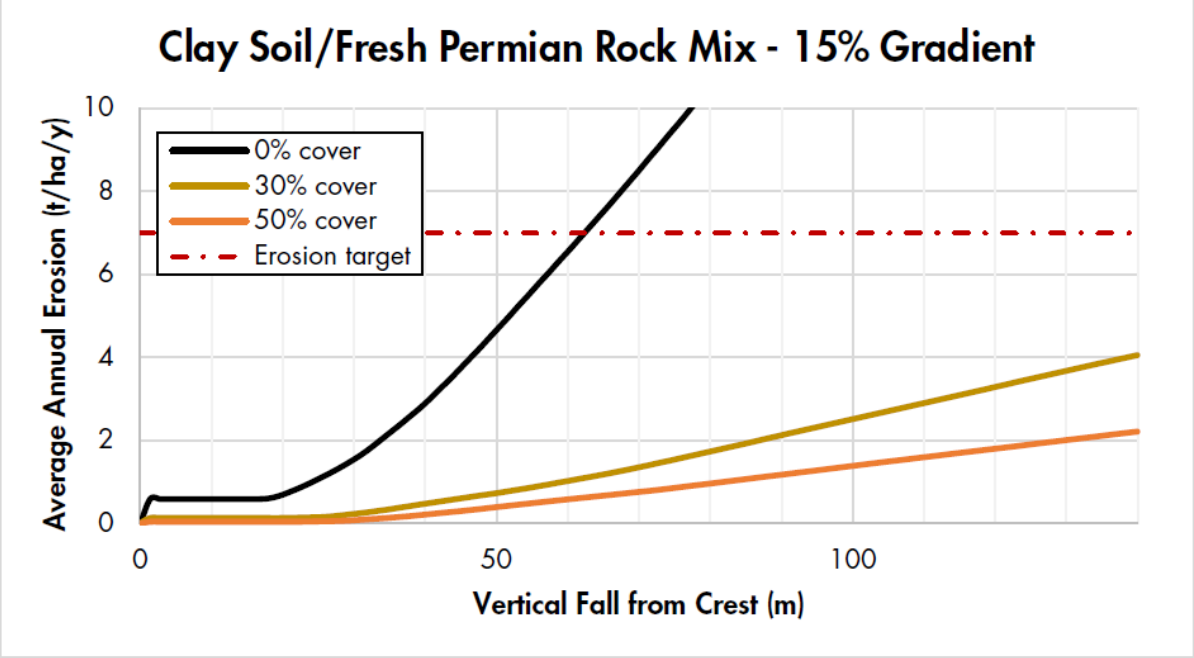


Figure 65 Predicted erosion rates along a 15% gradient batter slope with clay soil/ Fresh Permian rock mix surface and 0% - 50% vegetation cover

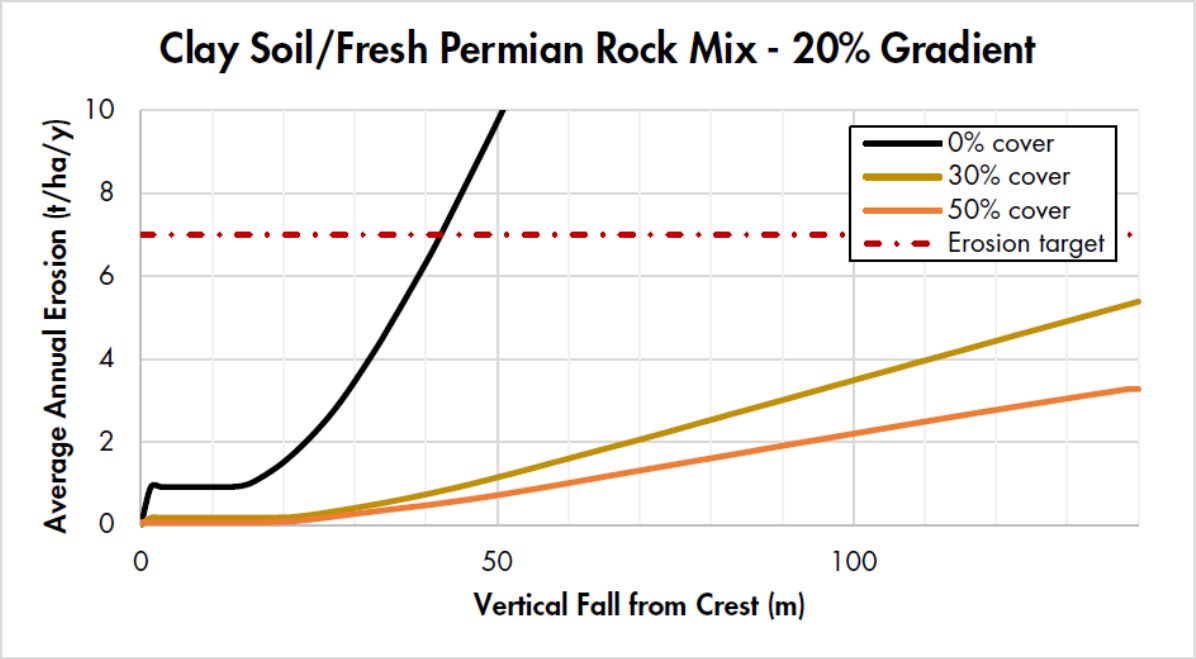


Figure 66 Predicted erosion rates along a 20% gradient batter slope with clay soil/ Fresh Permian rock mix surface and 0% - 50% vegetation cover

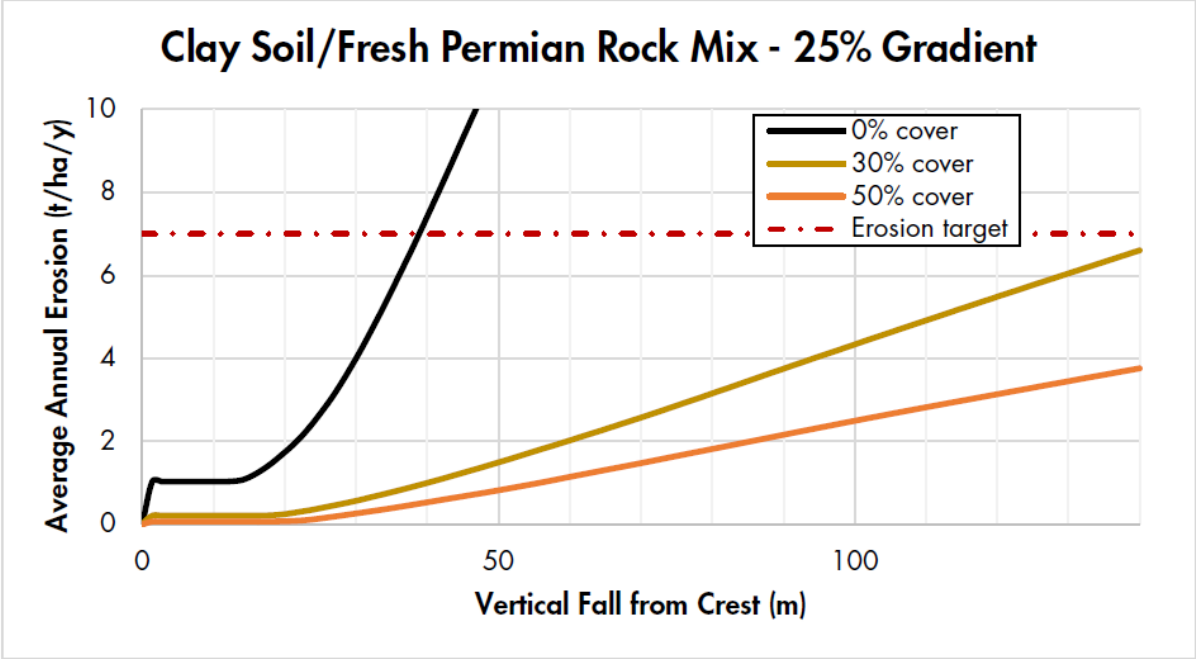


Figure 67 Predicted erosion rates along a 25% gradient batter slope with clay soil/ Fresh Permian rock mix surface and 0% - 50% vegetation cover

Long-term Landform Stability

The runoff and erosion simulations using the WEPP model and the landform evolution simulations using the SIBERIA model indicate that the proposed dumps and slope profiles at PTM can be expected to be stable over the long-term, provided the target levels of vegetation cover are achieved.

The results from the SIBERIA modelling predict the long-term development of channels and hillslopes in the landform catchments, considering runoff, erosion, and deposition. The model was run for 300 years, with outputs provided between 50 years and 300 years. At each output year, visualisations of the rate of erosion and gully development are provided, along with a table that includes rates for each material on the landform (Landloch, 2024).

The modelling predicted erosion rates and gully depths for the grazing PMLU and woodland PMLU areas are shown in Table 52. Consistent with the WEPP simulations, the SIBERIA results indicate that:

- At a vegetative cover level of 80%, predicted erosion rates of the grazing PMLU areas capped with clay soil are below the target erosion level of 5t/ha/y and has been adopted for this PMLU.
- At a vegetative cover level of 50%, predicted erosion rates of the woodland PMLU areas capped with clay soil mixed with fresh Permian rock are below the target erosion level of 5t/ha/y, however the WEPP results indicate erosional stability at 30% cover. Accordingly, a 30% groundcover criteria has been adopted for this PMLU, with 50% preferable if the rock mix and topsoil layer can support this level of cover.
- Cumulative predicated erosion at 300 years is <0.5m, which indicates the 1.9-2.0m fresh Permian layer underlying the growth media layer is sufficient to mitigate long-term erosion risk.

Figure 68 shows the overall modelled landform erosion rates for 300 years and demonstrates that the adopted erosion criteria limit is met across the Landform. It should be noted that as the 3D landform DEM is conceptual, minor adjustments were required to account for artifacts inherent in a design completed at this level of engineering maturity.

Table 52 Predicted Erosion Rates and Maximum Gully Depths

Simulation Year	Maximum Gully Depth (m)	Maximum Average Annual Erosion (t/ha/y)	Cumulative Erosion (mm)
Grazing PMLU Areas (80% cover)			
50	-	3.5	13
100	-	3.1	25
200	0.3	2.9	36
300	0.3	2.9	48
Woodland PMLU Areas (50% cover)			
50	-	3.5	13
100	-	3.0	25
200	0.3	2.8	36
300	0.3	2.8	46

As the predicted erosion rates provided in Table 52are based on an assumed ground cover, there is inherent uncertainty regarding both the validity and achievement of the maximum average annual erosion rate. Further collection of erosion monitoring data is required to calibrate the erosion rates shown in Table 52. On this basis, the rehabilitation milestone criteria proposed to demonstrate acceptable erosion of high-risk landforms is based on the erosion classification framework (RM6), referenced in Appendix 7 of the PRC Plan Schedule.

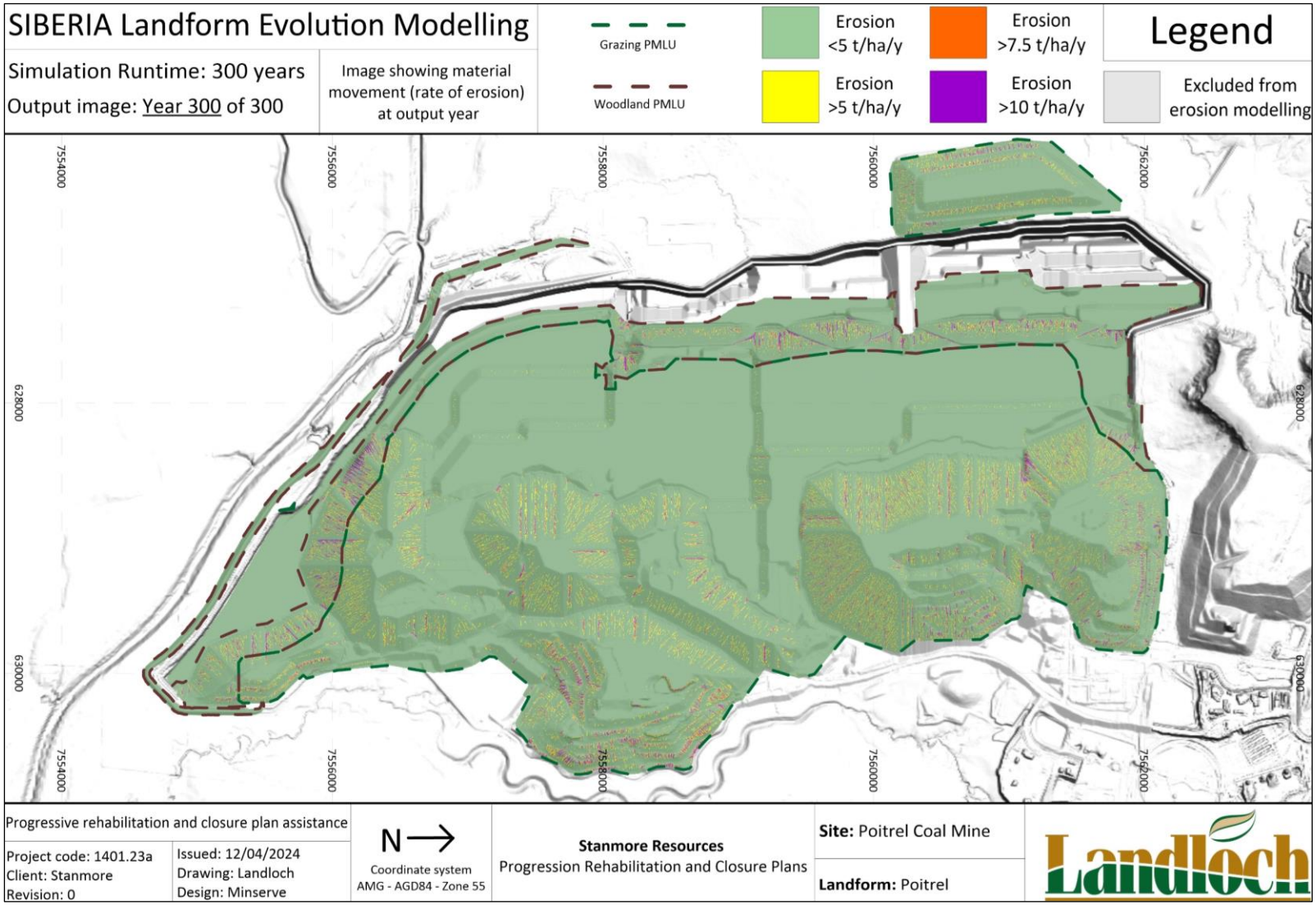


Figure 68 Predicted erosion rates of the PTM landform after 300 years.

3.6.1.5.6 Method of Construction

In alignment with the rehabilitation milestone criteria, relevant infrastructure will be removed, then the landform will be reprofiled to be consistent with design requirements. Dump areas will be reshaped using typical earthmoving equipment. Where required, temporary drainage controls will be designed and constructed to ensure erosion of the final landform is minimised.

Following landform profiling (with the requisite fresh Permian layer established), topsoil and graded fresh Permian rock (in the case of Woodland PMLU) will be imported, with shallow ripping to facilitate consistent mixing. Ameliorants and seeding will be applied using appropriately specialised machinery. Deep ripping along the contour for surface water management will be conducted.

3.6.1.5.7 Quality Assurance/Quality Control

Construction methodologies applied to landforms will be appropriately designed by a SQP, to ensure success in achieving the proposed completion criteria. Records of the method applied in construction of final landforms will enable objective assessment and monitoring against proposed rehabilitation milestones, as well as inform any corrective actions and changes to methodologies required to support success.

Typically, reshaping activities should achieve the design geometries ±0.2m vertical height measured over a maximum distance of 50m, allowing for some greater variation in microrelief caused by blockiness of the wastes (i.e. some rocks or larger particles may protrude from an otherwise suitably level surface).

It is critical that flow concentration on the batter slopes is minimised following construction, and temporary erosion and sediment controls, such as contour banks may be installed temporarily to facilitate revegetation and to protect bare surfaces. Cross ripping of the landform surface to ~500mm deep is also recommended to reduce the effects of sheet flow on landforms.

The key controls to manage the landform risks associated with achieving the PMLUs are discussed in the PRC Plan Risk Assessment (Section 3.7). Quality assurance and quality control activities are built into all necessary execution and verification activities of these controls. Construction monitoring and reporting records will verify controls and ensure that controls are executed effectively.

3.6.1.5.8 Trial Methodology

Assessments and modelling undertaken as part of PRC planning has indicated that as the landform rehabilitation will be executed as a single project, and accordingly trials on individual slopes may not be a viable option. If specific landform areas can be identified as appropriate for selected trials, these may be considered to confirm current milestone criteria can be achieved (including confirming preferred soil/rock ratio in the case of the Woodland PMLU). Maintenance and ongoing monitoring following construction will verify if the landforms are trending toward milestone criteria, or whether corrective actions, maintenance or change to the rehabilitation methodology is required.

3.6.1.5.9 Limitations and Assumptions

The key limitations and assumptions of the final landform design at the current conceptual level of engineering maturity include:

- Landforms designs are conceptual and have not been finalised and may be optimised during detailed design within acceptable design parameters as the knowledge base maturity is progressively improved.
- The final landform is dependent on the mining schedule, which can change due to increased geological knowledge, market factors and technology. These changes may result in differences to the landform, but the key considerations to ensure long-term stability, such as slope profiles and materials, will be maintained in the final closure landform design.
- Contaminated land assessments undertaken in RM2 (Section 3.1.4) will not impact this stage of the engineering design.
- All landforms are assumed to be track compacted during construction and internally reshaped with uniform soil/capping application. Accordingly and settlement over the long-term is expected to be consistent across the landform and does not require specific management.
- The fresh Permian overburden is used as a cover over the less suitable Tertiary overburden.

- The fresh Permian overburden poses a low risk and acid, metalliferous and saline drainage, such that the intent of the cover is for management of erosion and promotion of vegetation growth.
- Fresh, benign, rocky Permian overburden can be sourced in sufficient quantities to achieve the required cover.
- Vegetation groundcover levels of >30% can be sustainably achieved for the woodland PMLU.
- Vegetation groundcover levels specifically considers contact cover of vegetation on the surface. Practically, this means a combination of grass cover and anchored (not readily moved) surface litter.
- Considerations of surface cover do not include rock. Where rocky materials have had erodibility measured experimentally and those parameters are used in WEPP simulations, then effects of the rock are already accounted for within the parameters used.
- The erosion modelling assumes:
- No uncontrolled discharge of runoff from landform tops onto outer batter slopes.
- That batter slopes will not be formed with excessive flow-concentrating profiles (e.g. variations in surface elevation such that there is cross-slope concentration of flow into consistent depressions running downslope).
- Any cross-slope ripping will be carried out strictly on the contour.
- Soil management (including stripping, stockpiling, replacement, amendment, and fertilisation) will be carried out effectively to maximise early and continuing plant growth.
- Despite a blending 4:1 ratio being adopted for the modelling, other blending ratios could be considered in future modelling. It is possible that different blending ratios would also achieve acceptable long-term erosion rates.
- The landform shape supplied represented a dozer push plan to a final rehabilitation shape. As such, the design is not representative of a final design in that there are sections that will likely be modified as further design work and refinement occurs. However, the landforms have the overall conceptual 3D rehabilitation shape and modelling of long-term erosion of this design is useful insofar as it:
- Assesses the suitability of the overall batter geometry being adopted.
- Demonstrates aspects of the rehabilitation design that should be avoided in future refinement of the design.
- The final landform will be overall water-shedding. However, specific detailed surface water management features have not yet been integrated into the current design. It is expected that further refinements would need to include integration of those features.
- The landform is not lined as the waste stored is considered geochemically benign.
- Waste management and scheduling will be sufficiently aligned with eventual closure requirements to enable material to be incorporated into the upper layers of the final design.

3.6.1.6 Cover Design

PRC Plan Guideline (Section 3.6.1)

A cover design is required for the surface treatment of a mine landform or other waste material. Hence, the cover system design must be appropriate for the type(s) of waste the project will generate and reflect a risk-based approach. Where waste has the potential for AMD, neutral mine drainage or saline mine drainage, an appropriate cover system must be designed.

The cover design should include:

- identification and specification of the objectives of the cover system
- a detailed description of the design including the thickness of each layer
- 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 QA/QC for the construction of the cover system including the timely implementation of corrective actions where deviations from the design are identified.

Cover systems are typically required in mine waste storage facilities to provide a stable, reliable and sustainable constructed interface between the receiving environment and the mine waste, and to promote vegetation growth. Where mined waste material has the potential to cause AMD, Neutral Mine Drainage (NMD) or SD, store and release, barrier or engineered cover systems may be required to manage geochemical risks.

As part of PRC Planning, the risk of movement/migration of AMD, NMD and SD causing failure to achieve the PMLU was assessed, considering the geochemical characteristics of waste stored in the landform (Appendix 4 and 9). The study found that the waste materials had low potential for AMD, NMD or SD generation or elevated metal and/or sulphate concentration in surface waters or groundwaters (consistent with findings in Section 3.6.1.3). Accordingly, the recommended cover design is an erosion protection system only to manage erosion risks and promote vegetation establishment in line with milestone criteria. The soil and capping design, including justification for the use of the growth medium is presented in Section 3.6.1.4.

3.6.1.7 Water Management

PRC Plan Guideline (Section 3.6.1)

The rehabilitation planning part must include a description of the following:

- a description of the contaminants that pose a risk to environmental values of the receiving environment
- source, pathway and fate of contaminants that have the potential to impact environmental values
- infiltration and seepage intervention and collection controls
- surface water diversions and long-term management requirements
- dewatering requirements

ongoing water management and reduction requirements (i.e., treatment).

Management of water during operations is conducted in accordance with the PTM Water Management Plan. The WMP was developed by addressing the conditions of the EA and aims to protect receiving environments, particularly those within the Upper Isaac River sub-catchment. This is done so via water management infrastructure, consisting of a clean water diversion and a mine affected water (MAW) system consisting of dewatering and water transfer infrastructure, drains dams.

Water management for closure including controls, diversions, long-term management and dewatering requirements is summarised below, including identification and mitigation of risks to proposed PMLUs and the receiving environment. The proponent will also develop a Closure Water Management Plan (CWMP) prior to closure, addressing specific pre-closure, closure and post-closure water management requirements, monitoring, and maintenance.

The design of the closure landform for PTM aims to create landforms that satisfy the specified PMLU and NUMA milestone criteria, eliminating the necessity for continuous water management or dewatering post-closure. The evaluation of ongoing water management post-mining takes into account key considerations, outlined in detail in the relevant sections of this PRC Plan, including:

- The closure landform surface is intended to be free draining to prevent ingress into voids or ponding in the rehabilitated landform, with runoff flowing to the surrounding watercourses.
- Some dams will be retained (RA3) where they will have a demonstratable benefit to support the grazing PMLU. All others will be rehabilitated through decommissioning and removal (RM1).
- Contaminated land investigations will be undertaken (RM2) at the completion of mining where required, and any identified remediation/management requirements to render the site suitable for the nominated PMLUs will be undertaken.
- The final residual void would remain as a groundwater sink and groundwater would not flow from the residual void off-site.

3.6.1.7.1 Potential Contaminants

ERAs are authorised under the PTM EA. ERAs have the potential to release emissions and contaminants that can impact the environment and surrounding land users, causing environmental harm. PTM operations, to which ERAs pertain, encompass heavy industrial activities responsible for maintaining processing facilities, vehicles, and equipment necessary for coal extraction and processing. These operations involve the storage, utilisation, and disposal of various hazardous materials. Due to the nature of the activities at PTM, contaminants associated with the above activities can mobilise and become present in soil, surface water and groundwater. Upon completing mining operations, a contaminated land investigation (RM2) will evaluate the area for potential contamination, in accordance with the PRC Plan Schedule.

A summary of the potential contamination sources, the type of contamination and mechanism of contamination is presented in Table 53.

Table 53 Summary of Potential Contamination Sources (BHP, 2019)

Potential Source	Potential Contaminants	Mechanisms of Contamination
Runoff from disturbed land (pre-rehabilitation)	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Erosion, overland flow, capillary rise of salts, sodic spoils (elevating pH), acid generating rejects (lowering pH).
Runoff from rehabilitated land (contaminant loading expected to be significantly lower than disturbed areas)	Suspended Solids (Turbidity), Dissolved Solids, +/- pH, Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Erosion, overland flow, capillary rise of salts, sodic spoils (elevating pH).
Release of recycled waters, dams, sewage treatment plants and industrial areas, etc.	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, hydrocarbons, pathogenic microorganisms, metals	Releases from dams (seepage, catastrophic failure, by wash), pipes, drains, spills, acid generating rejects (lowering pH) ineffective sewage treatment, release from sewage ponds
Release of waters from pits and storages	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Releases from dams (seepage, catastrophic failure, by wash), pipes, drains, etc.
Release of waters from sediment dams	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	By wash, capacity reduced due to sedimentation.
Spilt or leaking flammable and combustible liquids and chemicals	Hazardous or toxic products, +/- pH, metals.	Contamination of land and surface runoff causing impact to regional water systems.

3.6.1.7.2 Contaminant Pathways

Water is a primary pathway of potential contamination to the receiving environment. At closure, dams and other infrastructure within the MAW management system will be assessed for potential contaminants, remediated (where required) and (excluding RA3) decommissioned and reshaped to achieve free draining conditions.

MAW has a higher potential to become acidic and metalliferous through contact with activities associated with the management and subsequent storage of mine waste. However, Section 3.6.1.3 suggests that this risk is low. Nonetheless, contaminants from spoil dumps and infrastructure areas have the potential to be mobilised via surface water runoff, and contribute to the generation of AMD, sediment laden water and/or saline drainage and then impact surface and groundwater receptors. Therefore, spoil dumps will be progressively rehabilitated and reshaped to form a free-draining landform designed to limit excess runoff and prevent the mobilisation of contained contaminants to downstream receptors. Where identified, higher risk material will be used to backfill the mining pits, or selectively encapsulated within spoil dumps to ensure that surface and ground water cannot become contaminated.

The post-closure hydrogeological technical report integrates a particle tracking analysis to inform migration/flow pathways for contaminants and residual voids, accessing potential particle migration routes. The findings predict that the water particles within the potential contaminant source areas of the mining leases, and within the voids themselves, will either migrate towards the residual voids and remain on the mining leases post-closure or remain within the voids on the mining leases post-closure.

Modelling confirmed that groundwater exchange in the void is expected to stabilise after mine closure; the residual void will operate wholly as a groundwater sink, with no water seepage into the natural environment (WSP, 2024). Therefore, there are no dedicated infiltration of seepage collection controls required. However, monitoring of groundwater will still occur (Section 3.8.5).

Further to this, flood modelling has demonstrated that the closure landform embankment (RA4), along with the permanent New Chum Creek diversion (RA7 and RA9), maintain a hydraulic regime that limits interaction with the residual void and closure landform, and subsequently the mobilisation of contaminants in floodwaters.

3.6.1.7.3 Surface Water Diversions and Long-Term Management

PTM has one existing surface water diversion within New Chum Creek (details in Table 54), which was designed and constructed to enable open-cut mining. A diversion assessment framework was developed (Engeny, 2020) that analysed the licenced creek diversion at PTM against industry standard performance criteria and objectives and found that:

- New Chum Creek Diversion (WL401913): Aligns with the defined assessment objectives for post-mining land use rehabilitation requirements related to watercourses. Consequently, in a closure state for PTM, the diversion will remain in its current alignment. The assessment findings include:
- The diversion either achieves or will progress towards achieving water license relinquishment objectives.
- In PTM's closure state, the land around the diversion will be used for grazing, ensuring the diversion's water quality, hydraulic, and sediment transport align with the natural upstream and downstream watercourse reaches.
- Monitoring and rehabilitation programs for the diversion will be sustained throughout PTM's operational phase (Section 3.8.3).
- The final land use of the diversion itself shall be ‘watercourse’.

The PTM creek diversion information, including water licenses, assessment result, and commitments for relinquishment, is provided in Table 55 . Forward work for the New Chum Creek diversion will involve rehabilitation efforts (removal of rock RA9) to ensure the creek diversion achieves a stable condition, facilitating its transition to a relinquishable state, not requiring long-term management.

Table 54 PTM Creek Diversion (New Chum Creek) Specifications (Source: Engeny, 2019)

Name	Stream Order	Water Licence No.	River Catchment	Total Length	Catchment Area	Construction Date
New Chum Creek	3	401913	Isaac River	4500m	25km^2	2007-2008

Table 55 PTM Surface Water Diversion Details and Forward Work Plan

Details	New Chum Creek Diversion
Water Licence	WL401913
Drainage Basin	Fitzroy River
Diversion Assessment Outcome	Diversion in its existing alignment is meeting or will continue progressing towards achieving the EA watercourse PMLU goals. Diversion will be relinquished in its existing alignment with a PMLU of Watercourse.
Operational Phase	Routine monitoring and maintenance of the diversion during the operational phase of the mine.
Rehabilitation Milestones	Removal and rehabilitation of any current or future mine infrastructure near the diversion including: • Removal of the rock armouring at the downstream limit of the diversion reach. • Removal of the upstream road crossing (Poitrel Mine Road). Review of design specifications and annual monitoring to determine if diversions are suitable or need repair/redesign in order to meet relinquishment criteria.

3.6.1.7.4 Dewatering

The only dewatering required will be associated with any dams to be decommissioned. All water within these storages will be dewatered back to the voids or other mine water storages if decommissioning occurs during operations or used for dust suppression during rehabilitation phase.

There are no other dewatering requirements with the final proposed landform and associated PMLUs/NUMA.

3.6.1.7.5 Ongoing Water Management

Based on the proposed rehabilitation strategy for PTM, once rehabilitation milestones are met and PMLUs have been achieved, no further water management are expected, including infiltration and seepage interventions, dewatering, and active reduction requirements due to:

- Any retained dams must not exceed the trigger values for livestock drinking water defined in ANZECC & ARMCANZ 2000 (RM6 of the PRC Plan Schedule).
- All other water storages, that were created for or by the mining operations, will be decommissioned and rehabilitated.
- Contamination will have been investigated, remediated and/or appropriately managed (RM2 of the PRC Plan Schedule).
- Residual void will generally continue to act as long-term sinks capturing and containing any groundwater seepage from the site, and will not overtop or interconnect with groundwater aquifers.
- The New Chum Creek Diversion will remain stable within its current alignment.
- Routine creek diversion performance monitoring is completed as part of the operations. The monitoring will continue throughout the LoA as part of the operations and closure.
- Upon relinquishment of WL associated with the diversion, and the subsequent closure of the mine, it is anticipated that there will be no requirement for ongoing, extended-term management of diversions at PTM.

3.6.1.8 Revegetation

PRC Plan Guideline (Section 3.6.1)

The revegetation plan must propose activities that will establish self-sustaining vegetation communities that are appropriate for the intended PMLU (e.g., natural ecosystems, grazing, forestry, and some agricultural and other land uses). Revegetation should, therefore, not only establish a ground cover, but also, in some domains, establish associated fauna habitat and other ecological services.

3.6.1.8.1 Revegetation Objectives

Rehabilitation methods adopted at PTM are considerate of the disturbed soil condition, such as depleted seed bank and increased susceptibility to weed growth. In particular, revegetation of disturbed land at PTM seeks to establish vegetation consistent with the proposed PMLU by comparing against established analogue sites and revised PRC Plan RE Benchmarks, with milestone timing that reflects a prolonged regeneration of the target ecological community.

The plan is aimed at establishing a safe, stable, and non-polluting landform, with a self-sustaining vegetation cover consistent with the proposed PMLUs. The revegetation plan does not aim to completely mimic conditions of the target REs in their remnant or undisturbed state.

Revegetation activities for the woodland habitat and watercourse PMLUs will focus on the establishment of groundcover to facilitate stability and topsoil retention, and shrub and tree cover to re-establish fauna habitat. Native seed mixtures will contain a variety of perennial grass, shrub, and tree species introduced by direct seeding to establish a self-sustaining woodland ecosystem.

Revegetation activities for the grazing PMLU will focus on establishment of a stable and productive pasture to facilitate stability and topsoil retention, and to enable the return of grazing and fauna habitat.

Cattle Grazing Objectives

Lower gradient disturbed areas where there was significant clearing prior to mining, are proposed to have a cattle grazing PMLU. The objectives related to revegetation for this PMLU include:

- To ensure cattle grazing pasture with land suitability class ≤3 or not different from pre-mining if ≥4.
- To ensure pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per “Stocktake: Balancing Supply and Demand” (Developed by FutureBeef – futurebeef.com.au).
- Leucaena stem density <250 stems >2m per ha (1 per 40m2) mean total area.
- Certification from an AQP that rehabilitation is resilient to fire and grazing pressures.

Woodland Habitat Objectives

The objectives of the Woodland Habitat PMLU is to establish habitat characteristics consistent with revised RE (11.10.1) Benchmark Criteria when assessed by an appropriately qualified person using the methodology outlined in the Queensland Herbarium’s BioCondition Assessment.

Watercourse Objectives

Watercourses rehabilitated to a Watercourse PMLU will seek to establish watercourse riparian vegetation with equal or greater conditions compared to upstream or downstream values, using Riparian Index Indicators (IDC method).

NUMA

Rehabilitation objectives for NUMAs are focused on ensuring they remain safe, stable, and non-polluting.

3.6.1.8.2 Species of Conservation Significance

Species of conservation significance are listed in Section 3.1.2.8.1. PTM has no specific obligations to include these species in revegetation activities, however the proposed woodland habitat and watercourse PMLUs will include habitat elements that support existing undisturbed vegetation and habitat values. Additionally, areas rehabilitated to a watercourse PMLU will connect existing riparian habitat values for potential conservation significant species.

3.6.1.8.3 Fauna Habitat and Use Requirements

Watercourse and woodland revegetation will provide connectivity and movement opportunity for threatened fauna species identified in field surveys in 2021 (BAAM,2022) including the Ornamental Snake and Southern Greater Glider, as well as for other species that occur or are likely to occur within the PTM MLs, such as the Koala, Squatter Pigeon and Grey Falcon.

3.6.1.8.4 Surface Preparation and Topsoil Quality to Support Vegetation Establishment and Management

Final rehabilitation will be undertaken progressively on disturbed areas as mining operations progress. The general sequence of works during each progressive rehabilitation campaign includes:

- Reshape disturbed areas when disturbance has been completed and the mine pit has progressed. Reshape to the final design shape (Section 3.6.1.5) (RM3).
- Identify and conduct sampling of the topsoil to be applied, to confirm soil ameliorant requirements (RM4).
- Rip surface to approximately 0.5m to reduce compaction and allow adequate water and root penetration into this layer.
- Spread growth medium at a minimum depth of 0.1m.
- Apply ameliorants (e.g., fertiliser) as required based on the sampling completed.
- Scarify the topsoil to incorporate soil ameliorants but not to a depth that will bring any waste material to the surface.
- Apply seed and till on the contour with a tyned implement, with tyne spacing no greater than 0.5m.
- Complete supplemental hand planting of trees and shrubs as required.

Topsoil Quality

Based on material characterisation (Landloch, 2022), topsoil properties to support the desired PMLU will have:

- Cation exchange capacity of above 14meq/100g for clays and 6meq/100g for loams.
- Major macronutrient concentrations in root zone (0–0.3m):
- Total nitrogen (N) above 1000 mg/kg.
- Available phosphorus (P) above 10 mg/kg.
- Potassium (K) above 160 mg/kg.
- Total organic carbon (TOC) above 1%.
- pH_w range of soil is between 6.0–9.0 to at least 0.3m.
- Primary growth media (0–0.3m) salinity ($EC_{1:5}$) is less than 0.75dS/m.

Prior to application, soil should be assessed by an appropriately qualified person, with amendments recommended as required. This is reflected in RM4.

3.6.1.8.5 Plant Species

Cattle Grazing Species

The recommended revegetation species mix for cattle grazing PMLU is based on preferred, palatable and productive (3P) pasture species and legumes cognisant of grazing best management practice. Suitable pasture species are provided in Table 56. These species have been recommended based on a combination of 3P species recorded during PTM baseline surveys, as well as a selection of 3P species suitable for the dominant clay and/or loam topsoils at the mine.

Table 56 Recommended Species to be Established in the Cattle Grazing PMLU

Common Name	Scientific Name	Sowing Rate (kg/ha)	Comments
Rhodes grass	*Chloris gayana* *cvv. Callide1*	3*	3P grass Tolerate a range of soils
	cvv. Katambora1	4*	3P grass Tolerate a range of soils Salt tolerant
Bisset Creeping Bluegrass	*Bothriochloa insculpta* *cvv. Bisset*	4*	3P grass Drought tolerant
Qld Blue grass	*Dicanthium sericeum*	2	3P grass Suitable for clay soils
Bambatsi panic	*Panicum coloratum* *cvv. makarikariense*	3*	3P grass
Purple pigeon	*Setaria incrassata*	2	3P grass
Burgundy bean[2]	*Macroptilium bracteatum*	2	Legume requires specific rhizobium inoculum strain CB1717
Stylo[2]	*Stylosanthes seabrana cvv. caatinga*	2	Legume requires specific rhizobium inoculum strain CB3481
Shirohie millet	*(e.g., Echinochloa esculenta[1])*	5	Cover crop for soil protection
Total		**27**	

Woodland Habitat Species

The species selected for the Woodland Habitat PMLU (presented in Table 57) expands from RE 11.10.1 to include as species from the relevant broad vegetation group (BVG). The relevant BVG for RE 11.10.1 located on the anthropogenic rocky landform is BVG 10a.

The total recommended seeding rates for upper-story tree species, mid and lower story tree and shrub species, and ground cover, is 5kg/ha.

Table 57 Recommended Species to be Established for the Woodland Habitat PMLU

BVG	Upper-Storey Tree Species	Mid and Lower Storey Tree and Shrub Species	Groundcover Species
10a	*Corymbia citriodora* *Eucalyptus crebra* *Eucalyptus fibrosa* *Corymbia hendersonii* *Corymbia clarksoniana* *Angophora leiocarpa* *thozetiana* *Eucalyptus cambageana* *Eucalyptus crebra* *Acacia harpophylla* *Acacia cambagei* *Casuarina cristata*	*Alphitonia excelsa* *Acacia leiocalyx* *Acacia cretata* *Acacia longispicata* *Petalostigma pubescens* *Breynia oblongifolia* *Capparis canescens*	*Cymbopogon refractus* *Themeda triandra* *Eremochloa bimaculate* *Arundinella nepalensis* *Panicum effusum* *Desmodium varians,* *Brunoniella australis* *Cyanthillium cinereum* *Chrysocephalum apiculatum* *Eustrephus latifolius* *Dianella revoluta* *Phyllanthus virgatus* *Evolvulus alsinoides*

BVG	Upper-Storey Tree Species	Mid and Lower Storey Tree and Shrub Species	Groundcover Species
			Lomandra confertifolia subsp. Pallida *Lomandra multiflora subsp. Multiflora* *Glossocardia bidens*

Watercourse Habitat Species

Previous ecological studies/diversion monitoring conducted at PTM indicate that watercourse habitat species within RA7 are consistent with RE 11.3.25. The species selection for the Watercourse PMLU for RM9 expands on the RE 11.3.25 species list to include as many species as possible from BVG 16a.

Generally, riparian vegetation includes species that are adapted to upper, mid, and lower banks (revegetation zones) as illustrated in Figure 69. The total recommended seeding rates for all these zones is 5kg/ha, with species outlined in Table 58.

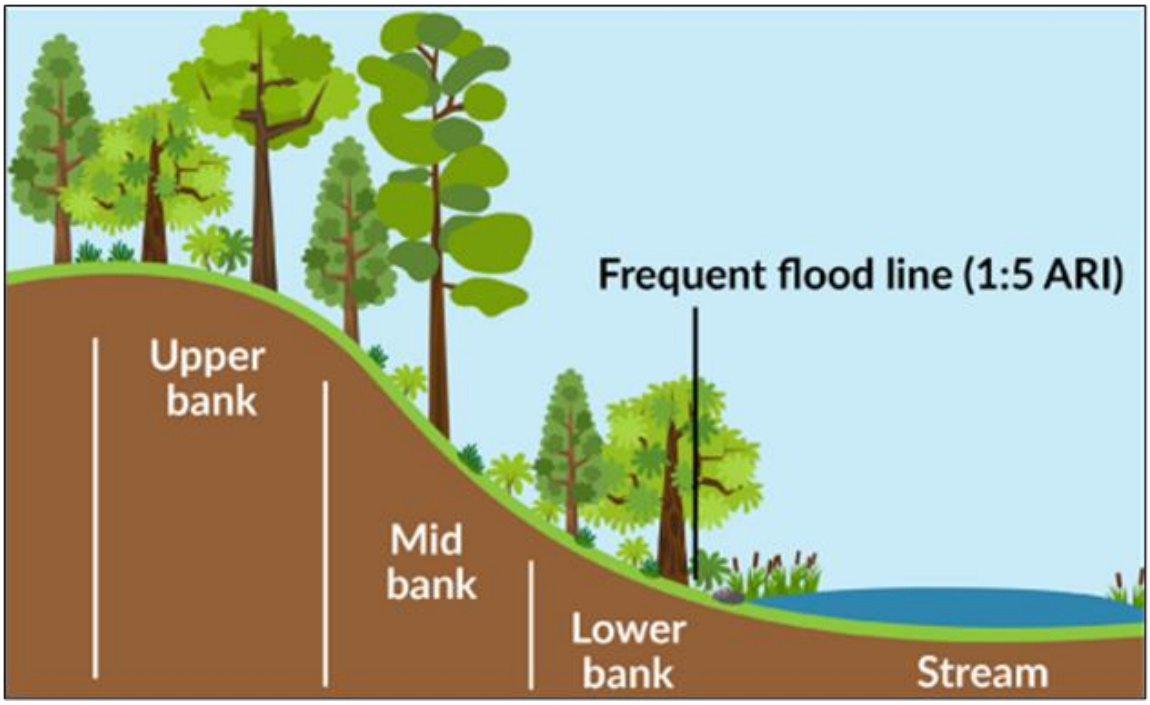


Figure 69 Typical Riparian Revegetation Planting Zones (BCCA, 2014)

Table 58 Recommended Species to be Established in the Watercourse PMLU

BVG	Upper-Storey Tree Species	Groundcover Species
16a	*Eucalyptus camaldulensis* *Eucalyptus tereticornis* *Eucalyptus coolabah* *Melaluca sp.* *Corymbia tessallaris* *Angophora spp. Casuarina cunninghamiana*	*Heteropogon contortus* *Themeda triandra* *Chrysopogon fallax* *Imperata cylindrica* *Eulalia aurea* *Cyanthillium cinereum* *Phyllanthus virgatus* *Eustrephus latifolius* *Brunoniella australis* *Crotalaria montana* *Rostellularia adscendens* *Evolvulus alsinoides* *Sida spp*

Planting Rates and Timing

A contingency of +20% should be applied to the seeding rates specified, to account for plant mortality.

Care should be taken to not overseed tree and shrub species, as this may cause undesirable densities of trees and shrubs to establish. Excess trees and shrubs can hinder and/or limit the establishment of groundcover species that are critical for limiting erosion of the final landform.

Revegetation activities will occur in the late summer or early autumn when soil moisture is high, and temperatures are milder.

Seed Collection and Procurement

If required, and where possible, native seed could be collected from populations on or near PTM to maintain endemic tolerance. Seed collection could occur in the years prior to commencement of rehabilitation, and then on an ongoing basis as rehabilitation occurs progressively through to the end of mining.

In the case where seed collection cannot supply sufficient seed (e.g., future dry periods that reduce seed set), species planted from seed may need to be purchased from local suppliers up to six months in advance, in quantities sufficient to undertake direct seeding operations. Seed shall be stored appropriately on-site once received and/or collected.

3.6.1.8.6 Vegetation Establishment and Management Methods

Seeding

Direct seeding will be preferred to achieve an even, continuous cover of vegetation for the Grazing, Woodland and Watercourse PMLUs. Seeding may be undertaken using conventional broadacre seeding equipment (e.g., combine seeder, spread with harrows or spinner).

In most cases, *Acacia* spp. seeds have a hard coat which is impermeable to water and germination will not normally occur unless some sort of pre-treatment is conducted. In nature this hard coat leads to seed dormancy until it is broken down over time or by the heat of bushfire. Approximately half of the hard-coated *Acacia* spp. seeds should be scarified prior to sowing. This will allow scarified seeds to imbibe and germinate. By only scarifying half of the seeds additional reserve are maintained in the soil seed bank. Seed scarification can be required from the supplier prior to delivery however needs to be sown as soon as possible after scarification.

Weed Control

Establishment of a self-sustaining ecosystem with comparable management requirements to similarly regional ecosystem will require weed management. It is suggested that:

- Weed density and diversity will not exceed 110% of baseline survey results.
- No declared weeds are to be present in rehabilitation.

Weed management methods include:

- Conduct employee weed and feral pest awareness training in scheduled tool-box talks.
- Provision of, and requirements for plant and vehicle wash down facilities.
- Wash down bays will collect seeds that are washed from the vehicles to prevent ingress to drainage lines.
- Regular weed monitoring and control programs.

Planting Success

Monitoring of newly seeded rehabilitation will commence immediately after planting and continue until plants have established. Plant health and mortality will be recorded, and any damaged or distressed plants will be attended to (e.g., watered, fertilised). If the mortality rate exceeds 30% of total plants, supplementary planting will be undertaken.

Fauna Control

Over grazing activity from native animals (e.g., kangaroos and wallabies), livestock (cattle, sheep, etc), and feral pests (e.g., pigs, goats, and mice) have the potential to impact rehabilitation success.

Grazing activity that impacts rehabilitation will be recorded during annual rehabilitation monitoring assessments. Where damage exceeds acceptable levels, grazing reduction treatments are to be engaged. Feral pest controls (e.g., trapping and shooting) will be instigated if they are found to be damaging revegetated areas. Damage from other animals may need to be managed through the establishment of exclusion areas (e.g., fencing) until rehabilitation has recovered.

3.6.1.8.7 Revegetation Monitoring

Monitoring is an integral part of the overall management strategy, enabling early detection of risks to rehabilitation and an indicator to commence effective risk management actions.

Key objectives of the monitoring program are to:

- Track the progress of rehabilitation activities with respect to milestones and benchmarks for comparable communities (at analogue sites).
- Identify problems affecting the progress or success of rehabilitation, which can then be addressed through management actions.
- Identify key site-specific success factors for successful rehabilitation and apply these more broadly throughout PTM.
- Collect data to objectively assess compliance with the PTM PRC Plan Schedule, relating to the creation of ecological values that are self-sustaining.

The timescales over which rehabilitation activities will be conducted can be expected to vary considerably between woodland and grazing communities. The establishment of functional woodland ecosystems may take decades, due to the slow growth rates of canopy vegetation. However, a range of incremental benefits in habitat value for ecosystem services can be expected throughout this period. In contrast, grazing pastures can be expected to form functional ecosystems over shorter timeframes of 10-15 years. The shorter timeframes for rehabilitation relate to the fast growth rate of grasses.

A summary of key stages expected in the rehabilitation of woodland and grazing ecosystems at PTM is provided in Table 59.

Table 59 Summary of Key Stages Expected in the Rehabilitation of Woodland and Grazing Ecosystems

		Anticipated Timeframe	
Revegetation Phase	**Definition**	**Woodland Habitat**	**Cattle Grazing**
Initiation and Establishment	Preparation of rehabilitated landform (topsoil, surface preparation and ameliorants) and seeding. The period required for rehabilitation to become self-reliant in normal seasonal conditions. Maintenance works may be required to maintain weeds and replace vegetation loses.	5 years	5 years
Maintenance	The period of growth post establishment until the time that the rehabilitation becomes dominant and self-sustaining on site.	10 years	10 years
Completion	Final vegetation community and associated fauna habitats establish.	15 years	10 years

The monitoring program allows for assessment of ecological values through time. In this way the assessment can track trends in ecological values with the intent that values trending towards those present in analogue

sites or consistent with published benchmarks but that may take long periods to reach (30+ years) can be used to demonstrate revegetation success in shorter periods of time (not less than 5 years).

Comparisons of ecological indicators will be made with those at analogue sites and/or with respect to published benchmarks for relevant ecosystem indicators (e.g., RE benchmarks and water quality guidelines). In addition to ecological indicators, soil indicators are also to be assessed against those present in analogue sites or those consistent with published benchmarks or suitability targets.

Watercourse monitoring will be conducted at PTM to assess the performance of the rehabilitated diversion disturbed by mining activities (New Chum Creek, RA7 and RA9). The purpose of the monitoring is to assess the performance of the rehabilitated watercourse in achieving watercourse stability requirements (RM6), final PMLU milestone criteria (RM9) and in accordance with the diversion water licence requirements (WL401913) for relinquishment.

Watercourse monitoring will be undertaken in accordance with the Index of Diversion Condition (IDC) methodology which is outlined in the Monitoring and Evaluation Program for Bowen Basin River Diversions (ID&A, 2001). The IDC is a quantitative monitoring method used to measure the geomorphic and riparian condition of diversions. In this aspect, it can be utilised to monitor the condition and existing rehabilitation associated with the New Chum Creek diversion.

The rehabilitation monitoring methodology for PTM, including rehabilitation success indicators and reporting requirements is provided in the attached PRC Plan Schedule and outlined further in Section 3.8.

3.6.1.8.8 Analogue Reference Sites

Vegetation analogue sites were established at PTM during initial rehabilitation monitoring assessments to provide comparable data for rehabilitated sites. These vegetation analogue sites were chosen based on their representative features of the respective land disturbances such as topography, soil characteristics and vegetation type and structure. Analogue sites were also selected based on their representation of the REs surrounding PTM. ID and co-ordinates of the analogue sites are included in Table 60., and images in Figure 70 and Figure 71. The location of these sites is presented in Figure 72.

Table 60 Rehabilitation Monitoring – Analogue Site Locations

Site ID	Easting GDA94	Northing	Period	Status
PTM07	630297.9	7554733.7	~10 years	Current
PTM08	627125.2	7560461.6	~10 years	Current

Figure 70 Analogue Site - PTM07 (Eco Logical 2023)

Figure 71 Analogue Site - PTM08 (Eco Logical 2023)

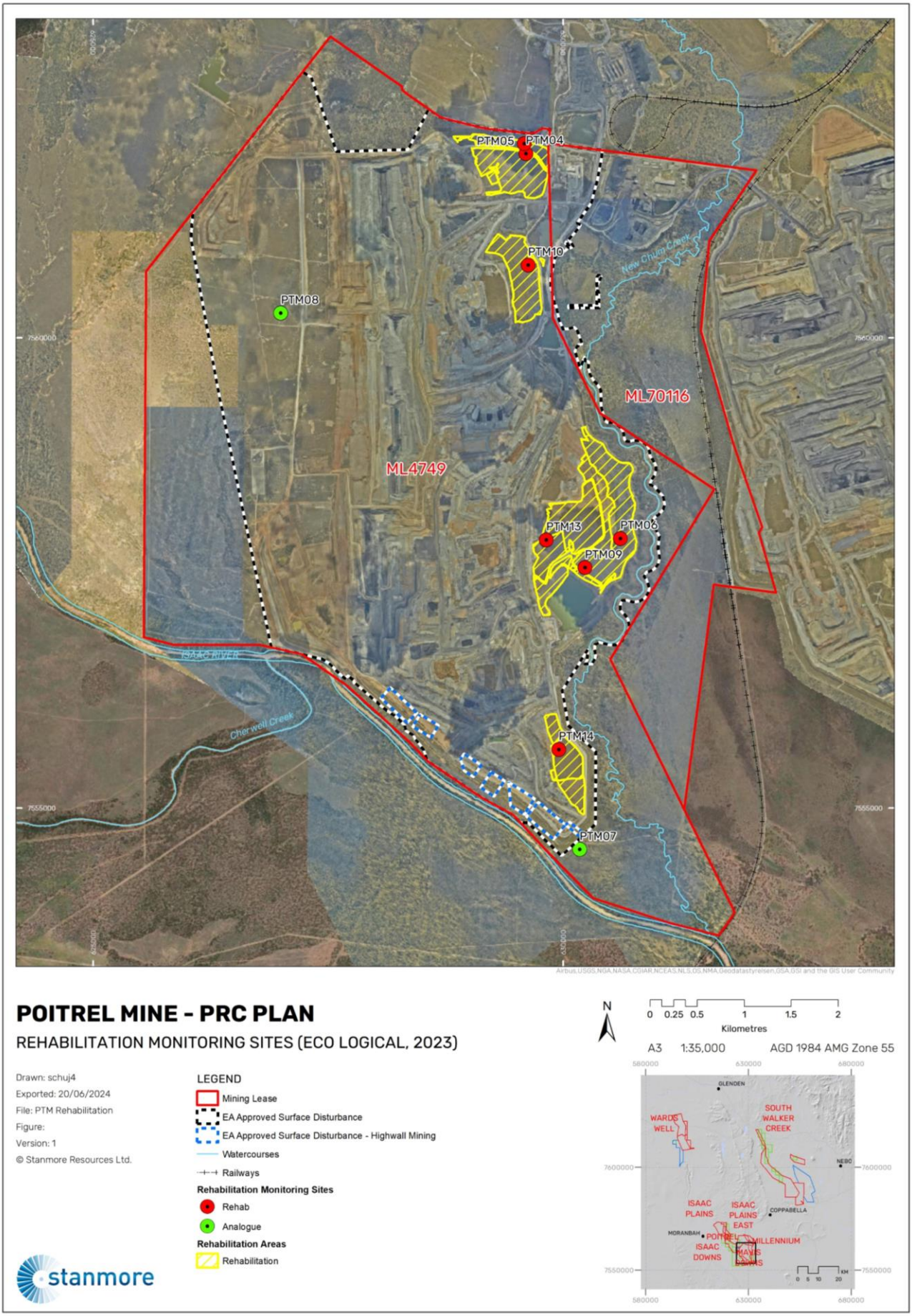


Figure 72 Rehabilitation Monitoring Sites

3.6.1.8.9 Revegetation Milestones and Objectives

Grazing

Pasture rehabilitation will be assessed by an AQP to certify that pasture meets a pasture condition rating of class ≤3, based on the Pasture Condition Assessment Table outlined in "*Stocktake: Balancing Supply and Demand*" (developed by FutureBeef –futurebeef.com.au) and provided in Table 61.. A summary of key assessable attributes includes:

- Certification that pasture achieves a condition rating class ≤3.
- Preferred pasture species (3P grasses) diversity of ≤2 species.
- Preferred pasture (3P grasses) % dry matter yield ≤10%.
- Annual grass species dry matter yield <70%.
- Grasses other than 3P grasses and other weeds dry matter yield <80%.
- Crown cover (3P grasses) – at worst, moderate to low density and some plants dead.
- Leucaena stem density <250 stems per ha (1 per 40m^2).
- Land suitability class ≤3 or not different from pre-mining if ≥4^.
- Certification from an AQP that rehabilitation is resilient to fire and grazing pressures.

Table 61 Pasture Condition Assessment

	Condition Indicators				
	Preferred Pasture Species				
Condition Rating	**% DM Yield**	**Crown Cover**	**Annual Grass % DM Yield**	**Undesirable Grasses and Other Weeds % DM yield**	**Preferred Pasture Species Diversity**
1	>80%	Dense and plants healthy	<20%	<20%	>5 species
2	60 – 80%	High to moderate density and some plants unhealthy	20 – 40%	20 – 30%	3 – 5 species
3	10 – 60%	Moderate to low density and some plants dead	40 – 70%	30 – 80%	2 – 3 species
4	<10%	Sparse and many plants dead	>70%	>80%	0 or 1 species

Woodland Habitat RE Benchmarks

Woodland rehabilitation will be assessed against representative published RE benchmark data with considerations given for the revegetation potential of reconstructed soil profiles at PTM.

Proposed assessable attributes and weightings for deriving the final BioCondition score are outlined in Table 62for RA4 and RA5 and Table 63 for RA8. Proposed rehabilitation completion criteria that incorporates BioCondition scoring is as follows:

- For RA4, RA5 and RA8, the BioCondition assessment demonstrates achievement of 50% of total maximum BioCondition score of undisturbed regional ecosystem 11.10.1.
- Table 62and Table 63contain BioCondition benchmark data for the nominated Regional Ecosystems that represent the native woodland planted for RA4, RA5 and RA8. Data is derived from Queensland Government BioCondition benchmark database. A revised PRC Plan benchmark is identified from the remnant vegetation benchmark, and only a subset of BioCondition assessable attributes are used, as some (i.e., large trees, course woody debris) would not be achievable in the timeframe from revegetation to achievement of the post-mining land use.
- It is noted that Table 62 and Table 63 do not contain BioCondition benchmark scores for mid story (shrubs) species. This is consistent with the Queensland Government Website which states that shrubs

may form a conspicuous layer. This is also consistent with the departments BVG 10a description which states, 'that a shrub layer is very sparse'.

Table 62 Representative RE Benchmark Criteria for Woodland Rehabilitation (>15% slope)

Regional Ecosystem	11.10.1 Benchmark	11.10.1 Revised Benchmark
Short Description	*Corymbia citriodora* +/-Eucalyptus crebra +/- *Corymbia clarksoniana* woodland	*Corymbia citriodora* +/-Eucalyptus crebra +/- *Corymbia clarksoniana* woodland
Recruitment	100%	100%
Non-Native Plant Cover	0	≤ 10%
Tree Species Richness	4	≥ 3 (inc. *Corymbia citriodora*)
Native shrub species richness	4	≥ 3
Native grass species richness	9	≥ 4
Native forb other species richness	17	≥ 5
Tree canopy cover	30%	≥ 15%
Shrub canopy cover	13%	N/A
Native perennial grass	16%	≥ 10%
Litter grid cover	50%	≥ 10%

Table 63 Representative RE Benchmark Criteria for Woodland Rehabilitation (>15% slope)

Regional Ecosystem	11.10.1 Benchmark	11.10.1 Revised Benchmark
Short Description	*Corymbia citriodora* +/-Eucalyptus crebra +/- *Corymbia clarksoniana* woodland	*Corymbia citriodora* +/-Eucalyptus crebra +/- *Corymbia clarksoniana* woodland
Recruitment	100%	100%
Non-Native Plant Cover not including pasture grasses species	0	≤ 10%
Tree Species Richness	4	≥ 3 (inc. *Corymbia citriodora*)
Native shrub species richness	4	≥ 3
Native grass species richness	9	≥ 4
Native forb other species richness	17	≥ 5
Tree canopy cover	30%	≥ 15%
Shrub canopy cover	13%	N/A
Native perennial grass and pasture grass species	16%	≥ 10%
Litter grid cover	50%	≥ 10%

Watercourse

Watercourse monitoring will be undertaken in accordance with the IDC methodology outlined in the Monitoring and Evaluation Program for Bowen Basin River Diversions (ID&A, 2001). The IDC is a quantitative monitoring method used to measure the geomorphic and riparian condition of diversions.

The IDC methodology encompasses:

- Visual inspection of the rehabilitated watercourse, upstream and downstream reaches (i.e., reference sites).
- Assessment of geomorphic index and riparian vegetation index at nominated monitoring points within the rehabilitated watercourse, upstream and downstream reaches.
- Determination of reach-averaged geomorphic index, riparian vegetation index and overall IDC scores for the rehabilitated watercourse, upstream and downstream reaches.
- Comparison of the geomorphic index, riparian vegetation index and overall IDC scores for the rehabilitated watercourse reaches to the relative upstream and downstream reaches.

The purpose of the IDC methodology is to compare the condition of the rehabilitated (diverted) watercourse with reference sites (i.e., upstream and downstream) and ensure that the diversion is continuing to track towards relinquishment. Monitoring locations for New Chum Creek have already been determined and will continue to be utilised for rehabilitation monitoring. Upstream and downstream reaches used for comparison are included in Section 3.8.3.

The IDC method utilises a suite of monitoring parameters to ensure the diversion can sustain an agreed PMLU of watercourse (Refer to Section 3.8.3).

3.6.2 Tailings

PRC Plan Guideline (Section 3.6.2)

The tailings require characterisation to determine the geochemistry, rheology and geotechnical parameters that influence the rehabilitation or management strategies and the capacity of the site to support revegetation.

There are no tailings storage facilities located at PTM therefore this chapter is not applicable.

3.6.3 Voids

PRC Plan Guideline (Section 3.6.3)

The information requirements of this domain are dependent on the nature of the proposed PMLU or NUMA for the void. For mine sites with voids, the rehabilitation planning part must include a void closure plan, which includes options for minimising final void area and volume; final void dimensions; pit wall geotechnical and geochemical stability, final slope angles, void hydrology, groundwater modelling, water balance and predicted long-term water quality.

A geotechnical report should focus on how the void will achieve post-closure slopes that will exhibit stability characteristics consistent with the planning and design of the post-closure mine void.

If floodwaters are likely to move over backfilled material, an assessment of the hydraulic properties must be conducted to assess whether instability may occur.

The rehabilitation and management strategies in the plan must include the supervision, verification and auditing of engineering works carried out to achieve the post-closure void landform, to ensure construction is consistent with the geotechnical design.

The rehabilitation and management strategy must also include confirmation that the post-closure landform demonstrates the level of stability as specified by the design.

A residual void is defined in the EA as "*an open pit resulting from the removal of coal and waste rock that will remain following the cessation of all mining activities and completion of rehabilitation processes*". The PTM final landform, following cessation of mining, will comprise of Ramp 10,20,30,40 and 50 pits forming one final residual void/NUMA, herein referred to as the PTM residual void.

The presence of a residual void at PTM is authorised under Schedule E (Condition E6 and E7) of the EA. The land outcome described for residual voids (Condition E6) is considered consistent with a NUMA. Therefore, the PTM residual void is taken to be pre-approved NUMA (refer Section 2 and Section 3.4).

A Void Closure Plan has been developed to support the improvement measures for the PTM residual void NUMA discussed in this PRC Plan (Appendix 8). Technical studies including flood modelling (Appendix 5 and 10), geotechnical stability assessments (Appendix 11), residual void water balance modelling and hydrogeology assessments (Appendix 3) have also informed the development of the Void Closure Plan. The technical studies were undertaken through an iterative approach to optimise the closure landform, resulting in the adoption of partial backfill of the void, and works to reduce the contributing catchment. This optimisation has resulted in a residual void design that is stable, and one that minimises the risk of environmental harm. A summary of the technical findings of the Void Closure Plan is provided below.

3.6.3.1 Void Hydrology

3.6.3.1.1 Flooding Interaction

Flooding assessments were completed by SLR (2022) and Engeny (2024). The SLR (2022) Voids in a Floodplain Assessment demonstrated that the PTM residual void is located within the Isaac River floodplain.

The Rehabilitation Flooding Assessment undertaken by Engeny (2024), demonstrated that the closure landform, including a final landform embankment between the Isaac River and R40/R50 portion of the residual void, provided 0.1% AEP flood immunity to the residual void. Consideration of flooding risk is discussed further in Section 3.6.1.2 but the modelling confirmed a low risk of scouring and/or erosion from flood events up to and including the 0.1% AEP.

3.6.3.1.2 Void Water Balance

A dedicated void water balance model (WBM) (WSP, 2024) – based on the closure landform was completed for the period from 2036 – 2199 (164 years) to understand residual void lake behaviour (including climate change considerations and groundwater interactions) within the residual void over time (Refer to Appendix 8 VCP for more details on model set up and assumptions).

In accordance with the PRC Plan Guideline, the WBM aimed to assess the following:

- Long-term water balance, formation of lakes, and predicted water levels in the residual voids.
- Potential for residual void lakes to interact with regional groundwater aquifers (creating sources or through-flow systems).
- Potential for overflow from the residual voids and subsequent release to surface water catchments.

Key findings are summarised in Table 64and Figure 73.

Key findings show that after 2120, mean water levels start to stabilise for the PTM residual void, with simulated mean inflow being very similar to mean outflow. This indicates that the mean water balance has reached an equilibrium by the end of the simulation period.

The void water level remains below the residual void spill point for the residual void for the duration of the simulation. Therefore, there is a very low risk of overtopping.

With sustained equilibrium water level below groundwater levels in residual void, acting as sinks, the minimal risk of groundwater flow beyond tenure boundaries eliminates the need for void hydrology-specific management activities.

Table 64 Summary of PTM Water Balance Model Findings

Residual Void	Spill Level (mAHD)	Mean Water Flows (year)		Long-Term Mean Void Lake Level Range (mAHD)
		Inflows (ML/yr)	Outflows (ML/yr)	
PTM Residual Void	197	**Year 2120**		165 - 172
		1903	1906	

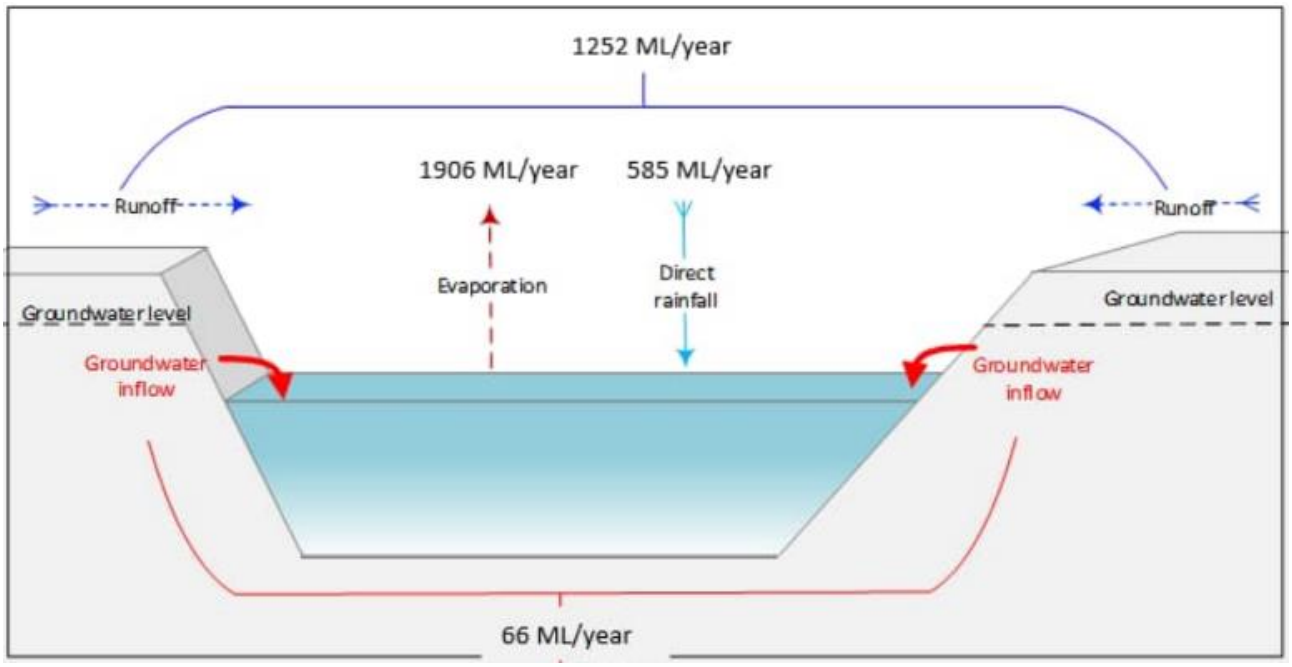


Figure 73 Average Inflows/Outflows Simulated for Period from 2180 to 2199 – PTM Residual Void

The risk of the residual void overtopping was found to be low, given that throughout the 164-year simulation period, water levels remained below the residual void spill point. Further to this, the modelled equilibrium water level within the residual void remains below interpreted and predicted groundwater levels. This means there is minimal risk of groundwater outflow from the residual void beyond tenure boundaries.

These findings did not prompt any additional change to the proposed closure landform, or adoption of hydrology-specific management measures. However, to manage the low risk presented, it is essential that the final design of closure landforms includes an update to hydrological models to verify that the residual void's catchment is being reduced to an area consistent with the long-term water balance model. It is also important that floodwater entry is prevented to ensure equilibrium inflow and outflow is maintained post-closure.

The review and update of void water balance modelling should incorporate any changes to the final mine closure landform, spill point elevation, rainfall, evaporation, surface water runoff, groundwater inflows, and climate projections. Additionally, certification from an appropriately qualified person should be obtained to ensure that the residual void will not cause environmental harm beyond the tenure boundary.

3.6.3.1.3 Geotechnical Stability

Geotechnical stability assessments (included in Appendix 8 and Appendix 11) have been completed to demonstrate that, post-closure, the PTM residual void high-walls and low-walls will all exhibit long-term geotechnical stability. Further, the assessment demonstrates that the presence of the residual void as a NUMA will not adversely impact nearby woodland and grazing PMLUs for at least the modelled period of 50 years (Henderson Geotech, 2024).

High-wall cross-sections through each void were selected to capture the greatest depth of weathering and Tertiary, and where creek channels occur close to the residual void crests (Henderson Geotech, 2024) (Figure 74).

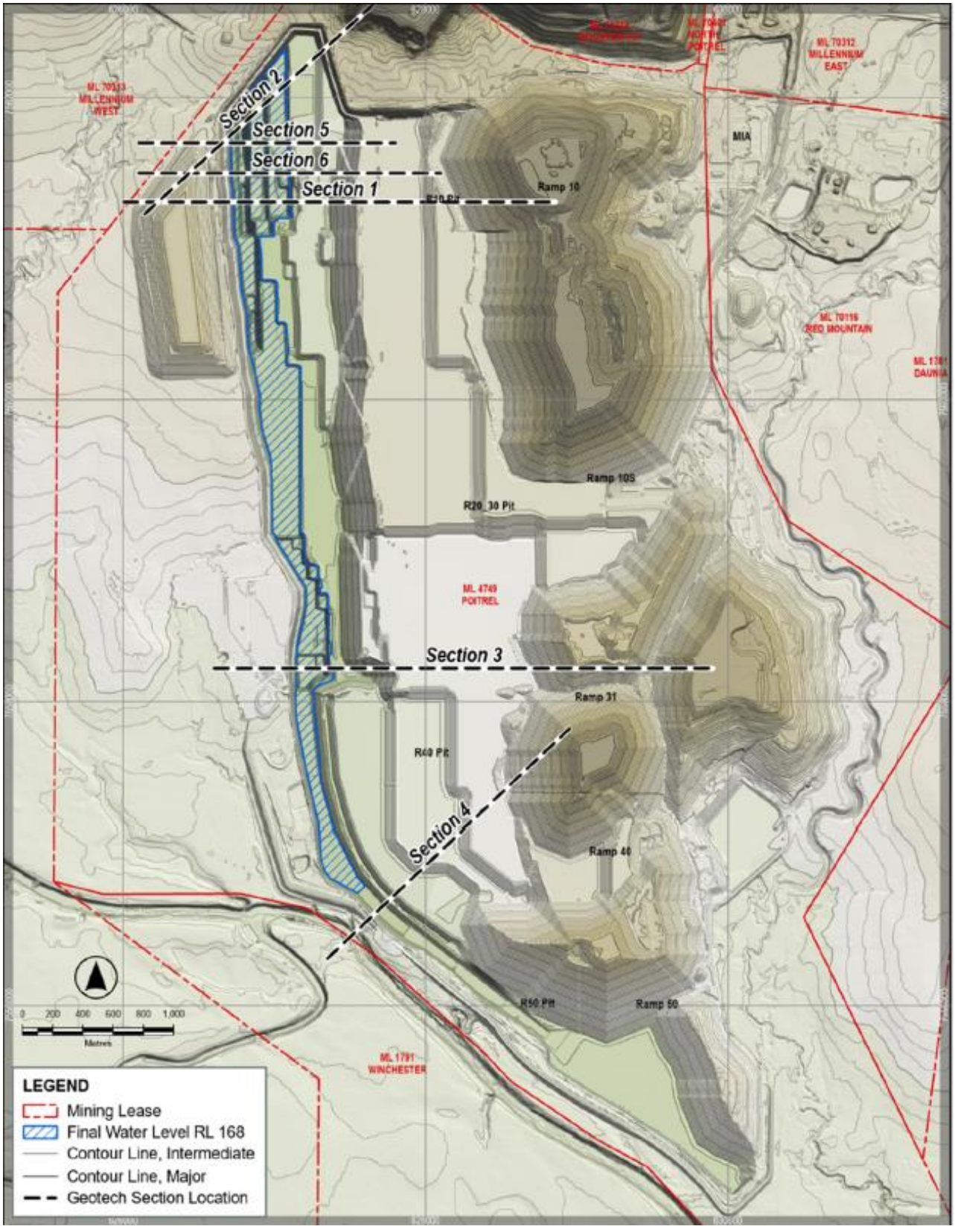


Figure 74 Cross-section locations for the PTM residual void high-wall geotechnical assessment

These cross-sections were then analysed using Slide2 Modeler, two-dimensional (2D) Limit Equilibrium Analysis for Slopes to determine the FoS. Three scenarios were modelled for each high-wall cross-section, the first assuming a 'dry' void at the end-of-mining, the second and interim pit lake, and the third adopting the long-term average equilibrium residual void lake levels from the water balance modelling (WSP, 2024).

The consequences of instability were determined by assessing the zone of instability, whereby instability contained wholly in the NUMA was considered a negligible risk (Appendix 11). From this classification, the following design acceptance criteria in Table 65was adopted.

Table 65 Design Acceptance Criteria

Scenario	Minimum Factor of Safety
Instability extending into grazing PMLU	1.5
Instability extending to watercourses or flood protection structures	1.5
Instability extending into woodland PMLU	1.35
Instability contained within NUMA	1.25

The results of the high-wall geotechnical assessment are presented in Table 66.

Table 66 High-Wall Geotechnical Stability Assessment Results for the Sections of the PTM Residual Void

Section	Residual Void Water Level	Minimum FoS	Setback Distance to Achieve Design FoS
1	End of Mining	1.30	FoS >1.35 22m behind crest FoS >1.5 39m behind crest
	Interim pit lake	1.36	FoS >1.5 34m behind crest
	Final residual void lake	1.44	FoS >1.5 36m behind crest
2	End of mining	1.41	FoS >1.5 at crest
	Interim pit lake	1.37	FoS >1.5 36m behind crest
	Final residual void lake	1.47	FoS >1.5 15m behind crest
3	End of mining	1.94	
	Interim pit lake	1.93	
	Final residual void lake	1.94	
4	End of mining	2.35	
	Interim pit lake	2.36	
	Final residual void lake	2.41	
5	End of mining	1.32	FoS >1.35 16m behind crest FoS >1.5 19m behind crest
	Interim pit lake	1.34	FoS >1.35 18m behind crest FoS >1.5 25m behind crest
	Final residual void lake	1.43	FoS >1.5 at crest
6	End of mining	1.42	FoS >1.5 14m behind crest
	Interim pit lake	1.44	FoS >1.5 26m behind crest
	Final residual void lake	1.52	

Based on the assessment results:

- All sections achieved the minimum FoS for NUMAs (>1.25).
- Where the void depth was greater than 120m (Sections 1 and 6), the minimum FoS for Woodland (>1.35) was achieved with a setback 25m behind the crest.
- Along the northern portion of the residual void, the FoS for grazing was met within 40m behind the highwall crest.

WSP (2024) assessed five (5) low-wall sections for geotechnical stability (using Slide2 Modeler) by selecting areas of the residual void low-wall where spoil material batters or slopes had a relatively high angle (Figure 75). The assessment concluded that, for the mine closure landform, the nominated design acceptance criterion was met, with each section having a minimum FoS greater than 1.5 (Table 67)

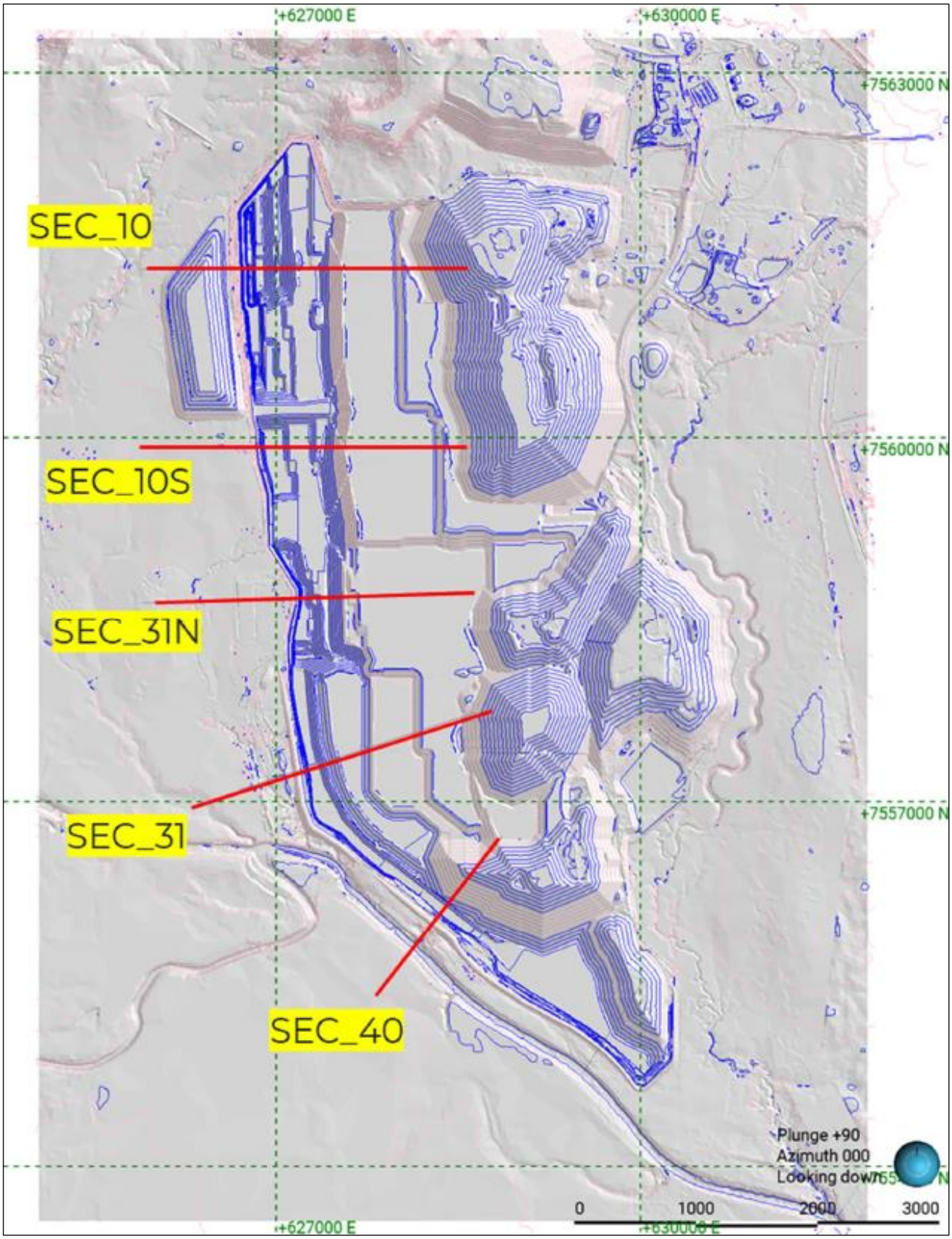


Figure 75 Cross-section locations for the PTM residual void low-wall geotechnical assessment

Table 67 Low-Wall Geotechnical Stability Assessment Results for the Sections of the PTM Residual Void

Section	Minimum FoS
SEC_10 (Ramp 10 pit)	2
SEC_10S (Ramp 10 pit-south)	2.4
SEC_31N (Ramp 30 pit-north)	2.1
SEC_31 (Ramp 30 pit)	2.4
SEC_40 (Ramp 40 pit)	1.8

The results of the stability assessment were used to define the extent of the NUMA and define an appropriate boundary between the NUMA and grazing and woodland PMLUs. In summary:

- Wherever the highwall or endwall is deeper than 120m (crest to exposed toe), the NUMA extent should extend at least 25m behind the wall crest.
- In the northern portion of the residual void, grazing PMLU should not be defined closer than 15m behind the wall crest.

3.6.3.2 Groundwater Modelling

Calibrated numerical groundwater modelling was undertaken to evaluate the potential groundwater-related impacts of the closure landform, including the residual void. The assessment incorporated the conceptual closure landform and adopted all projected inflows, outflows, and recharge rates from the closure WBM. The objectives of this modelling were as follows:

- Simulate the water level and rate of recovery of the residual void lake, and the water level and rate of recovery from mining-related groundwater drawdown in the groundwater system surrounding the void.
- Assess groundwater inflow to the final residual void.
- Identify areas of potential environmental or anthropogenic risk, such as impacts to private water supply bores or GDEs, where groundwater impact mitigation/control measures may be necessary post-closure.
- Assess the potential for migration/flow pathways for contaminants and residual void water through particle tracking.

The proposed closure landform was replicated in the model, and the predicted end-of-mining groundwater head levels were applied as the starting head levels for the post-closure simulation. The model simulation period commenced at the end-of-mining and ran for 2309 years, with a total of 82 stress periods.

Climate-related boundary conditions for recharge and evapotranspiration (ET) were set constant for the duration of the model simulation period. Recharge and ET were not applied in the numerical groundwater model to the residual void itself, as the water balance model accounts for these boundary conditions.

Over the first 50 years post-mining, the groundwater model predicted variable inflows and outflows for the PTM residual void. During this period, groundwater levels in the spoil and natural formations are recovering from mine dewatering and remain below the residual void lake level, as indicated by the WBM. Groundwater fluxes to the residual void are mainly driven by the difference between the void lake level and groundwater levels in the spoil. The void lake levels fluctuate based on climatic conditions applied to the WBM, and the translation of daily water balance results to the simplified stress periods in the groundwater model.

Model results show that, initially, outflows from rainfall captured in the residual void flow to the in-pit spoil surrounding the void lake, as groundwater levels in the spoil and natural geological formations gradually recover from mining. By the end of the simulation, groundwater inflows and outflows to/from the residual void stabilise, with net inflows to the void continuing throughout the simulation period.

3.6.3.3 Void Water Quality

The Void Closure Plan (Appendix 8) includes long-term water quality predictions of the void lake. The geochemical model was run for major cations, anions, and metal(loid)s where data was available. The results were calculated using the geochemical modelling code PHREEQC (Parkhurst, 2013) with the Minteq.v4 thermodynamic database, derived from the MINTEQA2 version 4 database (US EPA, 1998). The results were presented for two scenarios, one with and one without geochemical controls/reactions (i.e., mineral precipitation, sorption, and gas exchange). The water quality modelling builds directly on the void water balance assessment, including predictions over the same period of 164 years post-closure (from 2036 to 2199).

In closure, the geologic materials and associated mine waste materials (spoil and rejects) within the catchment of the residual void may react with water and release or immobilise solutes, according to their geochemical characteristics. Three main lithological groupings: coal, carbonaceous overburden, and non-carbonaceous overburden were derived for the residual void high-walls, low-walls and end-walls using drill-core data. Further geochemical source terms were extracted from the proponent's PTM groundwater and environmental geochemistry databases and included results from drill core analyses and solubility testwork on additional drill cores. The groundwater monitoring database includes data from 15 monitoring bores over 15 years (from February 2008) across three main aquifer types, with no differentiation between aquifers or bores in deriving the groundwater source term. The source term derivation data is summarised in Table 68.

Table 68 Summary of PTM Water Balance Model Findings

Water Inflow	Data Source	Comment
Initial void lake	-	It is assumed that no water is present in the PTM residual void at closure.
Rehabilitated catchment/in-pit spoil runoff	PTM drill-core database	It is assumed that non-carbonaceous interburden will be specified as cover material for final landform. Spoil runoff is, therefore, represented by leachate data from fresh non-carbonaceous drill core samples.
High-wall runoff	PTM drill-core database	The PTM drill core databases were used to derive source terms for each lithological domain/grouping.
Groundwater inflow	PTM drill-core database	Median water quality from PTM groundwater database.
Direct Rainfall	-	Pure water equilibrated with atmospheric carbon dioxide (CO2).

Following definition of the source terms, the geochemical model was run as follows:

- Source terms were mixed for annual timesteps, with inflow/outflow proportions calculated from the water balance model (WSP, 2024).
- Modelling was incremental, with the output for the void lake from the previous timestep being used as the input for the next time step.
- Geochemical reactions, such as mineral precipitation/dissolution, gas exchange and sorption were considered.

The key findings of the modelling were as follows:

- Acidic conditions are not expected to establish within the PTM residual void lake. The main geochemical control is CO2 degassing which raises pH, resulting in carbonate precipitation and reducing pH. These geochemical processes are driven by the input of dissolved inorganic carbon, from runoff and groundwater inflow to the void lake.
- TDS concentrations will continue to increase over time but remain below the EA-derived trigger value until around 2190, regardless of geochemical controls. The increase is mainly due to the

evapoconcentration of residual void lake water. Minor differences in TDS concentrations with geochemical controls are due to the removal of some metals/metalloids through precipitation. An equilibrium state for TDS concentrations, where TDS levels remain constant, is not reached.

- Steep sides, void depths, and elevated TDS present favourable conditions for stratification within the PTM residual void. Hydrodynamic/limnological analysis is required to assess the potential for thermal/chemical stratification to occur, and the importance of seasonal mixing processes and groundwater mixing inputs. However, as the residual void lake is considered a NUMA and modelled as a groundwater sink, further stratification assessment is not warranted.

As the residual void lake stabilises and remains a groundwater sink over time, it does not present an unacceptable risk of environmental harm beyond the tenure boundary, with all potential contaminants contained within the residual void itself.

3.6.3.4 Options for Minimising Final Void

Technical studies, including the water balance and hydrogeology modelling, have been undertaken through an iterative approach with the development of the mine closure landform design. These iterations have resulted in a mine closure landform design incorporating residual void partial backfill, catchment reduction and changes to surrounding landforms to minimise environmental harm from the residual void.

Further detail including a void minimisation options assessment is described in Section 3.4.3.

3.6.3.5 Final Void Dimensions

The residual void extents are defined by the high-wall, end-wall, and low-wall crests at natural ground level. Proposed final dimensions of the void are presented in Section 3.4.

3.6.3.6 Rehabilitation Strategies

The PTM residual void will be retained as a NUMA, and will become available for improvement once mining of each pit is complete and reshaping of the low-wall spoil dump outside of the NUMA area is complete (IA1). This is for safety reasons to eliminate the risk of any injury or damage within the NUMA area from the reshaping and rehabilitation activities.

The rehabilitation management strategies developed to inform the adopted MMs outlined in Section 3.4.4 and ultimately achieve PTM closure objectives, are summarised in Table 69..

Table 69 PTM Residual Void Management Strategies

Residual Void Closure Aspect	Closure Objective: Safety	Closure Objective: Stability	Closure Objective: Non-Polluting	Residual Void Closure Context	Rehabilitation Management Strategies
Geotechnical Stability	x	x	-	Stability outside of the NUMA extent = FoS ≥1.5. Extents of PTM residual void has been defined by geotechnical analysis and data available at the time of the analysis.	Develop geotechnical parameters that are specific to PTM for spoil and other materials to apply to the geotechnical modelling. As mining approaches the final limits, re-assess the geotechnical stability of the high- and low-walls based on the latest available data, including the developed site-specific geotechnical parameters. Use a minimum FoS≥1.5 as a guidance for ongoing void closure planning. (This may be refined over the mine life should industry research provide optimised guidance on observational methods and consequence assessment).
Void Hydrology	x	x	x	Based on rehabilitation flood modelling completed: The residual void in the current mine closure landform is not subject to inundation from floodwaters for the 0.1% AEP event. Floodwaters interact with the mine closure landform associated with the residual void, but do not exceed velocities greater than 1.5m/s. The long-term mean void lake level is predicted to remain below the interpreted and modelled groundwater levels, largely due to evaporative effects on the residual void lake. This results in a void that acts as a groundwater sink. After 2120, water levels in the residual void start to equilibrate, with simulated mean inflows of	Residual void catchment is minimised as far as practicable. The closure landform will continue to consider spoil dumping and landform design to exclude floodwaters entering the residual void. If necessary, identify and implement mitigation measures for appropriate protection works of landforms where floodwaters from watercourses interact with the closure landforms. At cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the void closure landforms, spill point elevation, rainfall and evaporation, surface water runoff, groundwater inflows, and climate projections.

Residual Void Closure Aspect	Closure Objective			Residual Void Closure Context	Rehabilitation Management Strategies
	Safety	Stability	Non-Polluting		
				1,934ML/year being equal to mean outflows of 1,935ML/yr.	Obtain certification from an appropriately qualified person that the residual void will not cause environmental harm beyond the tenure boundary.
Void Hydrogeology	-	-	x	Mining-related dewatering activities have lowered groundwater levels that will result in continued suppression of the water table centred on the PTM residual void. Void lakes are predicted to form in the residual void post-mining. Water levels in the void lake are modelled to remain below the interpreted and modelled groundwater levels due to evaporative effects on the residual void lake. The PTM residual void remains as groundwater sinks post-closure or any minor groundwater outflows remain within the mine closure landform and do not leave the tenure. Modelling, including particle tracking, indicates that infiltration of rainfall through the spoil and other areas around the void within the tenure will migrate towards, and be captured within the residual void. Groundwater flow is not expected to flow off-tenure toward the receiving environment, minimising the risk of environmental harm due to the proposed final mine closure landform.	At cessation of mining activities, review and update the groundwater modelling, incorporating updated void WBM outputs and in-field groundwater sampling data, as required. Obtain certification from an appropriately qualified person that, upon completion of mining, residual void does not present an unacceptable risk of environmental harm.
Void Water Quality	-	-	x	Acidic conditions are not expected to establish within the PTM residual void. TDS concentration in the PTM residual void will continue to increase over time.	At cessation of mining activities, review and update the void geochemical assessment including additional or refined data from in-pit surface water samples, surface- and groundwater samples, and biochemical modelling.

Residual Void Closure Aspect	Closure Objective			Residual Void Closure Context	Rehabilitation Management Strategies
	Safety	Stability	Non-Polluting		
				In addition to the above, the PTM residual void does not present an unacceptable risk of environmental harm beyond the void itself as it: Will remain as a NUMA post closure. Acts as a groundwater sink, ensuring any contaminants from the void or surrounding landform report to the void.	Obtain certification from an appropriately qualified person that the residual void will not present an unacceptable risk of environmental harm.
Void Access Control	x	-	-	Access to the residual void will be restricted for humans and livestock.	Following cessation of mining activities: Construct a safety bund at the setback distance determined by geotechnical analysis. Erect fencing and signage (where required) around the perimeter of the safety bund. Obtain certification from an appropriately qualified person that the residual void is safe to humans and livestock.

3.6.4 Underground Mining

PRC Plan Guideline (Section 3.6.4)

For underground mining operations, the rehabilitation planning part must include:

- a geotechnical study
- an assessment of groundwater interactions and potential lowering of groundwater levels
- the development of a hydrogeological conceptual model
- subsidence analysis and modelling and a subsidence vegetation/habitat impact assessment
- consideration of how potential entries to underground workings will be sealed (i.e., through some form of capping or back filling)
- how surface ponding and cracking will be mitigated
- identification of post-closure stabilisation of underground workings in order to manage the potential for unplanned surface subsidence and unplanned ground collapse such as sinkholes and pot holing.

Not applicable, as there is no underground mining at PTM.

3.6.5 Built Infrastructure

PRC Plan Guideline (Section 3.6.5)

The administering authority's expectation of rehabilitation relating to built infrastructure is that it will be decommissioned, demolished, salvaged and/or disposed of unless it is being formally retained by the landholder to achieve an appropriate PMLU.

The rehabilitation planning part must include:

a. Identification of infrastructure that will be decommissioned and the methods for decommissioning.
b. A description of infrastructure that will remain post rehabilitation and the identification of ongoing maintenance requirements.
c. Evidence of agreement for any infrastructure that will have ownership transferred.

In accordance with EA condition E15 - All infrastructure constructed by, or for the EA holder during the mining activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post-mining landowner/landholder (unless the landowner / landholder is also the environmental authority holder).

Table 70details the infrastructure associated with the mining activities at PTM.

The proponent surface infrastructure not beneficial to the PMLU will be removed in accordance with EA conditions. Surface infrastructure that may be retained to support the PMLUs will have a demonstratable benefit and may include a selection of the following: fencing; access tracks; services related infrastructure; sheds and buildings; hardstand areas/transport logistics areas; and water related infrastructure. Any infrastructure proposed to be retained to support the PMLUs will have written agreement from the post mining landholder (at the time) prior to commencement of rehabilitation milestones.

Priority will be to repurpose, salvage or recycle any infrastructure to be removed. Demolition and disposal will only be undertaken when alternatives are deemed by the proponent not to be viable. This approach is in line with the waste and resource management hierarchy outlined in the Queensland Waste Management and Resource Recovery Strategy created under the Queensland *Waste Reduction and Recycling Act 2011.*

Table 70 Infrastructure Associated with the Approved PTM Mining Activities

Category	Infrastructure
Built Infrastructure Steel Concrete and Brick Infrastructure	• MIA (e.g. administration, crib rooms, workshop, warehouse, storage and sheds. • Fuel, oil, and chemical storage. • Fuel and wash bays. • Communications towers. • Fences.
Supporting Services	• Pipes and pumps. • Switchyard and substations. • Communication and lighting towers. • Concrete pads and bitumen. • Culverts.
Offsite Infrastructure	• Rail and train loadout and related infrastructure. • Power lines.
Water Infrastructure	• Process water dams. • Raw water dams. • Drains and pipelines.

The timing of the decommissioning and removal of the infrastructure is based on the proposed timing of the PTM operation and rehabilitation activities.

Any public infrastructure associated with roads, power, water and communications supply to landowners or townships is not included in this PRC Plan or Schedule.

Further detail on the rehabilitation stages after decommissioning of the infrastructure, such as landform reshape, surface preparation, revegetation, and monitoring, are covered in the relevant sections of this PRC Plan.

3.6.5.1 Decommissioning Built Infrastructure

Decommissioning of the built infrastructure with no beneficial use to the PMLU will include:

- Disconnecting services (e.g., dismantle power feeds, water, or communication-related feeder lines).
- Buildings are demolished and removed.
- All mine roads and access tracks are removed.
- All pipelines are drained and removed.
- All waste removed from site.
- All exploration drill holes and pads have been rehabilitated in accordance with the eligibility criteria and standard conditions for exploration and mineral development projects – V2 (DEHP, 2016).

3.6.5.2 Decommissioning Water Infrastructure

Decommissioning of the water infrastructure with no beneficial use to the PMLU will include:

Removing any remaining water from the water infrastructure to the residual voids, or in accordance with:

- EA condition F27: “Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of: a) supplying stock water subject to compliance with the quality release limits specified in Table F9 (Stock Water Release Limits); or b) supplying irrigation water subject to compliance with quality release limits in Table F10 (Irrigation Water Release Limits); or c) supplying water for construction and/or road maintenance in accordance with the conditions of this environmental authority”.
- EA condition F28: “Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, for the purpose of supplying water to any operation licensed for either ERA13 (mining black coal) or ERA31 (mineral processing). The volume, pH and electrical conductivity of water transferred must be monitored and recorded”.
- EA condition F29: “If the responsibility for mine affected water is given or transferred to another person in accordance with conditions F27 or F28: a) the responsibility for the mine affected water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) the third party agreement must include a commitment from the person utilising the mine affected water to use it in such a way as to prevent environmental harm or public health incidents and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the Environmental Protection Act 1994, environmental sustainability of the water disposal and protection of environmental values of waters; and c) the third party agreement must be signed by both parties to the agreement”.
- Investigation and remediation (if required, RM2) of contaminated sediments, as determined by a suitability qualified person (SQP).
- Removal and disposal of geosynthetic liners (if applicable).
- Removal of embankments and reshaping of the area to make it free-draining (RM3).

3.6.5.3 Contaminated Land Assessment

In accordance with EA conditions E13, F1 and F43, contaminants must not be released in a manner that constitutes serious environmental harm, and spillage of any waste, contaminants or other materials must be cleaned up as quickly as practicable, stored in accordance with relevant standards, and handled in a way that prevents environmental harm.

At completion of mining operations and after infrastructure decommissioning (RM1) but prior to landform establishment, surface preparation and revegetation, a contaminated land investigation will be undertaken for selected RAs in accordance with RM2 and will include:

a. A contaminated land investigation, completed by an SQP in accordance with the *Environmental Protection Act (1994):*

    i. If identified, contaminated and hazardous material will either be remediated in-situ or removed / transported to an approved landfill for disposal and waste tracking information recorded and submitted. Following this, validation testing will be undertaken to confirm that contaminated and hazardous materials have been removed or remediated successfully.

b. If required, a contaminated land investigation document (CLID) including a site suitability statement will be prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act. The site suitability statement from an SQP will confirm that the uses or activities for which the land is suitable aligns to the approved PMLU.

3.7 Risk Assessment

Legislative Requirement

In accordance with section 126C(1)(f) of the EP Act, the rehabilitation planning part of the PRC Plan must identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.

3.7.1 Identifying, Assessing and Treating Risks

PRC Plan Guideline (Section 3.7)

As per section 126C(1)(j) of the EP Act, the administering authority considers it necessary for the proposed PRC Plan to contain a risk assessment of all proposed NUMAs. The risk assessment must be carried out to identify the risks of the NUMA causing environmental harm and not being safe and structurally stable and detail how the applicant intends to manage and minimise the identified risks.

The *AS ISO 31000:2018 Risk Management – Guidelines* (Standards Australia, 2018) describes risk assessment as the overall process of risk identification, risk analysis, risk evaluation and risk treatment. Each of these aspects must be included in the risk assessment in the rehabilitation planning part.

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Information requirements in this section apply to all applicants whether or not they are an existing EA holder. Existing holders may have the required information available from previously submitted plans/reports/applications that, if still valid, can be used in the PRC Plan.

3.7.2 Risk Methodology

A risk-based approach to the PTM PRC Planning has been undertaken in term of the method described in Figure 76.

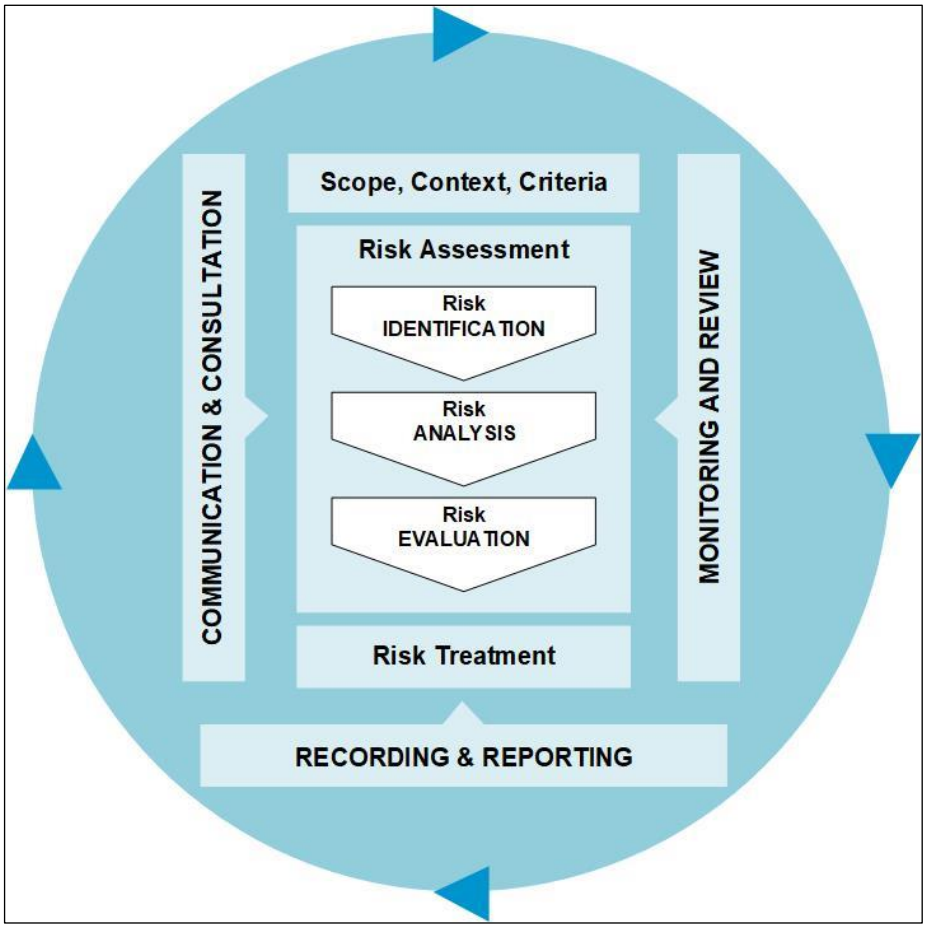

Figure 76 ISO 31000-Compliant Risk-Based Approach Followed for the PTM PRC Plan

3.7.3 Risk Identification

The risk event - a stable condition for land described as a post-mining land use not being achieved was assessed per ISO 31000 methodology described in Figure 76 above (the full risk assessment is included in Table 75 where stable condition is defined as per section 111A of the EP Act:

- The land is safe and structurally stable.
- There is no environmental harm being caused by anything on or in the land.
- The land can sustain a PMLU.

For PTM the PMLUs being assessed are cattle grazing, woodland habitat and watercourse (Section 3.3).

A number of scenarios were identified in the risk identification process related to a stable condition for the land described as the PMLUs not being achieved:

- Contaminated land impacting on environmental receptors, rehabilitation and attainment of PMLU.
- Alteration of hydrogeological conditions.
- Alteration of local hydrologic conditions.
- Insufficient volume of material available or unsuitable quality for rehabilitation activities.
- Inadequate vegetation cover and establishment.
- Impact of extreme weather events prior to final landform establishment leads to instability of final landforms.
- Landform establishment inconsistent with milestone criteria.

Additionally, the risk of NUMAs not meeting a stable condition consistent with milestone criteria was assessed.

3.7.3.1 Risk Analysis, Evaluation and Relevant Treatments

Table 75 provides the full detail of risk analysis, risk evaluation and risk treatment for these scenarios. Worst case outcomes were assessed for each scenario, preventative and mitigating controls identified and from there a residual risk rating was calculated. The likelihood and severity tables, as well as the outcomes of the residual risk rating (RRR) heat map ratings matrix are provided in Table 71,Table 72and Table 73respectively. Table 74 details neccessary risk treatments identified to achieve a stable condition for the PMLUs.

Table 71 Risk Likelihood Table

Likelihood Table			
Uncertainty	**Frequency**	**Likelihood Factor**	**Guidance**
Highly Likely	Likely to occur within a 1-year period	3	Event is expected to occur >80% of the time during a 5-year planning cycle
Likely	Likely to occur within a 1 - 5-year period	1	Event is expected to occur 60% to 80% of the time during a 5-year planning cycle
Probable	Likely to occur within a 5 - 20-year period	0.3	Event is expected to occur 30% to 60% of the time during a 5-year planning cycle
Unlikely	Likely to occur within a 20 - 50-year period	0.1	Event is expected to occur 10% to 30% of the time during a 5-year planning cycle
Highly Unlikely	Not likely to occur within a 50 year period	0.03	Event is expected to occur <10% of the time during a 5-year planning cycle

Table 72 Risk Severity Table

Severity Table		
Severity Level	**Descriptor**	**Severity Factor**
5	Severe impact to the environment and where recovery of ecosystem function takes 10 years or more.	1000
4	Serious impact to the environment, where recovery of ecosystem function takes between 3 and up to 10 years.	300
3	Substantial impact to the environment, where recovery of ecosystem function takes between 1 and up to 3 years.	100
2	Measurable but limited impact to the environment, where recovery of ecosystem function takes less than 1 year.	30
1	Minor, temporary impact to the environment, where the ecosystem recovers with little intervention.	10

Table 73 Residual Risk Rating (RRR) Heat Map

			Severity Level	**S1**	**S2**	**S3**	**S4**	**S5**
			Severity Factor	**10**	**30**	**100**	**300**	**1000**
	Likelihood	**Likelihood Factor**	**Timeframe**	**Residual Risk Calculation (With Controls in Place and Effective)**				
Likelihood	Highly Likely	3	Within 1 year	30	90	300	900	3000
	Likely	1	Within 1-5 years	10	30	100	300	1000
	Probable	0.3	Within 5-20 years	3	10	30	90	300
	Unlikely	0.1	Within 20-50 years	1	3	10	30	100
	Highly Unlikely	0.03	Within 50 years	0.3	1	3	10	30

With controls in place and implemented effectively, the RRR for the identified risk scenarios of this risk event is deemed to be medium (RRR of 10).

Table 74 Necessary Risk Treatments to Achieve a Stable Condition for the PMLUs

Aspect	**Risk Treatment**
Risk Event 1 - Contaminated land impacting on environmental receptors, rehabilitation, and attainment of PMLU	
Reasons for selecting treatment options	Conservatively, additional works are required to reduce contaminated land risks and to achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Suitably qualified person (SQP) to undertake contaminated land investigations and oversee ongoing monitoring requirements Sample collection, laboratory analysis, and engineering controls

Aspect	Risk Treatment
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	SQP reporting as per PRC Plan milestones
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule
Risk Event 2 - Insufficient volume of material available or unsuitable quality for rehabilitation activities	
Reasons for selecting treatment option	Studies and analysis performed show that these treatments achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Topsoil inventory Laboratory testing Survey Equipment capabilities Rehabilitation monitoring data AQP to undertake growth media assessment
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	Rehabilitation monitoring
Risk timing and scheduling	Alignment with PRC Plan milestone and schedule
Risk Event 3 - Inadequate vegetation cover and establishment	
Reasons for selecting treatment option	Studies and analysis performed show that these treatments achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Topsoil inventory Survey Equipment capabilities Rehabilitation monitoring data AQP to undertake growth media assessment
Performance measures and constraints	Alignmen with PRC Plan milestones
Reporting and monitoring	Rehabilitation monitoring
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule
Risk Event 4 - Alteration of hydrogeological conditions	
Reasons for selecting	Studies and analysis performed show that these treatments minimise and/ or prevent impacts
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75

Aspect	Risk Treatment
Resource requirements	Monitoring bores maintained and monitoring undertaken
Performance measures and constraints	Alignment with PRC Plan milestone criteria
Reporting and monitoring	Monitoring at defined frequency Reporting under existing EA requirements
Risk timing and scheduling	Alignment with PRC Plan milestone criteria and schedule
Risk Event 5 - Alteration of local hydrological conditions	
Reasons for selecting	Studies and analysis performed show that these treatments minimise and/ or prevent impacts
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Undertake surface water monitoring
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	Monitoring when surface water flows are available Reporting under existing EA requirements
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule
Risk Event 6 - Impact of extreme weather events prior to final landform establishment leads to instability of final landforms	
Reasons for selecting treatment option	Studies and analysis performed show that these treatments achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	AQP to undertake monitoring of final landforms post flood events Rehabilitation monitoring program Emergency response procedures
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	Rehabilitation monitoring
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule
Risk Event 7 - Landform establishment inconsistent with milestone criteria	
Reasons for selecting treatment option	Studies and analysis performed show that these treatments achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Data from waste characterisation In-situ geochemical monitoring data Construction QA

Aspect	Risk Treatment
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	Rehabilitation monitoring Waste Characterisation sampling and analysis Surface and Groundwater Monitoring
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule
Risk Event 8 - NUMA does not meet stable condition consistent with milestone criteria	
Reasons for selecting treatment option	Studies and analysis performed show that these treatments achieve a stable condition for the proposed final landform
Responsibility for plan: • Approval. • Implementation.	The proponent
Proposed actions	Refer to Table 75
Resource requirements	Rehabilitation monitoring data Surface and groundwater monitoring AQP to undertake certification
Performance measures and constraints	Alignment with PRC Plan milestones
Reporting and monitoring	Rehabilitation monitoring
Risk timing and scheduling	Alignment with PRC Plan milestones and schedule

Table 75 Risk Register

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Landform does not reach stable condition consistent with selected PMLU.	RM7, RM8, RM9	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9	• Erosional instability (including due to high erosion risk of spoil material). • Geotechnical instability. • Geochemical instability. • Insufficient or incorrect construction methods. • Inadequate vegetation cover and establishment (see separate risk event). • Insufficient volume of rehabilitation materials or unsuitable materials used (see separate risk event). • Extreme or significant weather events (see separate risk event). • Low pasture productivity/diversity. • Contaminated land impacting on environmental receptors, rehabilitation, and attainment of PMLU (see separate risk event).	• Unable to relinquish mining lease. • Extended period required to remediate landform. • Loss or degradation of cover materials. • Poor landform design (capping depth, materials, and thickness). • Ineffective monitoring and inspection program.	Probable (0.3)	3	Medium (30)	• Adopt setbacks to achieve geotechnical stability as a management measure, to ensure the risk of the NUMA not achieving stable conditions is managed. • Construction management, technical supervision, and QA/QC of final landforms and covers will be done by a SQP. • Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. • Cattle grazing (RA1, RA2, RA3, RA6) Landforms reshaped with maximum 15% slope. • Cattle grazing (RA1, RA2, RA3, RA6) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. • Woodland Habitat PMLU (RA4, RA5, RA8) Areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required. • Woodland Habitat PMLU (RA4, RA5, RA8) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP. • Updated hydraulic flood modelling using drainage designs. • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use. • The geochemical assessment has shown that the wastes are not anticipated to pose a significant risk in terms of acid, neutral metalliferous, or saline drainage, or elevated metal and/or sulphate concentration in surface waters or groundwaters. As a result, the recommended cover design is an erosion protection system only to manage erosion risks and promote vegetation establishment in line with milestone criteria. • Implement rehabilitation monitoring program. • Maintain dams, perimeter drainage and erosion and sediment control systems during establishment. • Monitoring of rehabilitated areas to be completed in accordance with monitoring criteria and identify re-work areas as applicable. • No evidence of erosion for all RA's excluding RA7, RA9 is classified as 'minor' 'moderate' or 'severe' as defined by PRC Plan Schedule Appendix 7: Erosion classification framework. • Assessment report completed by an AQP certifying that the diversion (RA7, RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. • Geomorphic index (IDC method) used to verify that Rehabilitation for (RA7, RA9) is erosionally stable. • Certification by an AQP that pasture meets a pasture condition rating suitability is class ≤3, based on the Pasture Condition Assessment Table as per "Stocktake: Balancing Supply and Demand" (developed by FutureBeef – futurebeef.com.au), as provided in PRC Plan Schedule Appendix 5: Pasture condition assessment. • A BioCondition assessment at RA4, RA5, and RA8 is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's BioCondition Assessment Manual. • The BioCondition assessment required for RA4, RA5, and RA8 demonstrates achievement of the PRC Plan Benchmark for each assessable attribute for the relevant regional ecosystem as per PRC Plan Schedule Appendix 6: Representative RE benchmark criteria for woodland habitat rehabilitation at RA4, RA5, and RA8.	Unlikely (0.1)	3	Medium (10)

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
								• Contaminated land investigation completed by a suitability qualified person (SQP) in accordance with the Environmental Protection Act (1994). • A site suitability statement from a SQP confirms the uses or activities for which the land is suitable and aligns to the approved PMLUs for the site. • Vegetation establishment per proposed rehabilitation criteria. • Earthworks timed to avoid periods of heavy predicted rainfall. • Protection from un-approved livestock access. • Only approved seed mixes to be used and seeding to occur at optimal timing for favourable weather conditions. • See also – controls for inadequate vegetation cover and establishment, insufficient volume of rehabilitation materials or unsuitable materials used and extreme or significant weather events.			
Contaminated land impacting on environmental receptors, rehabilitation, and attainment of PMLU.	RM2, RM3	RA2, RA3, RA5, RA6, RA8	• Erosional instability of landforms resulting in sediment mobilisation and exposure of encapsulated waste. • Unsuitable materials used in rehabilitation or as capping. • Potential contamination sources not adequately investigated and/or remediated. • Incorrect placement of geochemically unstable waste materials. • Seepage from MAW sources or residual voids.	• Contamination of soil, surface water and groundwater above selected thresholds / guidelines. • Migration of contaminants from source to sensitive receptors.	Probable (0.3)	3	Medium (3)	• Contaminated land investigation with a site investigation report prepared by an appropriately qualified person (AQP). • Removal and appropriate disposal of contaminated materials. • Conduct validation testing to confirm that contaminated materials have been removed or remediated. Certification from an AQP that all contaminated land has either been remediated or removed. • Landform and cover design technical specifications must include a QA/QC program. • Construction management, technical supervision, and QA/QC of final landforms and covers will be done by a SQP. • Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. • Cattle grazing (RA2, RA3, and RA6) landforms reshaped with maximum 15% slope. • Cattle grazing (RA1, RA2, RA3, and RA6) landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. • Woodland Habitat PMLU (RA4, RA5, and RA8) Areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required. • Woodland Habitat PMLU (RA4, RA5, and RA8) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP. • Updated hydraulic flood modelling using drainage designs. • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use. • No evidence of erosion for all RAs excluding RA7 and RA9 is classified as ‘minor’ ‘moderate’ or ‘severe’ as defined by PRC Plan Schedule Appendix 7: Erosion classification framework. • Assessment report completed by an AQP certifying that the diversion (RA7 and RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. • The residual void is expected to continue to act as a groundwater sink in closure. • Environmental monitoring and reporting as per the EP Act 1994 and existing EA requirements. • Implement rehabilitation monitoring program.	Unlikely (0.1)	3	Medium (10
Insufficient volume of material available or unsuitable quality	RM3, RM4, RM5	RA2, RA3, RA4, RA5, RA6, RA8, RA9	• Poor planning and management of rehabilitation materials	• Insufficient quantities of capping and cover materials to achieve rehabilitation of final	Unlikely (0.1)	4	Medium (30)	• Sufficient quantities of growth material estimated to be sourced from site for construction of final landform.	Highly Unlikely (0.03)	4	Medium (10)

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
for rehabilitation activities.			(soil, seed) leading to degradation. • Insufficient characterisation of soil and waste material. • Inadequate amelioration does not prepare soil for target vegetation impacting PMLU. • Inadequate amelioration does not prepare soil for target vegetation impacting PMLU.	landform to support PMLU. • Potential for acid mine drainage or saline mine drainage to reduce water quality in groundwater and surface water. • Insufficient quality of capping and cover materials to achieve rehabilitation of final landform to support PMLU. • High cost of remediation.				• Waste management and scheduling will be sufficiently aligned with eventual closure requirements to enable material to be incorporated into the upper layers of the final design • Soil sampling of stockpiles prior to placement to refine amelioration fertilizer rates. • Growth medium placed at a minimum depth of 100mm • An assessment of growth media characteristics is completed by an AQP that identifies amelioration and other treatments required to achieve the following primary growth media quality targets^: a. pH (1:5) 6.0–9.0 (0- 0.3m) b. Electrical Conductivity - EC (1:5) ≤ 0.75dS/cm ((0- 0.3m) c. ESP = ≤6% d. CEC and major macronutrient (N, P, K, and organic C) concentrations in root zone (0–0.3m) at least 80% of those measured at comparable reference sites. • Rip across slope.			
Inadequate vegetation cover and establishment.	RM5, RM6, RM7, RM8, RM9	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8 RA9	• Inadequate amelioration does not prepare soil for target vegetation impacting PMLU. • Weed and pest species infestation(s). • Soil / growth media not managed or applied as per required specifications. • Insufficient or incorrect construction methods. • Inadequate and/or inappropriate revegetation not in accordance with milestone criteria. • Seed unavailability or poor quality. • High erosion risk of spoil material. • Placement of unsuitable tertiary waste within 2m of the surface. • Poor introduction of livestock due to inadequate fencing or deviation from schedule.	• Excessive erosion of rehabilitated areas. • Extended period required to remediate landform. • Loss or degradation of cover materials. • Premature grazing could lead to poor seeding establishment or destruction of establishing vegetation. • Loss or degradation of cover materials.	Probable (0.3)	4	Medium (90)	• Waste characterisation to be undertaken when entering new un-tested areas. • Ongoing testing of mine-affected water throughout operations. • Primary growth media quality targets listed in PRC Plan Schedule are achieved based on a number of representative samples as determined by AQP. • Selection of appropriate vegetation species, seed species and their rates. • Soil sampling of stockpiles prior to placement to refine amelioration fertilizer rates. • Implement rehabilitation monitoring program. • Document growth media depth. Document ameliorants and physical treatments applied. • Document seed mix and source/s. Document seed application rates/density, planting timing and areas. • Appropriate topsoil stockpile management. • Provision of surface roughening such as dozer tracking (up and down slope) or ripping (across slope), to minimise rapid run off. • Growth medium placed at a minimum depth of 100mm • Management of topsoil stripping and application during rehabilitation in accordance with TMP and RMP. • Ameliorants and fertiliser applied per approved ratio. • Appropriate equipment to be utilised during activities. • Seeding at optimal time of year with respect to favourable rainfall conditions. • Monitoring of rehabilitated areas in accordance with monitoring schedule to identify reduced germination early. • Re-seeding where required in critical situations. • Variable seed criteria to allow for seasonal variation and availability. • Where applicable, additional ESC measures to be implemented. • Continual improvement through annual review of completed rehabilitation activities. • Only authorised vehicles and persons to access rehabilitated areas. • Fencing surrounding PTM is to be maintained to control external livestock access when required. • Monitoring to identify any erosion initiation and early rectification of erosion.	Unlikely (0.1)	4	Medium 30

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Alteration of hydrogeological conditions	RM1, RM2, RM3, RM4, RM5, RM6, RM7, RM8, RM9	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9	• Insufficient or incorrect landform design or construction methods. • Incorrect placement of geochemically unstable waste materials. • Seepage from MAW sources or residual voids.	• Adverse impacts to the receiving groundwater environment including contamination of groundwater above selected thresholds/guidelines.	Unlikely (0.1)	4	Medium (30)	• Construction management, technical supervision, and QA/QC of final landforms and covers will be done by a AQP. • Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. • Cattle grazing (RA1, RA2, RA3, and RA6) Landforms reshaped with maximum 15% slope. • Cattle grazing (RA1, RA2, RA3, and RA6) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. • Woodland Habitat PMLU (RA4, RA5, and RA8) Areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required. • Woodland Habitat PMLU (RA4, RA5, and RA8) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP. • Updated hydraulic flood modelling using drainage designs. • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use". • The geochemical assessment has shown that the wastes are not anticipated to pose a significant risk in terms of acid, neutral metalliferous, or saline drainage, or elevated metal and/or sulphate concentration in surface waters or groundwaters. As a result, a specific cover design to address these risks is not required. • No evidence of erosion for all RA's excluding RA7, and RA9 is classified as 'minor' 'moderate' or 'severe' as defined by PRC Plan Schedule Appendix 7: Erosion classification framework. • Assessment report completed by an AQP certifying that the diversion (RA7 and RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. • Geomorphic index (IDC method) used to verify that Rehabilitation for RA7 and RA9 is erosionally stable. • Contaminated land investigation with a site investigation report prepared by an AQP. • Removal and appropriate disposal of contaminated materials. • Conduct validation testing to confirm that contaminated materials have been removed or remediated. Certification from an AQP that all contaminated land has either been remediated or removed. • Document (map) locations where mining wastes will be stored during mining operations. • Water balance assessment was undertaken (WSP, 2024) and concluded that post-closure, PTM residual void will continue to act as sinks. • Landform embankment provides immunity up to a 0.1% AEP. • Implement rehabilitation monitoring program including groundwater quality monitoring. • All imported hazardous materials to be stored and used in accordance with relevant standards and removed from site on completion of operations. • Water quality in retained dams is not expected to cause degradation of adjacent or downstream surface or ground water resources, although testing will be carried out to establish whether water quality meets the water quality criteria in accordance with the PRC Plan schedule (RM6). • Particle tracking modelling confirms that residual voids will act as sinks and even if water levels rise, contaminants will report back to residual voids.	Highly Unlikely (0.03)	4	Medium

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
								• Groundwater monitoring to be undertaken in accordance with section 3.8.5 groundwater monitoring. • Appropriate management, placement/encapsulation, and monitoring of waste (spoil and rejects) during operations.			
Alteration of local hydrologic conditions	RM1, RM2, RM3, RM4, RM5, RM6, RM7, RM8, RM9	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9	• Insufficient or incorrect landform design or construction methods including not completing landform embankment design for PMF immunity. • Erosional instability of landforms resulting in sediment mobilisation into receiving environment. • Inadequate surface preparation or vegetation cover establishment. • Surface water contamination from unsuitable waste rock material. • Failure of ESC structures post establishment leading to loss of sediment offsite. • Interactions with the flood plain and final landform. • High velocities in landform drainage leading to erosion instability.	• Adverse impacts to the receiving surface water environment including contamination of surface water above selected thresholds/guidelines.	Probable (0.3)	4	Medium (90)	• Construction management, technical supervision, and QA/QC of final landforms and covers will be done by a SQP. • Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. • Cattle grazing (RA1, RA2, RA3, RA6) Landforms reshaped with maximum 15% slope. • Cattle grazing (RA1, RA2, RA3, RA6) Landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. • Woodland Habitat PMLU (RA4, RA5, and RA8) Areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required. • Woodland Habitat PMLU landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP. • Updated hydraulic flood modelling using drainage designs. • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use". • No evidence of erosion for all RA's excluding RA7 and RA9 is classified as 'minor' 'moderate' or 'severe' as defined by PRC Plan Schedule Appendix 7: Erosion classification framework. • Assessment report completed by an AQP certifying that the diversion (RA7 and RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. • Geomorphic index (IDC method) used to verify that Rehabilitation for RA7 and RA9 is erosionally stable. • Implement rehabilitation monitoring program including water quality monitoring. • All imported hazardous materials to be stored and used in accordance with relevant standards and removed from site on completion of operations. • Landforms will be designed with appropriate erosion protection for any areas with flood interactions. • Monitoring of retained dams to ensure suitability for supporting grazing PMLU. • Surface water monitoring to be undertaken in accordance with EA conditions and monitoring requirements. • Rehabilitation of disturbed areas will be undertaken as soon as practicable after land becomes available in accordance with PRC Plan Schedule. • Monitoring of the PTM diversion undertaken to ensure trajectory to achieving rehabilitation milestones. • Appropriate management, placement, and monitoring of waste (spoil and rejects) during operations. • Landforms designed and constructed to minimise the potential for flooding of the residual voids. Flood modelling confirms no ingress to residual voids up to and including the 0.1% AEP. • Schedule works outside of high erosion risk periods (i.e., December - February). • Implement rehabilitation monitoring program.	Unlikely (0.1)	4	Medium (100)

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
								• The proposed PMLU and landform is consistent and similar with existing/surrounding landforms and vegetation that is compatible to a PMLU of grazing and therefore has resilience/tolerability for current weather patterns. • Undertake regular update of hydrological models to ensure that the residual void catchments are minimised as far as practical. • If necessary, identify and implement mitigation measures for appropriate protection works of landforms where floodwaters interact with the final mine closure landforms. • As cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the voids closure landforms and spill point elevations, rainfall and evaporation, surface water runoff, groundwater inflows and climate projections. • Obtain certification from an appropriately qualified person that the residual voids will not cause environmental harm.			
Impact of extreme weather events prior to final landform establishment leads to instability of final landforms	RM1, RM2, RM3, RM4, RM5, RM6, RM7, RM8, RM9	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9	• Extreme weather such as cyclones, flooding, or uncontrolled fire. • Interactions with the flood plain and final landform.	• Damage to final landform and rehabilitation area. • Increased likelihood of erosion. • Loss or degradation of cover materials. • Extended period required to remediate landform. • Loss of vegetation cover may result in increased erosion and soil loss. • Failure to achieve milestone criteria pertaining to vegetation cover. • Loss or alteration of habitat.	Probable (0.3)	5	High (300)	• Schedule works outside of high erosion risk periods (i.e., December - February). • Implement rehabilitation monitoring program. • The proposed PMLU and landform is consistent and similar with existing/surrounding landforms and vegetation that is compatible to a PMLU of grazing and therefore has resilience/tolerability for current weather patterns. • Emergency response procedures (including fire). • Water cart availability during rehabilitation. • Establishment of vegetation within Watercourse PMLU suitable for the environment and reduces erosion risks. • Landforms will be designed with appropriate erosion protection for any areas with flood interactions. • Undertake regular update of hydrological models to ensure that the residual void catchments are minimised as far as practical. • Update and refine the final mine closure landform to consider spoil dumping and landform design to exclude floodwaters entering the residual void. • If necessary, identify and implement mitigation measures for appropriate protection works of landforms where floodwaters interact with the final mine closure landforms. • As cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the voids closure landforms and spill point elevations, rainfall and evaporation, surface water runoff, groundwater inflows and climate projections. • Obtain certification from an appropriately qualified person that the residual voids will not cause environmental harm. • Develop revegetation plan that considers vegetation suitability to adverse climatic conditions. Monitor climate and plant responses as part of ongoing monitoring.	Unlikely (0.1)	5	Medium (100)
Landform establishment inconsistent with milestone criteria	RM3, RM4, RM5, RM6, RM7, RM8, RM9	RA2, RA3, RA4, RA5, RA6, RA8, RA9	• Erosional instability. • Placement of unsuitable tertiary waste within 2m of the surface. • Rehabilitated Landforms Result in Alteration of Flood Hydrology Upstream and Downstream.	• Failure to establish proposed vegetative cover and therefore stable PMLU. • Loss or degradation of cover materials. • Adverse impacts to hydrological or hydrogeological system.	Likely (1)	4	High (300)	• Low slope gradient for gazing in landform design to limit capacity for sediment loss. Woodland habitat does not exceed 25%. • Surface preparation and sowing is to take place with regard to optimal weather conditions (no predicted heavy rainfall or extended periods of drought). • Approved seed mix includes rapidly establishing grasses. • ESC measures to be operational during surface preparation and revegetation. • Soil sampling of stockpiles prior to placement to refine amelioration fertilizer rates. • Landforms designed and constructed to minimise the potential for flooding of the residual voids. Flood modelling confirms no ingress to residual voids up to and including the 0.1% AEP.	Unlikely (0.1)	5	Medium (100)

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
			• Interactions with the flood plain and final landform. • High erosion risk of spoil material. • Insufficient or incorrect landform design or construction methods (including non-conformance to design shape). • Adverse climatic conditions (drought, heat, changing climate). • Insufficient volume of material available or unsuitable quality for rehabilitation activities.					• Undertake rehabilitation monitoring include landform erosion monitoring. Remediate aeras performing poorly with respect to erosion based on erosion monitoring data. • Implement erosion protection measures for appropriate protection works of landforms where floodwaters from watercourses interact with the final mine closure landforms. • As cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the voids closure landforms and spill point elevations, rainfall and evaporation, surface water runoff, groundwater inflows and climate projections. • Obtain certification from an appropriately qualified person that the residual voids will not cause environmental harm. • Development of a revegetation plan that considers vegetation suitability, seeding/planting methods, primary growth media suitability and a secondary growth media. Plan is to include measurable rehabilitation milestones for landform design, growth media and vegetation. • Construction management, technical supervision, and QA/QC of final landforms and covers will be done by a SQP. • Erosion and sediment control systems are designed by an AQP, installed, and fit for purpose. • Cattle grazing (RA2, RA3, RA4, RA6) landforms reshaped with maximum 15% slope. • Cattle grazing (RA2, RA3, RA4, RA6) landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5. • Woodland Habitat PMLU areas >15% to be assessed by an AQP as being stable long term, with rock mulch applied as required. • Woodland Habitat PMLU landforms design is assessed by an AQP as being geotechnically stable with a factor of safety ≥1.5 unless an alternative is justified by an AQP. • Updated hydraulic flood modelling using drainage designs. • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use". • No evidence of erosion for all RAs excluding RA7 and RA9 is classified as 'minor' 'moderate' or 'severe' as defined by PRC Plan Schedule Appendix 7: Erosion classification framework. • Assessment report completed by an AQP certifying that the diversion (RA7 and RA9) is operating in accordance with, DNRME Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000 (OSW/2019/4599) criteria and is in a stable condition. • Geomorphic index (IDC method) used to verify that Rehabilitation for RA7 and RA9 is erosionally stable. • Develop revegetation plan that considers vegetation suitability to adverse climatic conditions. Monitor climate and plant responses as part of ongoing monitoring.			
NUMA does not meet stable condition consistent with milestone criteria	MM1, MM2, MM3	IA1	• NUMA is not safe. • NUM A is no stable - geotechnical stability: • Stability outside of the NUMA extents of the high walls = FoS>= 1.5. • NUMA causing environmental harm.	• Steep slopes. • Rock falls. • Slope failure. • Residual void extends beyond permitted EA domain limits. • Impacts to adjacent PMLUs.	Likely (1)	4	High (300)	• Surface water management system. • Diversion drains. • Minimal external catchment into pit lake. • Monitoring of slip failure. • Residual void lake levels remain below groundwater levels and the voids act like sinks for the considered closure scenarios. • Groundwater modelling including particle tracking confirms residual voids act as a sink during closure.	Unlikely (0.1)	5	Medium (100)

Risk Event	Rehabilitation Milestone	Rehabilitation Area	Causes	Impact Description	Risk Analysis			Controls Mitigation	Residual Risk Ranking		
					Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
				• Void switches from a sink to a source to the groundwater aquifer. • Safety bunds and setbacks not achieved. • Overtopping.				• Obtain certification from an appropriately qualified person that the residual void is safe to humans and livestock. • Safety bund is constructed, where required, at the geotechnical set-back distance. • Fencing erected around perimeter of safety bund, where required. • Warning signage placed along the fence line (nominally one sign every 100m). • Hazard Assessment conducted to verify safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use. • As mining approaches the final limits, re-assess the geotechnical stability of the low walls based on the latest available data, including the developed site-specific geotechnical parameters. • Use a minimum factor of safety >=1.5 as a guidance for ongoing void closure planning. • If factor of safety extending into the woodland PMLU after re-assessment remains <1.5 following closure, review the risk of instability affecting the ability to achieve the PMLU milestone criteria. • Undertake regular update of hydrological models to ensure that the residual void catchments are minimised as far as practical. • Landforms designed and constructed to minimise the potential for flooding of the residual voids. Flood modelling confirms no ingress to residual voids up to and including the 0.1% AEP. • Implement erosion protection measures for appropriate protection works of landforms where floodwaters interact with the final mine closure landforms. • As cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the voids closure landforms and spill point elevations, rainfall and evaporation, surface water runoff, groundwater inflows and climate projections. • Obtain certification from an appropriately qualified person that the residual voids will not cause environmental harm.			

3.7.4 Rehabilitation Trials

PRC Plan Guideline (Section 3.7.1)

In accordance with section 126C(1)(j) of the EP Act, if rehabilitation trials are planned, the rehabilitation planning part must state:

- the objective of the trial(s).
- the trial design including, but not limited to, the location, underlying land characteristics and potential issues.
- the details of how the trial(s) will be carried out.
- when the trial(s) will commence.
- the duration of the trial(s).
- how the trial(s) will be assessed for success.
- how the results of the trial(s) will be incorporated into rehabilitation strategies and the development of milestones, and
- where the trials have previously been carried out by the applicant.

The information requirements in this section will apply to all applicants, whether or not they are an existing EA holder, who have planned or commenced rehabilitation trials. Existing EA holders can provide details of any rehabilitation trials that have occurred prior to the submission of the proposed PRC Plan.

Although no rehabilitation trials are currently planned at PTM, rehabilitation trials may be conducted at PTM as part of continuous improvement. Current rehabilitation practices will be executed in line with the PRC Plan rehabilitation and management methodologies outlined for each PMLU.

3.7.4.1 Previous Trials

No previous trials have been carried out at PTM however as referenced in Section 3.1.5, existing rehabilitation monitoring has been ongoing since 2009 and provides key learnings on success factors that can be implemented for future rehabilitation works.

3.8 Monitoring and Maintenance

PRC Plan Guideline (Section 3.8)

Under section 126C(1)(j) of the EP Act, the administering authority considers monitoring and maintenance necessary to decide if the PRC Plan is consistent with the requirements of the legislation. The rehabilitation planning part must contain a monitoring and maintenance program that identifies and describes the monitoring systems that will be carried out in order to demonstrate a milestone and milestone criteria have been achieved. The program must include, where relevant to the milestone and milestone criteria (but is not limited to):

- schedule of monitoring, reporting and review for each milestone.
- description of methodologies and standards, which could include field-based assessments and the application of new remote sensing, GIS, and other relevant emerging technologies.
- monitoring that enables the repeatable collection of relevant statistically valid data.
- monitoring using appropriate quality assurance and data management processes and systems.
- regular analysis of site data including multi-year comparison trends and benchmarking against analogue/reference sites.
- contingency strategies if monitoring data indicates milestone criteria are not being met.
- post-closure monitoring to ensure milestone criteria has been demonstrated.
- intent of monitoring reports, such as provision of results and key findings.

The information requirements in this section will apply to all applicants whether or not they are an existing EA holder. However, existing holders may already have the required information available from previously submitted plans/reports/applications that, if still valid, could be used in the PRC Plan. If there has/is any monitoring or maintenance of areas already rehabilitated, details must be included in the PRC Plan

3.8.1 Rehabilitation Milestone Monitoring

The RMs and associated milestone criteria for PTM are detailed in Table 76.

Rehabilitation milestone monitoring and reporting will be undertaken at PTM to demonstrate achievement of the RMs, as they relate to achieving surface requirements and PMLU criteria for cattle grazing, woodland habitat, and watercourses.

A combination of approaches will be used to monitor and report on achievement of RMs. Monitoring and reporting requirements for RM1 to RM9 are listed against each milestone in Table 76and will primarily involve documentation and/or inspections and sign off by an appropriately qualified person that milestones have been achieved. Rehabilitation milestone monitoring for achieving the PMLUs will involve ongoing monitoring in accordance with a schedule whereby permanent monitoring sites will be established, and data will be collected in a repeatable manner to enable statistical analysis to assess the performance of rehabilitation. The results of ongoing PMLU monitoring will be used to determine if rehabilitation areas are on track towards achieving the relevant PMLU criteria or if rehabilitation areas may require maintenance, as discussed in Section 3.8.8 to improve their performance.

The approach to monitoring is discussed in more detail for each PMLU as follows:

- Woodland habitat.
- Cattle grazing.
- Watercourse.

Further discussion on the estimated time that has been scheduled for achieving each PMLU is discussed in Section 3.8.6.

Table 76 Rehabilitation Milestones with Relevant Reporting Requirements

Milestone Reference	Rehabilitation Milestone	Reporting Requirements
RM1	Infrastructure decommissioning and removal	Undertake visual inspections Document inspections
RM2	Identification and or remediation of contaminated land	Documentation by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment.
RM3	Landform establishment	Survey/LiDAR of landform Analyse final landform against design Documentation of riverine and/or operation works permits or associated exemptions
RM4	Surface preparation	Survey/LiDAR of surface and extent after topsoil is placed Document topsoil depth Document growth media assessment Document growth media ameliorants and physical treatments applied Watercourse - Documentation of riverine and/or operation works monitoring
RM5	Revegetation	Document seed mix, purity information, planting timing, planting rates and areas as per PRC Plan Schedule
RM6	Achievement of stable condition	Undertake rehabilitation monitoring as per Sections 3.8.2 – 3.8.5
RM7	Achievement of cattle grazing PMLU	Undertake rehabilitation monitoring as per Sections 3.8.2 – 3.8.5
RM8	Achievement of woodland habitat PMLU	Undertake rehabilitation monitoring as per Sections 3.8.2 – 3.8.5
RM9	Achievement of watercourse PMLU	Undertake rehabilitation monitoring as per Sections 3.8.2 – 3.8.5

3.8.2 Cattle Grazing and Woodland Habitat Rehabilitation Monitoring

3.8.2.1 Monitoring Locations

For the woodland habitat PMLUs monitoring locations will be identified using the methodology outlined in the latest version of the Queensland Herbarium's BioCondition Assessment Manual.

No reference sites will be included in the rehabilitation monitoring program for cattle grazing as the performance is based on standard methods for assessing pasture condition consistent with industry guidelines.

Nevertheless, reference/analogue sites have previously been identified (Section 3.6.1.8) and will potentially be incorporated into the assessment process of rehabilitation success.

Permanent rehabilitation monitoring sites will be established at the start of the rehabilitation monitoring program (Year 0). The permanent sites will be assessed during all phases of rehabilitation monitoring.

In addition to the using the Queensland Herbarium's BioCondition Assessment Manual permanent field monitoring sites will be selected prior to commencing any field monitoring work and selected using the following criteria:

- Representative of rehabilitation slope.

- Located in a lower slope position to capture maximum hydrologic and erosion processes.
- Accessibility (vehicle access preferred).
- Located on mining lease or proponent owned land.
- Low risk of site being disturbed by mining activity in the future.

3.8.2.2 Monitoring Schedule

At least one permanent rehabilitation monitoring site will be established in each RA.

The woodland habitat and cattle grazing PMLU rehabilitation monitoring program has been designed to demonstrate achievement of surface preparation (RM4) and woodland habitat and cattle grazing PMLUs to a safe, stable, non-polluting, and self-sustaining condition (RM1-RM9) (Section 3.3.1).

The monitoring program follows a phased approach whereby initial monitoring is undertaken to assess the performance of rehabilitation as it relates to achieving initial surface preparation and revegetation requirements at Year 0 and Year 1. This approach allows a timely assessment of the performance of rehabilitation post initial seeding (RM5) and provides critical information to determine if rehabilitation is on track towards achieving initial surface requirements and revegetation or if maintenance may be required (Section 3.6.1.8). Additional rehabilitation parameters are included into the monitoring program commencing year two, and every four years thereafter, to assess the performance and track rehabilitation in relation to achievement of each PMLU (RM7-RM8).

The consistent phased approach of the monitoring program ensures that there is continual monitoring of rehabilitation parameters against milestone criteria up to the point of surrender of the EA.

Table 77illustrates the monitoring schedule for cattle grazing and woodland habitat PMLUs and indicates the rehabilitation parameters monitored during each phase of the schedule commencing from Year 0. This allows assessment of the performance and trajectory of the rehabilitation against milestone criteria and accounts for the influence of seasonal variations and extreme weather events over time.

Table 77 Monitoring Schedule and Measured Rehabilitation Parameters

	Monitoring Schedule				
	Year 0	**Year 1**	**Year 2**	**Year 6**	**Year 10+ (4 Yearly Thereafter**
All PMLUs					
Landform and erosion	✓	✓	✓	✓	✓
Soil and spoil	✓	×	✓	✓	✓
Groundcover	✓	✓	✓	✓	✓
Invasive plants	✓	✓	✓	✓	✓
Cattle Grazing					
Pasture species diversity	✓	✓	✓	✓	✓
Pasture yield	×	×	✓	✓	✓
Pasture condition	×	×	✓	✓	✓
Grazing Land Suitability Assessment	×	×	×	✓	✓
Water Quality Monitoring for Retained Water Storages	Will commence when the surrounding rehabilitated landform progresses to RM6 and continue at one sampling round for each dam 4 yearly thereafter.				
Woodland Habitat					
Recruitment	×	×	✓	✓	✓
Non-native plant cover	✓	✓	✓	✓	✓

	Monitoring Schedule				
	Year 0	**Year 1**	**Year 2**	**Year 6**	**Year 10+ (4 Yearly Thereafter**
Tree, shrub, grass, and forb species richness	✓	✓	✓	✓	✓
Tree and shrub canopy cover	×	×	✓	✓	✓
Native perennial grass	✓	✓	✓	✓	✓
Litter grid cover	✓	✓	✓	✓	✓

3.8.2.3 General Rehabilitation Monitoring Parameters

3.8.2.3.1 Landform and Erosion

Landform and erosion are assessed as part of all monitoring phases.

Prior to commencing the field monitoring work, a desktop assessment using LiDAR data and aerial imagery will be completed to:

- Develop a Digital Elevation Model (DEM) to assess the rehabilitated slope against the landform design (Year 0).
- Identify new areas of potential erosion for field validation.

Field-based erosion monitoring will be conducted at the permanent monitoring sites as well as any new areas identified in the desktop assessment.

The field survey involves establishing an erosion monitoring transect by running a 50m tape perpendicular to the slope and across the erosional activity identified during the LiDAR analysis.

Erosion should then be assessed against the erosion classification framework (Appendix 7 of the PRC Plan Schedule) and classified as minor, moderate or severe.

3.8.2.3.2 Topsoil and Spoil

Soil profile pits or cores within the rehabilitated areas will be established at the permanent rehabilitation monitoring sites during Year 0 monitoring. The parameters detailed in Table 78are monitored during Year 0, Year 2, and every four years thereafter. Surface sampling refers to the layer at 0 – 10cm; and sub-surface sampling refers to layers at 10 – 30cm, 30 – 60cm and 90 – 100cm.

The surface soil sampling results should be compared to the target suitability characteristics for growth medium in RM4.

Table 78 Soil and Spoil Analysis Parameters for the PTM Monitoring Program

			Depth		Monitoring Phase	
Category	**Analyte**	**Purpose of Analyte**	**Surface**	**Sub-Surface**	**Year 0**	**Year (and 4 Yearly Thereafter**
Acidity / Alkalinity	pH	Identify anomalies that may affect plant growth and sustainability.	✓	✓	✓	✓
Salinity	EC	Identify leaching profile. High salinity can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓	✓	✓
	Chloride	Identify leaching profile. High chloride can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓	✓	✓
Exchangeable Cations	Cation exchange Capacity (CEC)	Major factor in soil fertility. Controls soil stability, nutrient availability, and buffers soil's chemical properties.	✓	✓	✓	✓
	Exchangeable cations	Exchangeable Calcium is linked to soil stability. High levels of exchangeable Magnesium can cause clay dispersion, instability when wet and hard setting.	✓	✓	✓	✓
	Exchangeable Sodium Percentage (ESP)	ESP is a measure of the dominance of sodium ions on the soil's cation exchange complex. Sodicity in soils can lead to slaking and dispersion which impact soil structure and stability.	✓	✓	✓	✓
Organic Matter	Organic carbon	An indicator of soil nutrient stores and a contributor to improvements in soil structure. Changes through time in organic carbon are a key indicator of rehabilitation success.	✓	×	✓	✓
Major Elements	Total Nitrogen	Indicator of soil nutrient store and is also a major plant nutrient.	✓	×	✓	✓

Category	Analyte	Purpose of Analyte	Depth		Monitoring Phase	
			Surface	Sub-Surface	Year 0	Year (and 4 Yearly Thereafter
	Extractable Phosphorous (Colwell method)	Indicator of Phosphorous readily available to plants.	✓	×	✓	✓
	Total Phosphorous	Indicator of total store of Phosphorous, some of which is readily available. Key indicator of potential for long-term success or failure of rehabilitation.	✓	×	✓	✓
	Potassium	Important plant nutrient.	✓	×	✓	✓
	Total Sulphur	Indicator of potential for Acid and Metalliferous Drainage processes.	✓	×	✓	✓
	Sulphate	Important plant nutrient and can be an indicator of potential Acid and Metalliferous Drainage processes.	✓	×	✓	✓
	Calcium	Important plant nutrient.	✓	×	✓	✓
	Magnesium	Important plant nutrient.	✓	×	✓	✓
Trace Elements	Manganese	Trace element with minor importance for vegetation success.	✓	×	✓	✓
	Iron	Trace element with minor importance for vegetation success.	✓	×	✓	✓
	Zinc	Trace element important for vegetation success.	✓	×	✓	✓
	Copper	Trace element important for vegetation success.	✓	×	✓	✓
Metals	-	Metals that have been identified as occurring at elevated levels during material characterization analysis should be tested during monitoring.	✓	✓	✓	✓
Physical Parameters	Particle size (PSA)	Soil texture strongly affects water entry and storage. Soil texture will impact erosion and	✓	✓	✓	×

Category	Analyte	Purpose of Analyte	Depth		Monitoring Phase	
			Surface	Sub-Surface	Year 0	Year (and 4 Yearly Thereafter
		vegetation success and should be considered when planning species mixes for planting.				
	Emerson aggregate test	Indicator of clay dispersion. Should be interpreted in conjunction with ESP and EC data.	✓	✓	✓	×
Field Analysis	Soil profile characteristics	Horizon depths, Field colour, Field texture, Structure, Root density and depth, Soil plant available water capacity (PAWC – initial only).	✓	✓	✓	×

3.8.2.3.3 Groundcover

Groundcover is assessed at the permanent rehabilitation monitoring sites as part of all monitoring phases.

Groundcover type is recorded as either live cover (with species recorded and distinguishing between non-native, native perennial, preferred pasture species and undesirable/weed grass cover), standing dry cover, litter, rock, coal, fallen woody debris or bare ground, and percent cover calculated.

3.8.2.3.4 Invasive Plants

An invasive plant is a prohibited or restricted matter under the Queensland Biosecurity Act 2014, and is defined as a species that has, or is likely to have an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of the species in an area. A complete list of invasive plant species is outlined in schedule 4 of the Biosecurity Regulations 2016.

Invasive plants are assessed at the permanent rehabilitation monitoring sites as part of all monitoring phases.

The presence and percent cover of invasive plants, calculated as a percentage of the total vegetation cover, is recorded at each site.

3.8.2.4 Cattle Grazing Rehabilitation Parameters

3.8.2.4.1 Pasture Species Diversity

Pasture species diversity is assessed at the permanent rehabilitation monitoring sites as part of all monitoring phases. Table 56outlines the recommended species list and sowing rates for the cattle grazing PMLU (RA2, RA3, RA6).

Species diversity is classified into the number of preferred pasture species (identified as perennial grasses that are productive and palatable to stock) (3P), within the pasture including but not limited to those listed in Table 56.

3.8.2.4.2 Pasture Yield

Pasture yield and quality is assessed at the permanent rehabilitation monitoring sites from Year 2. This allows at least two seasons after seeding for pasture species to establish.

Pasture yield is assessed using percentage dry matter (DM) yield in kg/ha for preferred pasture species as well as the proportion of dry matter yield for annual grasses and undesirable grasses or weeds.

3.8.2.4.3 Pasture Condition

Pasture condition is assessed at the permanent rehabilitation monitoring sites from Year 2. This allows at least two seasons after seeding for pasture species to establish. Pasture condition is assessed using preferred species diversity, pasture health and pasture yield. Pasture condition ratings and criteria are shown in Table 79. Pasture condition assessments will also track Leucaena stem density.

Table 79 Pasture Condition Assessment Table

	Condition Indicators				
	Preferred Pasture Species				
Condition Rating	% DM Yield	Crown Cover	Annual Grass % DM Yield	Undesirable Grasses & Other Weeds % DM Yield	Preferred Pasture Species Diversity
1	> 80 %	Dense and plants healthy	< 20 %	< 20 %	> 5 species
2	60 – 80 %	High to moderate density and some plants unhealthy	20 – 40 %	20 – 30 %	3 – 5 species

	Condition Indicators				
	Preferred Pasture Species				
Condition Rating	% DM Yield	Crown Cover	Annual Grass % DM Yield	Undesirable Grasses & Other Weeds % DM Yield	Preferred Pasture Species Diversity
3	10 – 60 %	Moderate to low density and some plants dead	40 – 70 %	30 – 80 %	2 – 3 Species
4	< 10 %	Sparse and many plants dead	> 70 %	> 80 %	0 or 1 species

3.8.2.4.4 Grazing Land Suitability Assessment

A land suitability assessment according to the grazing rule-set (Section 3.3.1.1) is undertaken to track achievement of a PMLU of cattle grazing from the commencement of rehabilitation in Year 6. If the rehabilitation fails to meet the completion criteria according to the grazing rule-set (PRC Plan Schedule), amelioration and maintenance works may be implemented and another assessment will be undertaken during the next scheduled monitoring.

3.8.2.4.5 Retained Water Infrastructure

Any water storages retained that will support the grazing PMLU and have a demonstratable benefit will also have their water quality monitored. The water within the retained water storages will be tested for the trigger values for livestock drinking water (as defined in ANZECC & ARMCANZ 2000).

Water quality monitoring for retained water storages will commence when the surrounding rehabilitated grazing landform progresses to RM6 and continue at a frequency of one sampling round for each dam 4 yearly thereafter.

3.8.2.5 Woodland Habitat Rehabilitation Parameters

Woodland habitat rehabilitation monitoring involves BioCondition monitoring assessments completed by an appropriately qualified person using the methodology outlined in the Queensland Herbarium's BioCondition Assessment Manual. Key parameters are outlined in the sections below and will collect data required to compare to criteria within Appendix 6 of the PRC Plan Schedule.

3.8.2.5.1 Species Richness

Species richness is assessed at the permanent rehabilitation monitoring sites as part of all monitoring phases. Species richness is assessed for native tree, shrub grasses and forbs by recording the number of flora species at each site. If vegetation composition across the rehabilitation appears to have a high degree of spatial variability, it is likely that the monitoring site may not capture a representative species richness for canopy species (trees). In this case, it may be necessary to establish additional vegetation assessment sites across the rehabilitation – these will be identified and included in the monitoring program as rehabilitation monitoring proceeds over time.

3.8.2.5.2 Tree Canopy and Shrub Cover

Tree canopy and shrub cover is assessed at the permanent rehabilitation monitoring sites from Year 2.

Canopy cover is recorded using the line intercept method for tree canopy and shrub canopy at each monitoring site. Each tree (single-stemmed woody plant greater than 2m tall) and shrub (multi-stemmed woody plant or single stemmed woody plant less than 2m tall) crown is recorded and summed as a total canopy distance and converted to a percent cover.

3.8.2.5.3 Recruitment

Recruitment is assessed at the permanent rehabilitation monitoring sites from Year 2.

Recruitment is assessed as the proportion of woody perennial canopy (<10cm diameter at breast height (DBH)) and shrub species that are regenerating. The dominant canopy and shrub species are identified and then the proportion of these species which are observed to be present in a juvenile state are recorded.

3.8.3 Watercourse PMLU Monitoring

Watercourse monitoring will be conducted at PTM for the New Chum Creek diversion with the Watercourse PMLU to assess the performance of the rehabilitated watercourses and creek diversions disturbed by mining activities. The purpose of the watercourse monitoring is to assess the performance of the rehabilitated watercourse in achieving watercourse surface requirements RM3, RM4 and RM5 (for RA9 only) and RM6 and final PMLU milestone criteria RM9 (for both RA7 and RA9).

The methodology for watercourse PMLU monitoring utilises the IDC methodology which is outlined in the ACARP guidelines for Monitoring and Evaluation Program for Bowen Basin River Diversions (ACARP, 2001).

3.8.3.1 Watercourse Monitoring Locations

Monitoring locations have been established in the existing New Chum Creek Diversion and are shown in Figure 77.

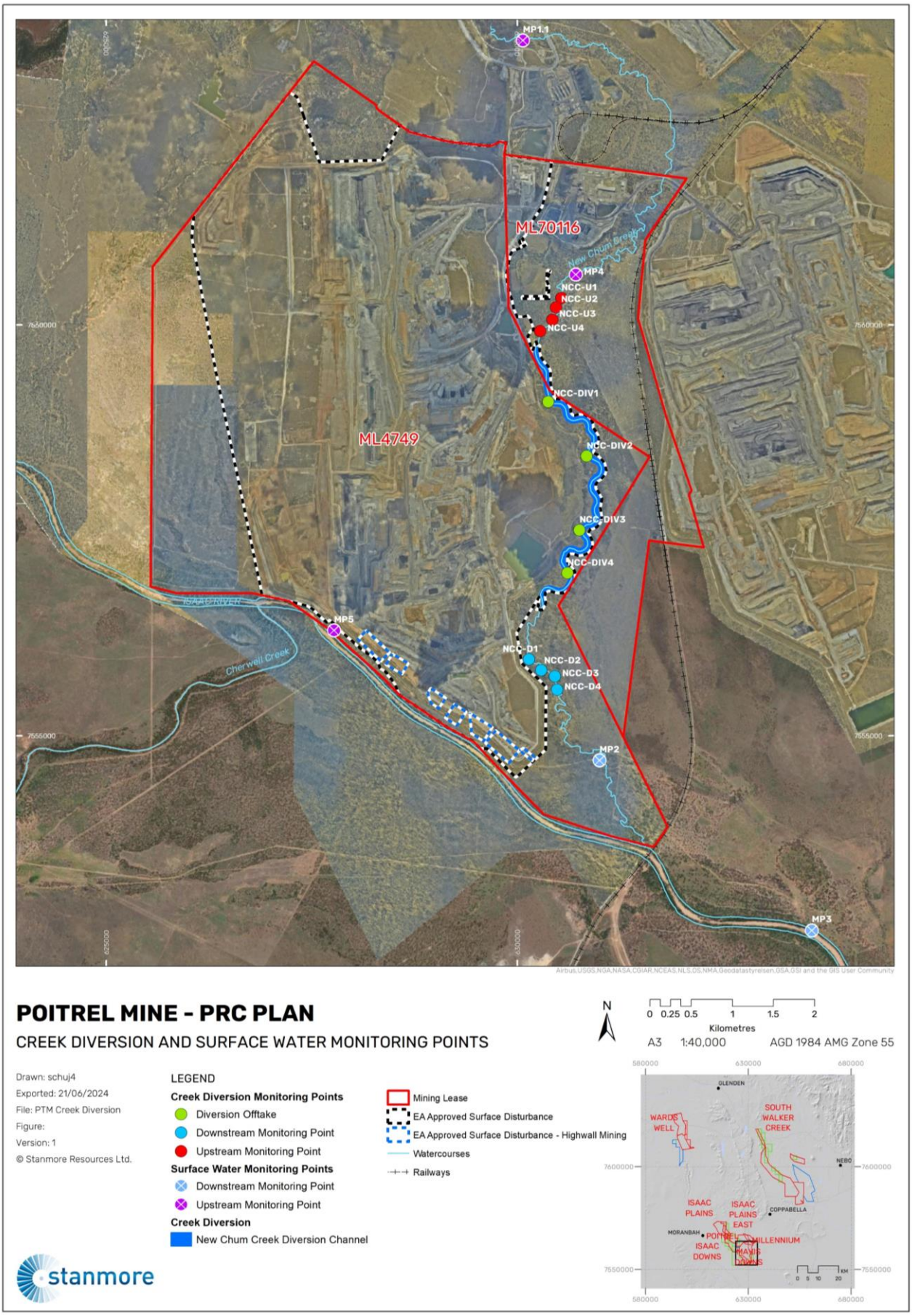

Figure 77 PTM Watercourse Creek Diversion and Surface Water Monitoring Locations

3.8.3.2 Monitoring Schedule

The PTM watercourse monitoring schedule is provided in Table 80. The monitoring schedule indicates the IDC parameters are measured annually aligned with operational water licence conditions, until relinquishment and achievement of milestone outcomes (RM9).

Table 80 Watercourse PMLU Schedule and Measured Rehabilitation Parameters

Monitoring Parameters		**Monitoring Schedule**
Parameter	**Monitoring Detail**	**Annually**
Geomorphic Index Parameters • Groundcover. • Stream width. • Bank condition. • Piping of banks. • Bed condition. • Spoil piles. • Recovery. • Instream Structures.	• Groundcover (%). • Width of high flow channel (m). • Width of active channel (m). • Width of low flow channel (m). • Presence of erosion. • Presence of piping on the banks. • Presence of aggradation or degradation within the channel bed. • Proximity of spoil dumps in relation to the monitoring point. • Presence or absence of benches with/without vegetation. • Stability of each identified instream structure.	✓
Riparian Vegetation Index Parameters • Riparian zone. • Structural intactness. • Regeneration. • Longitudinal continuity.	• Width of riparian zone (m). • Over-storey, understorey, and ground cover (% density). • Presence or absence of regeneration on banks. • Assess the gaps in the riparian vegetation corridor along the banks.	✓

3.8.3.3 IDC Monitoring

The IDC is a quantitative monitoring method used to measure the geomorphic and riparian condition of diversions. The purpose of the IDC methodology is to compare the condition of diversions with the reference (i.e., upstream) condition and flag potential management issues for remediation. The IDC monitoring methodology encompasses:

- Visual inspection of the diversion reach, and upstream and downstream reaches to undertake the IDC assessments.
- Assessment of Geomorphic Index and Riparian Index at nominated monitoring points in the diversion, upstream and downstream reaches.
- Determination of reach-averaged Geomorphic Index, Riparian Index and overall IDC scores for the diversion, upstream and downstream reaches.
- Compare the Geomorphic Index, Riparian Index and overall IDC score for the diversion reach to the relative upstream and downstream reaches. The Geomorphic and Riparian Index of a reach are each given a score out of 10. Overall IDC scores of above 12 are considered ‘good’ whereas scores less than 8 are considered ‘poor’ (ACARP, 2014).
- Compare the Geomorphic Index, Riparian Index and overall IDC scores for the diversion, upstream and downstream reaches against the corresponding scores from previous monitoring activities to assess any changes and trends. The value of assessing IDC overtime is to demonstrate how the watercourse PMLU is maintaining or on a trajectory towards achieving the stable and self-sustaining rehabilitation goals.

The IDC method utilises a suite of monitoring parameters to ensure the watercourses are able to sustain an agreed PMLU of watercourse.

3.8.4 Receiving Water Quality Monitoring

Receiving water quality indicators and acceptance criteria are detailed in Table E1 (Rehabilitation Requirements) of the EA. EC, pH and turbidity have been transitioned for the purposes of this PRC Plan. Furthermore, additional monitoring parameters have also been included to ensure a complete assessment. The suite of receiving water quality indicators will include:

- pH.
- EC.
- Turbidity.
- As.
- Mb.
- Se.
- Total recoverable hydrocarbons (C6–C9).
- Total recoverable hydrocarbons (C10–C36).

The rehabilitation acceptance criteria in Table E1 outlines that the surface water quality will not be '*significantly different to upstream values'.* This has been transitioned to the PRC Plan with the following modification to ensure it meets the SMART principals:

- RM6 - The downstream receiving water quality monitoring points (MP2 and MP3) must not be significantly higher (>15%) when compared to the upstream value at MP4 and MP5 for the water quality parameters specified above.

Water quality monitoring will be undertaken in accordance with the Monitoring and Sampling Manual: Environmental Protection (Water) Policy, (DES, 2018).

3.8.4.1 Surface Water Monitoring Schedule

As the watercourses at PTM are ephemeral, the collection of surface water samples and assessment of surface water quality representative of discharges to receiving environments cannot be undertaken on a fixed schedule. Due to the temporal nature of the receiving waters within the ephemeral drainage lines, rehabilitation-related surface water monitoring will need to be undertaken opportunistically during appropriate surface water runoff events.

Opportunistic surface water monitoring will be undertaken for the analytes listed in above. A minimum of five samples per relevant monitoring point will be collected. This sampling will supplement the surface water monitoring completed under the EA conditions that includes the Receiving Environment Monitoring Program and the water release sampling. It is recommended that five additional samples are collected for upstream monitoring locations. For cattle grazing, woodland habitat, and watercourse PMLUs, sampling will be undertaken between completion of revegetation (RM5) and achievement of the nominated PMLUs (RM7, RM8, and RM9) for a minimum period of three years. After three years, results will be assessed against the relevant milestone criteria within the approved schedule and a review of the surface water data will be undertaken by an appropriately qualified person to determine milestone completion.

3.8.4.2 Surface Water Monitoring Locations

Surface water rehabilitation monitoring will be conducted at the monitoring locations outlined in Table 81and Figure 77.

Table 81 PTM Surface Water Monitoring Locations

Monitoring Point (MP)	Receiving Waters Location	Easting (GDA94)	Northing (GDA94)
Upstream Monitoring Point			

Monitoring Point (MP)	Receiving Waters Location	Easting (GDA94)	Northing (GDA94)
MP5	Isaac River – 4760m upstream of the confluence of New Chum	627831	7556405
Downstream Monitoring Point			
MP3	Isaac River – 3000m downstream of the confluence of New Chum Creek and Isaac River	633694	7552809

3.8.5 Groundwater Monitoring

Groundwater monitoring will be undertaken on the nine existing EA compliance bores (OBS1, OBS2, OBS5, OBS8, OBS10, OBS15, OBS16, OBS 17, OBS18 and OBS19), and any additional monitoring bores deemed required by the proponent to evaluate the site's groundwater condition. Where required, these bores may be decommissioned and are installed to allow final landform establishment.

3.8.5.1 Groundwater Quality

Groundwater monitoring during operations will continue as per the currently approved EA.

For rehabilitation monitoring of groundwater quality in the PTM EA (Table E1 Rehabilitation Requirements) currently specifies:

- EC not significantly different to:
  - The EPP (Water and Wetland Biodiversity) schedule documents water quality objectives for relevant groundwater chemistry zones, or
  - Local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.

In order to comply with SMART principles, the above acceptance criteria has been modified to:

- Groundwater bores specified in Table I1 in EPML00963013 must be monitored for quality and levels at the location specified in Appendix 9 of the PRC Plan schedule: Ground water monitoring points for a period of at least three years with monitoring intervals ≥ 4 weeks and ≤ 16 weeks.
- Ground water quality results for compliance bores must remain within the 95th percentile of the site-specific limits detailed in Table I2 EPML00963013 for a minimum of 36 samples taken at intervals specified in RM6(i).

3.8.5.2 Groundwater Levels

Groundwater levels will be monitored to ensure:

- Groundwater levels for compliance bores specified in Table I1 EPML00963013 must not exceed a drawdown ≥2m from the baseline RL level (refer EA Table I2).

3.8.5.3 Groundwater Monitoring Schedule

During operations, groundwater monitoring will continue per the applicable EA conditions.

Upon completion of surface preparation, post-mining rehabilitation groundwater monitoring will be undertaken in accordance with the PRC Plan schedule (RM6). For cattle grazing, woodland habitat and watercourse PMLUs, groundwater monitoring will be undertaken between completion of revegetation (RM5) and achievement of the nominated PMLUs (RM7 and RM9) for a minimum of three years. After three years of groundwater monitoring results will be assessed against the relevant milestone criteria within the approved schedule and a review of the groundwater data will be undertaken by an appropriately qualified person to determine milestone completion.

3.8.5.4 Groundwater Monitoring Locations

Groundwater monitoring to support the assessment of closure conditions will be undertaken on bores that provide a geographical distribution across PTM and coverage of the key hydrogeological units. The

groundwater monitoring bore network to assess closure conditions will include selected bores existing at closure and bores installed specifically to close data gaps and to replace bores that may have been lost due to mining disturbances or otherwise are not operational.

The groundwater monitoring network to be utilised for assessment of rehabilitation are illustrated in Figure 78.

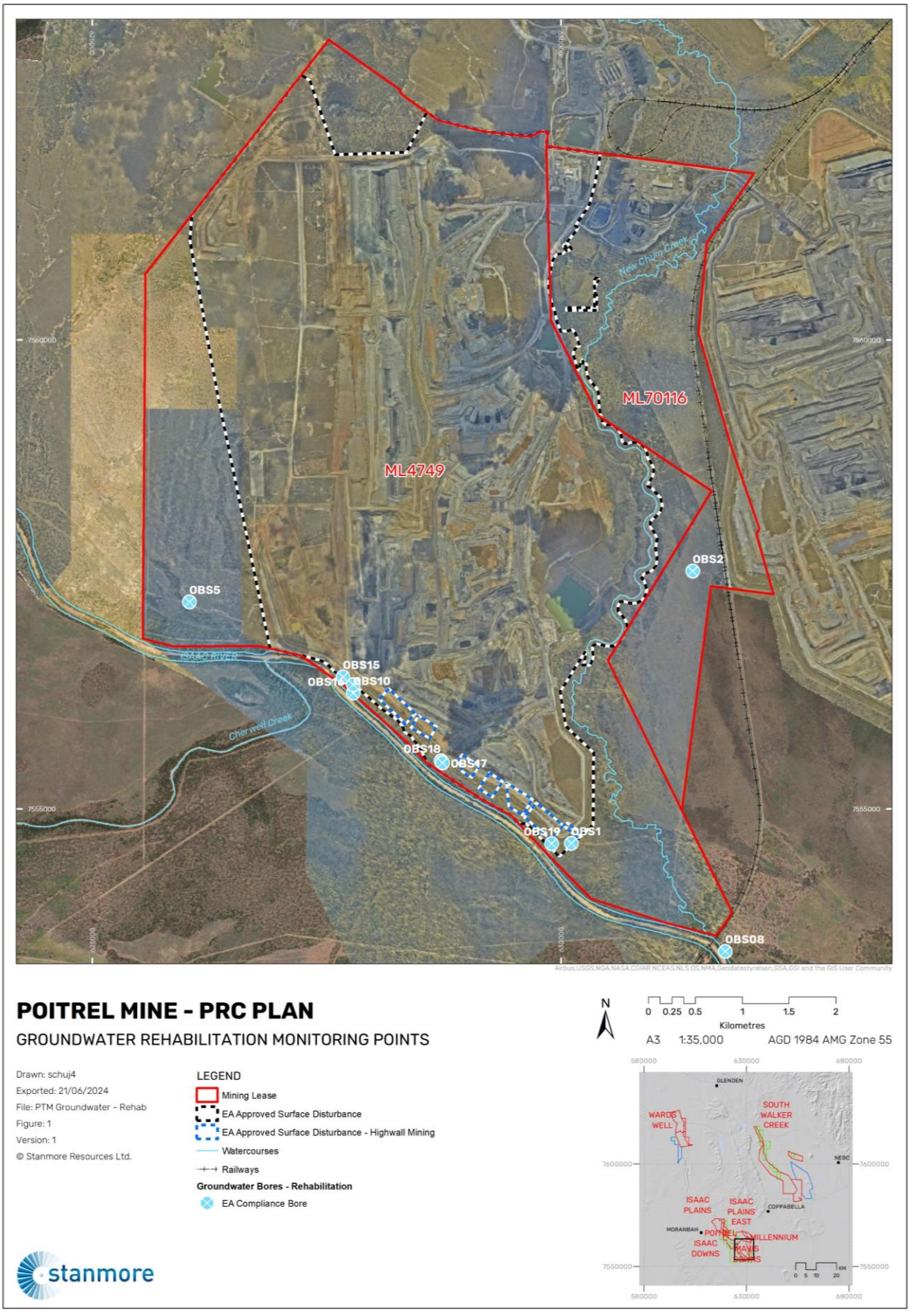

Figure 78 Rehabilitation Groundwater Monitoring

3.8.6 PMLU Achievement Schedule

RM1 to RM9 will be subject to ongoing reporting requirements to ensure achievements of the associated milestone criteria. The timing of the rehabilitation milestones specific to achievement of surface requirements (RM6) and achievement of PMLUs (RM7-RM9), are listed in Table 82and detailed in the section that follows.

Table 82 Time for Achievement of Surface Requirements and PMLU Rehabilitation Milestones

Rehabilitation Milestone Reference	PMLU	Rehabilitation Milestone	Milestone Achievement Timeline After Revegetation (In PRC Plan Schedule)
RM6	Cattle Grazing	Achievement of stable condition	10 years
RM6	Woodland Habitat	Achievement of stable condition	10 years
RM6	Watercourse	Achievement of stable condition	10 years
RM7	Cattle Grazing	Achievement of PMLU	10 years
RM8	Woodland Habitat	Achievement of PMLU	15 years
RM9	Watercourse	Achievement of PMLU	15 years

3.8.6.1 Cattle Grazing

Achievement of stable condition (RM6) for cattle grazing is proposed within a 10-year timeframe from revegetation. There are a number of factors which can influence the successful establishment of pastures on post-mined land including soils and landform, soil management and amelioration species selection, sowing rates, and sowing timing plus rainfall. The revegetation plan has considered these elements and allows a period up to 10 years to achieve a stable condition (RM6) for seasonal rainfall variation to successfully establish a pasture suitable for a PMLU of cattle grazing at PTM.

Achievement of PMLU for cattle grazing (RM7) is proposed within a 20-year timeframe from initial revegetation. This includes the 10 years allowed for achieving (RM6) plus an additional 10 years for achievement of (RM7) (20 years). This will allow for sufficient time to demonstrate the ongoing sustainability of the PMLU for cattle grazing through additional rehabilitation monitoring data associated with landform, erosion, soils, vegetation, pastures, and surface water (Section 3.8.2).

3.8.6.2 Woodland Habitat

Achievement of stable condition (RM6) for woodland habitat is proposed within a 10-year timeframe from revegetation. This allows for comparability to reference sites whereby rehabilitation will require development of multiple tree layers (canopy and shrub) as well as evidence of recruitment comparable to reference sites which would not be possible in <10 years.

Achievement of PMLU for woodland habitat (RM8) is proposed within a 25-year timeframe from revegetation. This includes the 10 years allowed for achieving (RM6) plus an additional 15 years for achievement of (RM8) This allows for initial establishment and successional process, and senescence of *Acacia spp.* and other pioneer species as well as natural recruitment to occur.

3.8.6.3 Watercourse

Achievement of stable condition (RM6) for watercourse is proposed within a 10-year timeframe from revegetation. This allows for comparability to reference sites whereby rehabilitation will require development of multiple tree layers (canopy and shrub) as well as evidence of recruitment comparable to reference sites which would not be possible in <10 years.

Achievement of PMLU for watercourse (RM9) is proposed within a 25-year timeframe from revegetation. This includes the 10 years allowed for achieving (RM6) plus an additional 15 years for achievement of (RM9) This allows for initial establishment and successional process, and senescence of *Acacia spp.* and other pioneer species as well as natural recruitment to occur.

3.8.7 Data Analysis and Reporting

Rehabilitation monitoring data will be collected and analysed by an appropriately qualified person and assessed against the milestone criteria. The data will be analysed to identify changes and trends, as well as map the trajectory of rehabilitation to identify whether it is on track to achieve the milestone criteria or requires remedial actions or maintenance.

The rehabilitation data will be stored and processed within internal geospatial and document management systems.

3.8.8 Maintenance

Maintenance will be implemented when monitoring identifies issues with the rehabilitation, or milestone criteria are not being met. In order to select the most appropriate remedial actions, the likely cause would be assessed. Contributing factors may be related to:

- Climatic conditions (i.e., droughts).
- Weed presence.
- Poor drainage design.
- Insufficient vegetation cover.
- Influence of adjacent land use.
- Soil type.

Required rehabilitation actions are to be entered into the proponent's work management system for actioning.

3.8.9 Quality Assurance and Data Management

Where monitoring assessments indicate rehabilitation is not progressing towards completion milestones contingency steps will be implemented. This quality assurance and quality control process as part of PTM ongoing rehabilitation monitoring is illustrated in Figure 79. The process provides for initial execution of the rehabilitation in accordance with the rehabilitation measures, followed by verification of how this execution was undertaken (again, according to these measures). Based on the verification outcomes, allowance is made for implementation of corrective action and/or maintenance (i.e., contingency strategies), as needed (Section 3.8.8). The rehabilitated areas as well as corrected and/or maintenance areas then undergo further rehabilitation monitoring, and subsequent execution of the rehabilitation measures. This process allows for a repetitive execution-verification-monitoring QA/QC approach, to ensure rehabilitation areas progress on a trajectory towards achievement of milestone criteria and eventual certification.

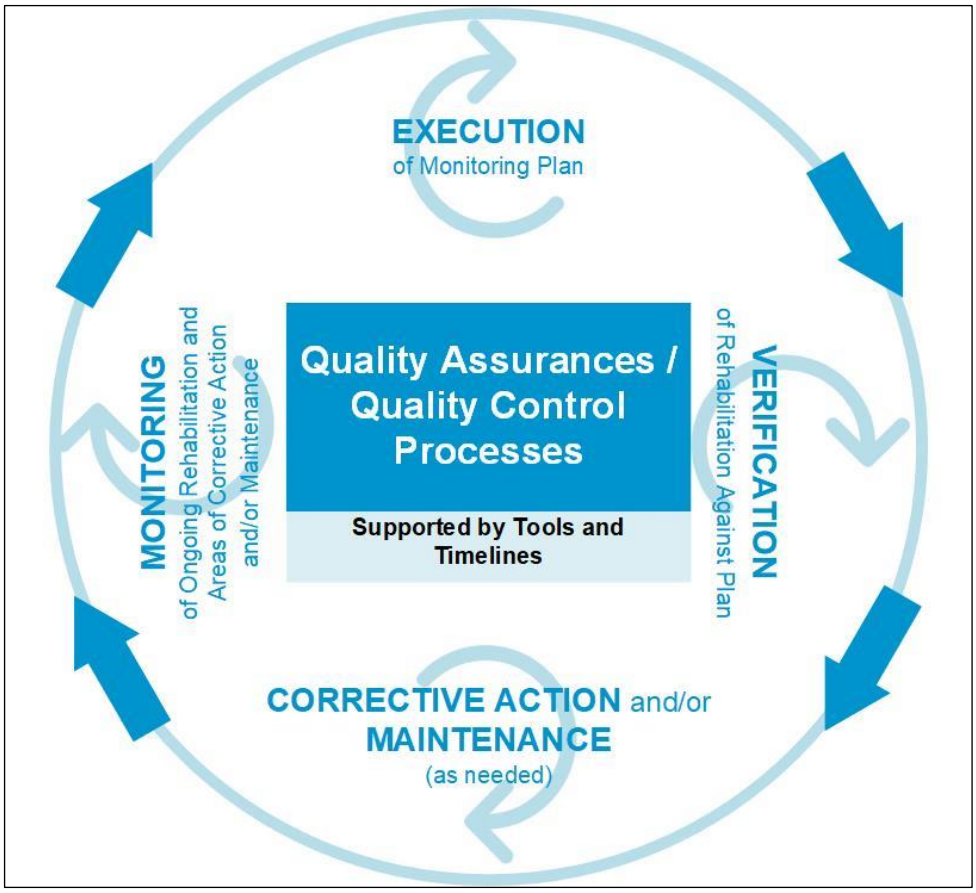

Figure 79 Rehabilitation Monitoring Quality Assurance / Quality Control Process

4. APPENDICES AND ATTACHMENTS

Section B (Attachment 1 EPML00963013 Poitrel Mine PRCP Schedule) is attached to this PRC Plan and includes the PRC Plan Schedule for PTM.

Section C is attached to this PRC Plan and includes any relevant required reports/plans appended to this submission.

Attachment 2 Progressive Rehabilitation and Closure Plan – spatial data submission

Attachment 3 Progressive Rehabilitation and Closure Plan – spatial data submission confirmation email

Attachment 4 EPML00963013 Poitrel Mine PRCP Application Signed

5. REFERENCES

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SECTION B – PRC Plan SCHEDULE

Legislative Requirement

In accordance with section 126D (1) of the EP Act, the PRC Plan Schedule in the PRC Plan must:

a) describe the area of each resource tenure either a post-mining land use or non-use management area, and

b) for each post-mining land use state:

   i. each rehabilitation milestone required to achieve a stable condition, and

   ii. when each rehabilitation milestone is to be achieved, and

c) for each non-use management area state:

   i. each management milestone, and

   ii. when each management milestone is to be achieved, and

d) include maps showing the land mentioned in (a), (b) and (c).

Final Site Design

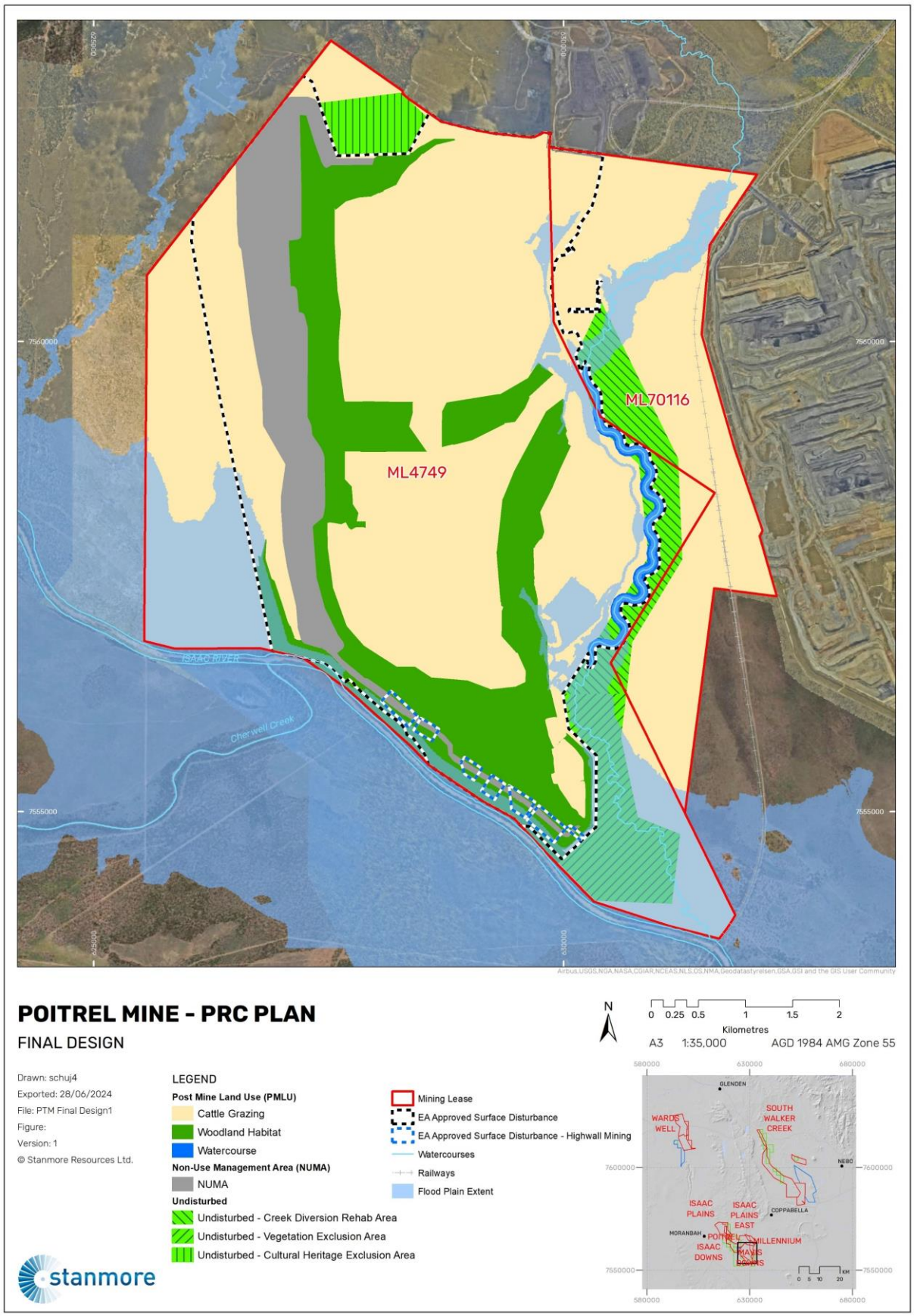


Figure 80 PTM Final Site Design

Reference Map

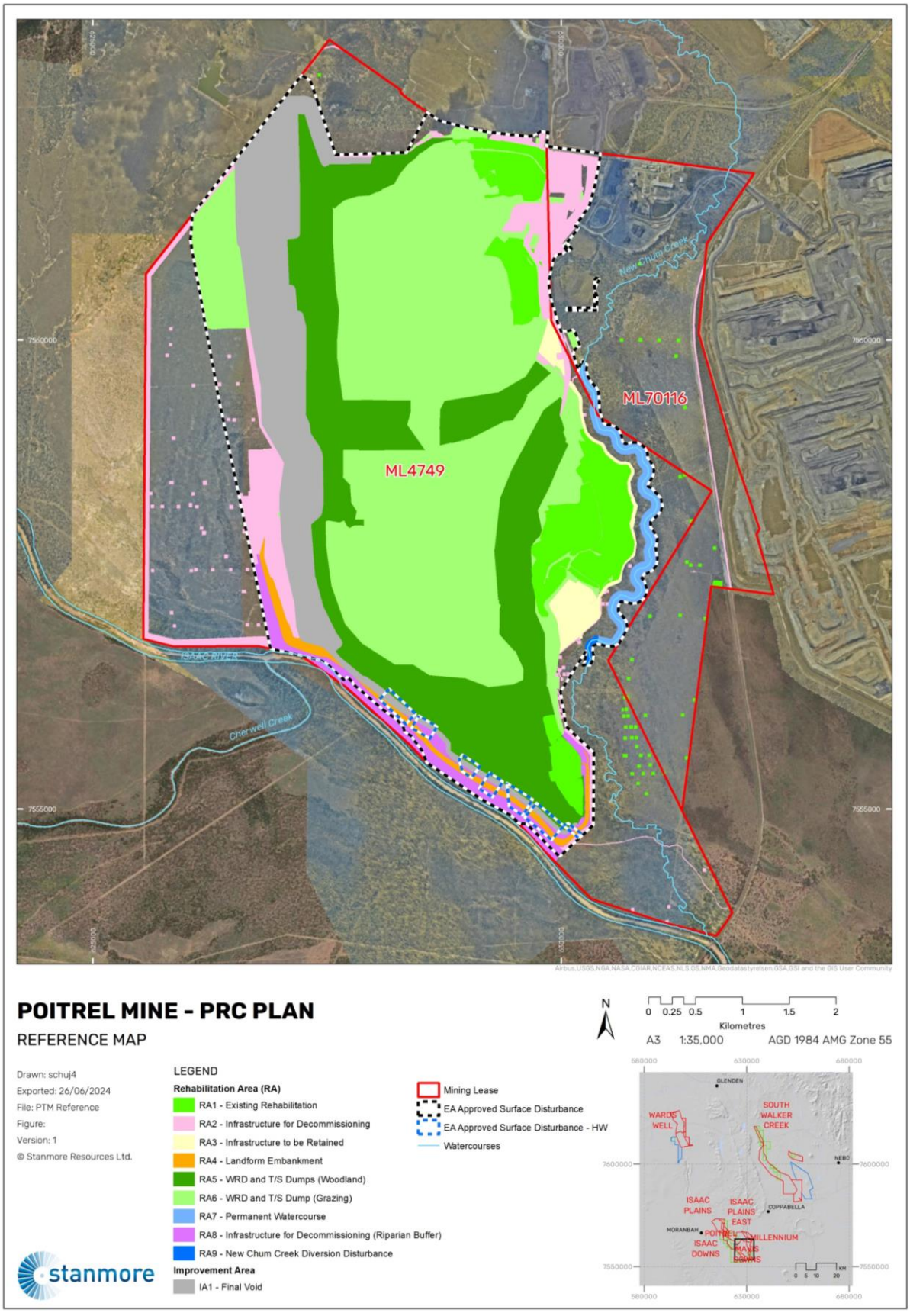


Figure 81 Reference Map

Schedule and Rehabilitation Milestones

Refer to attached PRC Plan Schedule

SECTION C – APPENDICES

Appendix 1 Poitrel Mine Environmental Authority (EPML00963013) (1 March 2024)

Appendix 2 Progressive Rehabilitation and Closure Plan Transition Notice and Extension Notice

Appendix 3 Hydrogeology Assessment (3 May 2024)

Appendix 4 Material Characterisation Study (8 June 2022)

Appendix 5 Voids in Floodplain Assessment (26 April 2022)

Appendix 6 Waste Characterisation (26 June 2024)

Appendix 7 Landform Design (28 June 2024)

Appendix 8 Void Closure Plan (1 July 2024)

Appendix 9 Cover Design (28 June 2024)

Appendix 10 Flooding Assessment (25 June 2024)

Appendix 11 Geotechnical Stability Assessment (June 2024)

Appendix 12 Revegetation Plan (28 June 2024)

Appendix 1 Poitrel Mine Environmental Authority (EPML00963013) (1 March 2024)

Permit

Environmental Protection Act 1994

Environmental authority EPML00963013

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00963013

Environmental authority takes effect on 01 March 2024

The anniversary date of this environmental authority is the same day each year and remains 15 September. The payment of the annual fee will be due each year on this day.

An annual return will be due each year on 01 April.

Environmental authority holder(s)

Name(s)	Registered address
STANMORE SMC PTY LTD	Level 32, 12 Creek St BRISBANE CITY QLD 4000 Australia

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Schedule 3 13: Mining black coal	ML70116, ML4749
Ancillary 08 - 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)	ML70116, ML4749
Ancillary 60 - Waste disposal 1(d) - Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(d) - more than 200,000t.	ML4749, ML70116
Ancillary 62 - Resource recovery and transfer facility operation 1(c) - Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 2 regulated waste	ML70116, ML4749
Ancillary 63 - Sewage Treatment 1(b-i) - Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of 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	ML70116, ML4749

ABN 46 640 294 485

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days);

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise-on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Sustainable Planning Act 2009* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Juliana McCosker
Department of Environment, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre Coal
Department of Environment, Science and Innovation
Phone: 07 4987 9320
Email: crmining@des.qld.gov.au

Date issued: 01 March 2024

Privacy statement

Pursuant to section 540 of the EP Act, the Department is required to maintain a register of certain documents and information authorised under the EP Act. A copy of this document will be kept on the public register. The register is available for inspection by members of the public who are able take extracts, or copies of the documents from the register. Documents that are required to be kept on the register are published in their entirety, unless alteration is required by the EP Act. There is no general discretion allowing the Department to withhold documents or information required to be kept on the public register. For more information on the Department's public register, search 'public register' at www.qld.gov.au. For queries about privacy matters please email privacy@des.qld.gov.au or telephone 13 74 68.

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Conditions of environmental authority

Schedule A: General	
Condition number	**Condition**
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	**Prevent and /or minimise likelihood of environmental harm** In carrying out the environmentally relevant activities, the environmental authority holder must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused. Any environmentally relevant activity, that, if carried out incompetently, or negligently, may cause environmental harm, in a manner that could have been prevented, shall be carried out in a proper manner in accordance with the conditions of this environmental authority.
A3	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; c) that such measures, plant and equipment are operated in a proper manner; and d) that all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
A4	**Monitoring and records** Except where specified otherwise in another condition of this environmental authority, all monitoring records and reports required by this environmental authority must be kept for a period of not less than **five (5) years**.
A5	Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person.
A6	Upon request from the administering authority, copies of monitoring results, records, registers, management plans and reports required by the conditions of this environmental authority must be made available and provided to the administering authority within **ten (10) business days** or an alternative timeframe agreed between the administering authority and the environmental authority holder.

A7	**Notification of emergencies, incidents and exceptions** The environmental authority holder must notify the administering authority by written notification within **twenty-four (24) hours** after becoming aware of any emergency or incident that results in the release of contaminants not in accordance, or reasonably expected to be not in accordance, with the conditions of this environmental authority.
A8	Within **ten (10) business days** following the initial notification under condition **A7**, or the receipt of monitoring results associated with the notification made under condition **A7**, whichever is the latter, the environmental authority holder must provide further written advice to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
A9	**Complaints** The environmental authority holder must record all environmental complaints received about the mining activities, including: a) name, address and contact number of the complainant; b) time and date of complaint; c) reasons for the complaint; d) investigations undertaken; e) conclusions formed; f) actions taken to resolve the complaint, including the use of appropriate dispute resolution if required; g) any abatement measures implemented; and h) person responsible for resolving the complaint.
A10	A register of alternative arrangements must be established and maintained by the environmental authority holder. The register must include: a) the location to which the alternative arrangement applies; b) the period of the alternative arrangement; c) details about the particular environmental nuisance impact or impacts the arrangement is for; and d) details about the mitigation measures, where relevant.

A11	**Monitoring on request** When requested by the administering authority, the environmental authority holder must investigate any nuisance, or contaminant release, or environmental harm, or complaint that is neither frivolous nor vexatious in the opinion of the authorised person, by: a) undertaking the monitoring specified by the administering authority; b) undertaking the monitoring in the timeframe nominated or agreed to by the administering authority; c) completing an analysis and interpretation of the monitoring results; and d) implementing abatement measures, where required.
A12	The results of the investigation undertaken in accordance with condition **A11** must be provided to the administering authority within **twenty (20) business days** of completion of the monitoring timeframe in accordance with condition **A11(b)**, or a longer timeframe agreed to by the administering authority.
A13	**Coal extraction rate** The environmental authority holder is approved for a coal extraction rate of up to seven (7.0) million tonnes per annum (mtpa) of run-of-mine (ROM) ore in accordance with this environmental authority. The measurement basis is specified as 1 July to 30 June in the following year.
A14	**Authorised disturbance** **Surface disturbance** by mining activities is authorised within areas marked "Approved surface disturbance" in **Figure 1 (Authorised Surface, Sub-Surface and Highwall Mining Disturbance Areas)**.
A15	**Sub-surface** disturbance by mining activities is authorised within areas marked as "Approved sub-surface disturbance" in **Figure 1 (Authorised Surface, Sub-Surface and Highwall Mining Disturbance Areas)**.
A16	**Highwall Mining** disturbance is authorised within areas marked as "Approved Highwall Mining Area" in **Figure 1 (Authorised Surface, Sub-Surface and Highwall Mining Disturbance Areas)**.
A17	Any disturbance outside of the areas marked "Authorised surface disturbance" in **Figure 1 (Authorised Surface, Sub-Surface and Highwall Mining Disturbance Areas)**: a) is only authorised to the extent reasonably necessary for roads, fences, underground services, low-impact telecommunications facilities, electrical sub-stations, transmission grid works and supply network works, storage depots, similar minor infrastructure and ancillary facilities for any of the above listed minor infrastructure; and b) must not result in significant residual impact to prescribed environmental matters.

Schedule B: Air	
Condition number	**Condition**
B1	**Odour nuisance** The release of noxious or offensive odour or any other noxious or offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
B2	If the administering authority determines odour released from the mining activities to constitute an environmental nuisance, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.
B3	**Dust nuisance** The release of dust or particulate matter or both resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
B4	Monitoring of dust and particulate matter resulting from the mining activities, undertaken in accordance with condition **A11**, must be carried out at a place relevant to the potentially affected sensitive place or commercial place and must not exceed the following levels when measured at any sensitive place or commercial place: a) dust deposition, measured as total insoluble matter, of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard *AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.* b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either: i. Australian Standard *AS3580.9.6 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – Gravimetric method*; or ii. Australian Standard *AS3580.9.8 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser*; or iii. Australian Standard *AS3580.9.9 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} low volume sampler – Gravimetric method*; or iv. Australian Standard *AS3580.9.11 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} beta attenuation monitors*. *NOTE: Exceedances due to events that cannot be managed by the environmental authority holder, such as bushfires, fuel reduction burning for fire management purposes or dust storms, would not be considered to be in breach of condition **B4** if the environmental authority holder can demonstrate that the exceedance was caused by such events.*

B5	If monitoring, undertaken in accordance with condition **A11**, indicates exceedance of the relevant limits in condition **B4**, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.
B6	**Monitoring of ambient weather conditions** A weather station for continuous representative monitoring and recording of wind direction and wind speed must be installed and operated on the mining leases.
B7	**Dust deposition monitoring** Dust deposition monitoring must be carried out in accordance with **Table B1 (Dust Deposition Monitoring)**, to confirm the modelling prediction that operations will not result in a significant increase in dust levels. *NOTE: Monitoring must be carried out in accordance with Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.*
B8	**Air Quality Management Plan** An Air Quality Management Plan must be developed and implemented by an appropriately qualified person by **31 March 2021**.
B9	The Air Quality Management Plan required by condition **B8** must include: a) an air quality monitoring program for PM_{10} and dust deposition; b) a Trigger Action Response Plan; and c) a requirement for 2-yearly review and update.

Table B1 (Dust Deposition Monitoring)

Air Quality Determination	Monitoring Points	Frequency
Particulate matter deposition rate in milligrams per square metre per day (averaged over one month)	Olive Downs Residence	Monthly
	Winchester Downs Residence	

Schedule C: Noise and Vibration	
Condition number	**Condition**
C1	**Noise nuisance** Noise from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
C2	Noise is not considered an environmental nuisance under condition **C1** if monitoring shows that noise does not exceed the limits in **Table C1 (Noise Limits)** at any sensitive place or commercial place.
C3	**Noise monitoring** Noise monitoring, undertaken in accordance with condition **A11**, must comply with the most recent version of the administering authority's *Noise Measurement Manual*, and must include the following descriptors, characteristics and conditions: a) $L_{A\ eq,\ adj,\ 1\ hour}$; b) $L_{A\ 1,\ adj,\ 10\ mins}$; c) the level and frequency of occurrence of impulsive or tonal noise; d) atmospheric conditions including wind speed and direction; e) effects due to extraneous factors such as traffic noise; and f) location, date and time of recording.
C4	If monitoring, undertaken in accordance with condition **A11**, indicates exceedance of the relevant limits in **Table C1 (Noise Limits)**, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.

Table C1 (Noise Limits)

Noise Level dB(A)	**Monday to Sunday (including public holidays)**		
	Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
Sensitive Place			
$L_{A\ eq,\ adj,\ 1\ hour}$	40	40	35
$L_{A1,\ adj,\ 10\ mins}$	50	50	45
Commercial Place			
$L_{A\ eq,\ adj,\ 1\ hour}$	50	50	50

C5	**Vibration nuisance** Vibration from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
C6	Vibration is not considered an environmental nuisance under condition **C5** if monitoring shows that vibration does not exceed the limits specified in **Table C2 (Vibration Limits)**.
C7	**Airblast overpressure nuisance** The airblast overpressure level from blasting operations on the mining leases must not cause an environmental nuisance, at any sensitive place or commercial place.
C8	Airblast overpressure is not considered an environmental nuisance under condition **C7** if monitoring shows that airblast overpressure does not exceed the levels specified in **Table C3 (Airblast Overpressure Level)**.
C9	**Vibration and/or airblast overpressure monitoring** Vibration and/or airblast overpressure monitoring, undertaken in accordance with condition **A11**, must comply with the most recent version of the administering authority's *Noise Measurement Manual*, and must include the following descriptors, characteristics and conditions: a) location of the blast within the mining area (including which bench level); b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and c) location, date and time of recording.
C10	If monitoring, undertaken in accordance with condition **A11**, indicates exceedance of the relevant limits in **Table C2 (Vibration Limits)** or **Table C3 (Airblast Overpressure Level)**, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.

Table C2 (Vibration Limits)

Location	Vibration Measured
Sensitive place or commercial place	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

Table C3 (Airblast Overpressure Level)

Location	Airblast Overpressure Measured
Sensitive place or commercial place	115 dB (Linear peak) for nine (9) out of ten (10) consecutive blasts and not greater than 120 dB (Linear peak) at any time.

Schedule D: Waste	
Condition number	**Condition**
D1	**Waste management** The holder of this Environmental Authority must develop, document and implement a waste management program for all mining activities at the licenced place. The program must include: a) a description of the mining activity that may generate waste; and b) waste management control strategies including: i. recording of the types and amounts of wastes generated by the mining activity; ii. segregation of the wastes; iii. storage of the wastes; iv. transport of the wastes; v. disposal of waste including leachate management; and vi. monitoring and reporting matters concerning the waste; and c) the hazard characteristics of the wastes generated including disposal procedures for regulated wastes; and d) a program for reusing, recycling or disposing of all wastes; and e) how the waste will be dealt with in accordance with the waste and resource management hierarchy, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices in the waste management hierarchy (i.e. avoidance, reuse, recycling, energy recovery, disposal); and f) how the waste will be stored, handled and transferred in a proper and effective manner; and g) procedures for identifying and implementing opportunities to minimise the amount of waste generated, promote efficiency in the use of resources and improve the waste management practices employed; and h) procedures for dealing with accidents, spills, and other incidents that may impact on waste management; and i) how often the performance of the waste management practices will be assessed; and j) indicators or other criteria on which the performance of the waste management practices will be assessed; and k) staff training and induction to the waste management program; and l) a system for regular review; and m) be updated at intervals of no greater than 5 years.
D2	The environmental authority holder must submit the Waste Management Program required by condition **D1** to the administering authority: a) upon request; and/or b) prior to commencing a new process, or varying an existing process, for reprocessing any waste.

D3	**Waste receipt** The only waste permitted to be received is: a) the types of waste specified in Table D1 (Mining Waste) and b) sewage and sludge for treatment in accordance with **Schedule H: Sewage Treatment**; and c) from Red Mountain Infrastructure CHPP (EPML00819113), South Walker Creek Coal Mine (EPML00712313), Isaac Downs Coal Mine (EA0002817)**,** Isaac Plains Coal Mine (EPML00932713), Millennium Coal Mine (EPML00819213) and Vulcan Coal Mine (EA0002912).
D4	**Waste reprocessing** The only waste permitted to be reprocessed is: a) spoil or overburden; b) vegetation; c) water or sediment containing hydrocarbons; d) fuels, oils, lubricants and coolants; e) bulk rubber; f) inert waste; g) poly-pipe and other plastic; h) fibreglass; i) treated and untreated timber; and j) asphalt.
D5	**Waste disposal** Unless otherwise specified in Table D1 (Mining Waste), waste, other than spoil or overburden or vegetation removed as part of the mining activity, must not be disposed of within the mining leases listed on this environmental authority and must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the *Environmental Protection Act 1994*.

Table D1 (Mining Waste)

Waste type	**Authorised Disposal Location**
Rejects and sediment containing hydrocarbons	• Spoil emplacements • Regulated structures in accordance with Schedule G: Structures of this environmental authority • Pits and voids • Dedicated rejects emplacements
Tailings and water or sediment containing hydrocarbons	Temporarily stored in structures in the overburden for the purpose of dewatering/ evaporation prior to being disposed as rejects in accordance with this Table.

Bulk rubber, inert waste, polypipe and other plastics, fibreglass, treated and untreated timber, asphalt, and asbestos.	• In pits or voids • In spoil emplacements; and • Left in situ below ground level;

Schedule E: Land	
Condition number	**Condition**
E1	**Topsoil** Topsoil must be strategically stripped ahead of mining in accordance with a Topsoil Management Plan.
E2	A topsoil inventory, which identifies the topsoil requirements for rehabilitation and availability of suitable topsoil on site, must be provided with any Estimated Rehabilitation Cost application.
E3	**Rehabilitation landform criteria** Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with **Table E1 (Rehabilitation Requirements)**.

Table E1 (Rehabilitation Requirements)

Post Mining Land Use	**Goal**	**Objective**	**Indicator**	**Acceptance Criteria**
Cattle grazing	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
		Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover >50% 2. 70% of slopes ≤20%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland)* unless otherwise agreed in writing between the administering authority and the environmental authority holder.
			Leucaena stem density	<250 stems >2m height per ha (1 per 40m^2), mean total area

Post Mining Land Use	Goal	Objective	Indicator	Acceptance Criteria
Dryland cropping	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
		Rehabilitation is erosionally stable	Percentage of cultivation at >1% slope gradient with functional contour banks	100% of rehabilitated areas
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable dryland cropping	Land suitability assessment for dryland cropping	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with the *Regional Land Suitability Frameworks for Queensland 2013* unless otherwise agreed in writing between the administering authority and the environmental authority holder.
Woodland habitat	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5 unless an alternative is justified by an appropriately qualified person
		Rehabilitation is erosionally stable	Groundcover (steep slopes, >15%)	80%
			Groundcover (lesser slopes, ≤15%)	50%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.

Post Mining Land Use	Goal	Objective	Indicator	Acceptance Criteria
	Able to sustain the agreed post-mining land use	Native bushland characteristics	Species richness Trees Shrubs Grasses	 ≥2 ≥3 ≥4
			Tree canopy cover	≥16%
Water Storage	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of Safety	≥1.5
		Rehabilitation is erosionally stable (banks and immediate surrounds)	Groundcover	>50%
		Highwall Mining Area is geotechnically stable	Factor of Safety	≥1.5
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation retains water that is a potential resource for cattle grazing, with quality according to ANZECC guidelines version October 2000	TDS Calcium Magnesium Nitrate Nitrite Sulphate	≤5,000mg/L ≤1,000mg/L ≤2,000mg/L ≤400mg/L ≤30mg/L ≤1,000mg/L
Watercourse	Safe to humans and wildlife	Safety hazards are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is erosionally stable	Geomorphic index (IDC method)	Greater or equal to upstream or downstream values.
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
	Able to sustain the agreed post-mining land use	Riparian vegetation	Riparian vegetation index (IDC method)	Greater or equal to upstream or downstream values.

E4	Progressive rehabilitation must commence within **three (3) years** when areas become available within the mining leases.
E5	Review and update an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria by **30 June 2010** for administering authority review and comment. The Rehabilitation Management Plan must, at a minimum: a) map existing areas of rehabilitation; b) develop design objectives for rehabilitation of disturbed areas and post mining land uses across the mine; c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; d) detail rehabilitation methods applied to areas; e) contain landform design criteria including end of mine design; f) detail how landform design will be consistent with the surrounding topography; g) identify success criteria for areas and itemise revegetation criteria; h) explain planned native vegetation rehabilitation areas and corridors; i) identify at least a minimum of **three (3) reference** and **three (3) rehabilitation** sites to be used to develop rehabilitation success criteria; j) describe rehabilitation indicators and the monitoring program to be used; k) develop a contingency plan for rehabilitation maintenance or redesign; l) describe end of mine landform design plan and post mining land uses across the mine; and m) include a cost benefit analysis / triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.
E6	**Residual void outcome** Residual voids 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 residual void itself and subject to any other condition within this environmental authority.

E7	Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria and landform design criteria by **30 June 2010** for administering authority review and comment. On acceptance of the criteria proposed in the Residual Void Management Plan, the criteria must be specified in the environmental authority. The investigation must at a minimum include the following: a) a study of options available for minimising final void area and volume; b) develop design criteria for rehabilitation of final voids; c) a void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term; d) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; e) a study of void capability to support native flora and fauna; and f) a proposal/s for end of mine void rehabilitation success criteria and final void areas and volumes. These studies will be undertaken during the life of the mine, and will include detailed research and modelling.
E8	**Rehabilitation Monitoring Program** Once rehabilitation has commenced, the environmental authority holder must conduct a Rehabilitation Monitoring Program every **two (2) years**, which must include sufficient spatial and temporal replication to enable statistically valid conclusions as established under the rehabilitation program.
E9	The Rehabilitation Monitoring Program must be developed and implemented by a person possessing appropriate qualifications and experience in the field of rehabilitation management, nominated by the environmental authority holder.
E10	The Rehabilitation Monitoring Program must be included in the annual return and updated with each subsequently submitted annual return, describing: a) how the rehabilitation objectives as per condition **E5** will be achieved; and b) verification of rehabilitation success.
E11	**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 the mining leases 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.

E12	The Post Closure Management Plan must include the following elements: a) operation and maintenance of: 1. wastewater collection and reticulation systems; 2. wastewater treatment systems; 3. the groundwater monitoring network; 4. final cover systems; and 5. vegetative cover. b) monitoring of: 1. surface water quality; 2. groundwater quality; 3. seepage rates; 4. erosion rates; 5. the integrity and effectiveness of final cover systems; and 6. the health and resilience of native vegetation cover.
E13	**Preventing contaminant release to land** Contaminants must not be released to land in manner that constitutes a nuisance, material harm or serious environmental harm.
E14	**Storage and handling of chemicals and flammable or combustible liquids** All chemicals and flammable or combustible liquids must be stored and handled in accordance with the most recent version of an Australian Standard where such is applicable. Where no relevant Australian Standard exists, store such materials within an effective on-site containment system.
E15	**Infrastructure** All infrastructure, constructed by or for the environmental authority holder during the mining activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining landowner/ landholder. *NOTE: This is not applicable where the landowner/ landholder is also the environmental authority holder.*
E16	**Exploration** The environmental authority holder must rehabilitate in accordance with this environmental authority, any disturbance from mining activities which were undertaken under: a) this environmental authority; or b) any other environmental authority that applied to the land that is the subject of this environmental authority.

E17	**Impacts to Prescribed Environmental Matters** Significant residual impacts to prescribed environmental matters, other than if the impacts were authorised by an existing authority issued before the commencement of the *Environmental Offsets Act 2014*, are not authorised under this environmental authority or the *Environmental Offsets Act 2014* unless the impact is specified in **Table E2 (Significant Residual Impacts to Prescribed Environmental Matters)** and **Figure 2 (Ground-truthed Regulated Vegetation and Regional Ecosystems)**.
E18	Records demonstrating that each impact to a prescribed environmental matter not listed in **Table E2 (Significant Residual Impacts to Prescribed Environmental Matters)** did not, or is not likely to, result in a significant residual impact to that matter must be: a) completed by an appropriately qualified person; and b) kept for the life of the environmental authority.

Table E2 (Significant Residual Impacts to Prescribed Environmental Matters)

Prescribed Environmental Matter	Maximum Extent of Impact	Environmental Offset Required
Regulated Vegetation		
Endangered regional ecosystem – 11.4.9	142ha[2]	No[1]
Endangered regional ecosystem – 11.4.8		
Endangered regional ecosystem – 11.3.1		
Protected Wildlife Habitat		
Habitat for an animal that is vulnerable wildlife – *Geophaps scripta scripta* — Squatter Pigeon (southern)	310.2ha	No[1]

NOTE:
[1] Offsets for these values are to be offset under the EPBC Poitrel Mine Approval 2004/1770
[2] 156ha of regulated vegetation has been offset under EPBC Poitrel Mine Approval 2004/1770.

Schedule F: Water	
Condition number	**Condition**
F1	**Contaminant Release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the mining activities, except as permitted under the conditions of this environmental authority.
F2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table F1 (Mine Affected Water Release Points)**.
F3	The release of mine affected water to internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with conditions **F33** to **F37** inclusive is permitted.

Table F1 (Mine Affected Water Release Points)

Release Point (RP)	Easting (GDA94)	Northing (GDA94)	Mine Affected Water Source and Location	Monitoring Point	Receiving Waters Description
RP1	630315	7557024	Sediment Dam 3	End of outlet pipe or spillway	Isaac River (via New Chum Creek)
RP2	630080	7560088	Sediment Dam 2	Pump inlet	Isaac River (via New Chum Creek)
RP3	TBA	TBA	Sediment Dam 4	End of outlet pipe or spillway	Isaac River (via unnamed drainage line)

F4	Notwithstanding condition **F2** of this environmental authority, the release of mine affected water to waters from RP3 is not permitted until the environmental authority holder amends this environmental authority to include: a) the location details for RP3 in Table F1 (Mine Affected Water Release Points, Sources and Receiving Waters); b) the location details for RP3 in **Table F2 (Mine Affected Water Release Limits)**; c) the location details of Sediment Dam 4 in **Table F5 (Onsite Water Storage Monitoring)**; and d) the location details of MP6 in **Table F8 (Receiving Water Upstream Background Sites and Downstream Monitoring Points)**.
F5	The release of mine affected water to waters in accordance with condition **F2** must not exceed the release limits stated in **Table F2 (Mine Affected Water Release Limits)** when measured at the monitoring points specified in **Table F1 (Mine Affected Water Release Points)** for each quality characteristic.

Table F2 (Mine Affected Water Release Limits)

Quality Characteristic	Release Limit	Monitoring Frequency [1]	Comment
Electrical Conductivity (µS/cm)	Release limit specified in **Table F4** for variable flow criteria.	Daily during release (the first sample must be taken within 2 hours or as soon as practicable of commencement of release)	
pH (pH units)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours or as soon as practicable of commencement of release)	
Turbidity [2] (NTU)	500	Daily during release (the first sample must be taken within 2 hours or as soon as practicable of commencement of release)	Turbidity is required to assess ecosystem impacts and can provide instantaneous results.
Suspended Solids * (mg/L)	N/A	At commencement and prior to cessation of release (at a minimum) and weekly during release.	Suspended solids are required to measure the performance of erosion and sediment control measures.
Sulphate (SO_4^{2-}) (mg/L)	Release limit specified in **Table F4** for variable flow criteria.	At commencement and prior to cessation of release (at a minimum) and weekly during release.	Drinking water environmental values from NHMRC 2006 guidelines or ANZECC.

NOTES:
** Limit for suspended solids can be omitted if turbidity limit is included. Limit for turbidity not required if suspended solids limit included. Both indicators should be measured in all cases.*
[1] While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.
[2] Insufficient historical analysis of suspended solid concentration prevents the establishment of a site specific trigger. Future monitoring of suspended solid concentrations will enable a trigger level to be determined. Turbidity is proposed to be used as a surrogate in the interim.

F6	The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table F1 (Mine Affected Water Release Points)** for each quality characteristic and at the frequency specified in **Table F2 (Mine Affected Water Release Limits)** and **Table F3 (Release Contaminant Trigger Investigation Levels)**. *NOTE: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition **F6** is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table F3 (Release Contaminant Trigger Investigation Levels)

Quality Characteristic	Trigger Level (µg/L)	Comment of Trigger Level	Monitoring Frequency
Aluminium	55	For aquatic ecosystem protection, based on SMD guideline	Commencement of release and thereafter weekly during release
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	4	For aquatic ecosystem protection, based on SMD guideline	
Mercury	0.2	For aquatic ecosystem protection, based on LOR for CV FIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1900	For aquatic ecosystem protection, based on SMD guideline	
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	Protection of livestock and short-term guideline	
Sodium	TBA	See note 5	

NOTES:
1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
*2. The quality characteristics required to be monitored as per **Table F3** can be reviewed once the results of two years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table F3** by amendment.*
3. SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).
4. LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.
*5. Environmental authority holder will continue to monitor for all quality characteristics listed in **Table F3** until such time that sufficient data has been acquired to either enable site specific trigger levels to be determined or to justify the removal of a characteristic from **Table F3**.*

F7	If quality characteristics of the release exceed any of the trigger levels specified in **Table F3 (Release Contaminant Trigger Investigation Levels)** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in **Table F3 (Release Contaminant Trigger Investigation Levels)** and: (1) where the trigger values are not exceeded then no action is to be taken; or (2) where the downstream results exceed the trigger values specified in **Table F3 (Release Contaminant Trigger Investigation Levels)** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; (a) if the result is less than the background monitoring site data, then no action is to be taken; or (b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: i. details of the investigations carried out; and ii. actions taken to prevent environmental harm. *NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with condition **F7(2)(b)**, no further reporting is required for subsequent trigger events for that quality characteristic.*
F8	If an exceedance in accordance with condition **F7(2)(b)** is identified, the environmental authority holder must notify the administering authority within **twenty-four (24) hours** of receiving the result.
F9	**Mine Affected Water Release Events** The environmental authority holder must ensure a stream flow gauging station is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table F4 (Mine Affected Water Release During Flow Events)**.
F10	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition **F2** must only take place during periods of natural flow events in accordance with the receiving water flow criteria for discharge specified in **Table F4 (Mine Affected Water Release During Flow Events)** for the release point specified in **Table F1 (Mine Affected Water Release Points)**.
F11	The release of mine affected water to waters in accordance with condition **F2** must not exceed the Electrical Conductivity and Sulphate release limits or the Maximum Release Rate (for all combined release point flows) for each receiving water flow criteria for discharge specified in Table **F4 (Mine Affected Water Release During Flow Events)** when measured at the monitoring points specified in **Table F1 (Mine Affected Water Release Points)**.
F12	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in **Table F1 (Mine Affected Water Release Points)**.
F13	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.

Table F4 (Mine Affected Water Release During Flow Events)

Receiving waters	Release Point (RP)	Gauging Station	Gauging Station Easting (GDA94)	Gauging Station Northing (GDA94)	Receiving Water Flow Recording Frequency	Receiving Water Flow Criteria for Discharge (m^3/s)	Maximum Release Rate (for all combined RP flows)	Electrical Conductivity and Sulphate Release Limits
Isaac River	RP1, RP2 & RP3	Isaac River Upstream Monitoring Point (MP5) Hydrological modelling has indicated that the actual flow at this point is equal to 2.93 multiplied by the flow measured at the Goonyella Gauging Station Overtime as better quality gauging data becomes available the Isaac River Upstream Monitoring site will be preferred.	627831	7556405	Continuous (minimum daily)	**Low Flow** <14 m^3/s for a period of 28 days after natural flow events that exceed 14 m^3/s	Maximum 6 m^3/s and release rate must not exceed the natural flow rate in the receiving waters when measured at the gauging station at MP5	Electrical conductivity 720 µS/cm Sulphate (SO_4^{2-}): 250 mg/L
						Medium Flow (Low) > 14 m^3/s	< 3.5 m^3/s	Electrical conductivity 1500 µS/cm Sulphate (SO_4^{2-}): 500 mg/L
							< 1.5 m^3/s	Electrical conductivity 3000 µS/cm Sulphate (SO_4^{2-}): 500 mg/L
							< 1.2 m^3/s	Electrical conductivity 3500 µS/cm Sulphate (SO_4^{2-}): 500 mg/L
							< 0.8 m^3/s	Electrical conductivity 5000 µS/cm Sulphate (SO_4^{2-}): 500 mg/L
						Medium Flow (High) > 35 m^3/s	< 5.8 m^3/s	Electrical conductivity 2000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
							< 2.9 m^3/s	Electrical conductivity 3500 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
							< 2.0 m^3/s	Electrical conductivity 5000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
						High Flow > 59 m^3/s	< 6.0 m^3/s	Electrical conductivity 3000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
							< 3.3 m^3/s	Electrical conductivity 5000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
							< 2.3 m^3/s	Electrical conductivity 7000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L
						Very High Flow > 290 m^3/s	< 6 m^3/s	Electrical conductivity 7000 µS/cm Sulphate (SO_4^{2-}): 1000 mg/L

F14	**Notification of release event** The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than **twenty-four (24) hours** after commencing to release mine affected water to the receiving environment. The release commencement notification must include the submission of written advice to the administering authority of the following information: a) release commencement date and time; b) expected release cessation date and time; c) release point; d) release rate; e) receiving water including the natural flow rate; and f) any details (including available data) regarding likely impacts on the receiving water.
F15	The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than **twenty-four (24) hours** after cessation of a release event notified under condition **F14**. The release cessation notification must include the submission of written advice to the administering authority of the following information: a) release cessation date and time; b) receiving water including the natural flow rate; and c) volume of water released. *NOTE: Successive or intermittent releases occurring within **twenty-four (24) hours** of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions **F14** and **F15** and **F16**, provided the relevant details of the release are included within the notification provided in accordance with conditions **F14** and **F15** and **F16**.*
F16	Within **twenty-eight (28) days** of notification under condition **F15**, the environmental authority holder must provide the administrating authority via WaTERS the following information in writing: a) confirmation of: i. the release commencement date and time; ii. the release cessation date and time; iii. receiving water including the natural flow rate; iv. volume of water released; b) all in-situ and laboratory water quality monitoring results; c) details regarding the compliance of the release with the conditions of **Schedule F: Water** of this environmental authority (i.e. contamination limits, natural flow, discharge volume); d) whether the release of water resulted in any impacts to the receiving environment; and e) any other matter pertinent to the water release event.
F17	**Notification of release event exceedance** If the release limits defined in **Table F2 (Mine Affected Water Release Limits)** are exceeded, the environmental authority holder must notify the administering authority within **twenty-four (24) hours** of receiving the results.

F18	The environmental authority holder must, within **twenty-eight (28) days** of the notification provided in accordance with condition **F17**, provide a report to the administering authority via WaTERS detailing: a) the reason for the release; b) the location of the release; c) the total volume of the release and which (if any) part of this volume was non-compliant; d) the total duration of the release and which (if any) part of this period was non-compliant; e) all water quality monitoring results; f) any general observations; g) all calculations; and h) any other matters pertinent to the water release event.
F19	**Monitoring of Water Storage Quality** Water storages stated in **Table F5 (Onsite Water Storage Monitoring)** which are associated with the release points must be monitored for the water quality characteristics specified in **Table F6 (Onsite Water Storage Contaminant Limits)** at the monitoring locations and at the monitoring frequency specified in **Table F5 (Onsite Water Storage Monitoring)**.
F20	In the event that water storages defined in **Table F5 (Onsite Water Storage Monitoring)** exceed the contaminant limits defined in **Table F6 (Onsite Water Storage Contaminant Limits)**, the environmental authority holder must implement measures, where practicable, to prevent access to waters by all livestock.

Table F5 (Onsite Water Storage Monitoring)

Water Storage Description	Easting (GDA94)	Northing (GDA94)	Monitoring Location	Monitoring Frequency
Sediment Dam 1	630088	7561371	At pump inlet – mixed sample over depth profile	Quarterly
Sediment Dam 2	629918	7560183	At pump inlet – western embankment of dam	
Sediment Dam 3	630303	7557057	At release gates – mixed sample over depth profile	
Sediment Dam 4	TBA	TBA	TBA	

Table F6 (Onsite Water Storage Contaminant Limits)

Quality Characteristic	Units	Test Value	Contaminant Limit
pH	pH units	Range	Greater than 4, less than 9[2]
Electrical Conductivity	µS/cm	Maximum	5970[1]
Sulphate	mg/L	Maximum	1000[1]
Fluoride	mg/L	Maximum	2[1]
Aluminium	mg/L	Maximum	5[1]
Arsenic	mg/L	Maximum	0.5[1]
Cadmium	mg/L	Maximum	0.01[1]
Cobalt	mg/L	Maximum	1[1]
Copper	mg/L	Maximum	1[1]
Lead	mg/L	Maximum	0.1[1]
Nickel	mg/L	Maximum	1[1]
Zinc	mg/L	Maximum	20[1]

NOTES:
Total measurements (unfiltered) must be taken and analysed
[1] Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines.
[2] Page 4.2-15 of ANZECC & ARMCANZ (2000) "Soil and animal health will not generally be affected by water with pH in the range of 4–9".

F21	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored at the locations specified in **Table F8 (Receiving Water Upstream Background and Downstream Monitoring Points)** for each quality characteristic and at the monitoring frequency stated in **Table F7 (Receiving Waters Contaminant Trigger Levels)** and **Table F3 (Release Contaminant Trigger Investigation Levels)**.
F22	If quality characteristic of the receiving water at the downstream monitoring point MP3 exceed any of the trigger levels specified in **Table F7 (Receiving Waters Contaminant Trigger Levels)** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or (2) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: (a) details of the investigations carried out; and (b) actions taken to prevent environmental harm. *NOTE: Where an exceedance of a trigger level has occurred and is being investigated in accordance with **F22(2)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*

Table F7 (Receiving Waters Contaminant Trigger Levels)

Quality Characteristic	Trigger Level	Monitoring Frequency[3]
pH (pH units)	6.5 to 8.5	Daily during the release (the first sample must be taken within 2 hours or as soon as practicable of commencement of release)
Electrical Conductivity (µS/cm)	1000	
Turbidity (NTU)	750	
Suspended Solids (mg/L)	TBA[1]	
Sulphate (SO_4^{2-}) (mg/L)	250	
Sodium (mg/L)	TBA[2]	

NOTES:
[1] Insufficient historical analysis of suspended solid concentration prevents the establishment of a site specific trigger. Future monitoring of suspended solid concentrations will enable a trigger level to be determined. Turbidity is proposed to be used as a surrogate in the interim.
[2] Insufficient analysis of sodium concentration prevents the establishment of a site specific trigger. Future monitoring of sodium concentrations will enable a trigger level to be determined.
[3] While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.

Table F8 (Receiving Waters Upstream Background and Downstream Monitoring Points)

Monitoring Point (MP)	Receiving Waters Location Description	Easting (GDA94)	Northing (GDA94)
Upstream Background Monitoring Points			
MP4	New Chum Creek – upstream of the diversion	630824	7560800
MP5	Isaac River – 4760m upstream of the confluence of New Chum Creek and Isaac River	627831	7556405
Downstream Monitoring Points			
MP2	New Chum Creek – downstream of the diversion	631136	7554887
MP3	Isaac River – 3000m downstream of the confluence of New Chum Creek and Isaac River	633694	7552809

NOTES:
*[1] Requires only in situ samples taken using electronic sampling equipment. Data obtained from MP4 and MP2 are for information purposes only, and is not subject to condition **F22**.*
(a) The upstream monitoring point should be within 5km of the release point (New Chum Creek confluence with Isaac River).
(b) The downstream point should not be greater than 4km from the release point (New Chum Creek confluence with Isaac River).
(c) The data from background monitoring points must not be used where they are affected by releases from other mines.

F23	**Receiving Environment Monitoring Program (REMP)** The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Isaac River and connected or surrounding waterways within **fifteen (15) kilometres** downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
F24	The REMP must: a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality); b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected; c) include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release (as a minimum, the locations specified in **Table F8 (Receiving Water Upstream Background and Downstream Monitoring Points)**); d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the *Queensland Water Quality Guidelines 2009*. This should include monitoring during periods of natural flow irrespective of mine or other discharges; e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in **Table F2 (Mine Affected Water Release Limits)** and **Table F3 (Release Contaminant Trigger Investigation Levels)**); f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments); g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology, h) apply procedures and/or guidelines from ANZECC & ARMCANZ 2000 and other relevant guideline documents; i) describe sampling and analysis methods and quality assurance and control; and j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.
F25	A REMP Design Document that addresses each criterion presented in conditions **F23** and **F24** must be maintained. Due consideration must be given to any comments made by the administering authority on the REMP Design Document and subsequent implementation of the REMP.

F26	A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with conditions **F23** and **F24** must be prepared annually. This report must include the following: a) an assessment of background reference water quality; b) the condition of downstream water quality compared against water quality objectives; and c) the suitability of current discharge limits to protect downstream environmental values.
F27	**Water reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of: a) supplying stock water subject to compliance with the quality release limits specified in **Table F9 (Stock Water Release Limits)**; or b) supplying irrigation water subject to compliance with quality release limits in **Table F10 (Irrigation Water Release Limits)**; or c) supplying water for construction and/or road maintenance in accordance with the conditions of this environmental authority.

Table F9 (Stock Water Release Limits)

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	5000

Table F10 (Irrigation Water Release Limits)

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	Site specific value determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines

F28	Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, for the purpose of supplying water to any operation licensed for either ERA13 (mining black coal) or ERA31 (mineral processing). The volume, pH and electrical conductivity of water transferred must be monitored and recorded.

F29	If the responsibility for mine affected water is given or transferred to another person in accordance with conditions **F27** or **F28**: a) the responsibility for the mine affected water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) the third party agreement must include a commitment from the person utilising the mine affected water to use it in such a way as to prevent environmental harm or public health incidents and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the *Environmental Protection Act 1994*, environmental sustainability of the water disposal and protection of environmental values of waters; and c) the third party agreement must be signed by both parties to the agreement.
F30	**Water general** All determinations of water quality and biological monitoring must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the administering authority's *Monitoring and Sampling Manual*; c) collected from the monitoring locations identified within this environmental authority, within ten hours of each other where possible; d) carried out on representative samples; and e) analysed at a laboratory accredited (e.g. NATA) for the method of analysis being used. *Note: Condition **F30** requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.*
F31	The release of any contaminants as permitted by this environmental authority, directly or indirectly to waters, other than internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with conditions **F33** to **F37** inclusive: a) must not produce any visible discolouration of receiving waters; and b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.

F32	**Annual water monitoring reporting** The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
F33	**Water Management Plan** A Water Management Plan must be developed by an appropriately qualified person and implemented for all mining activities.
F34	The Water Management Plan required by condition **F33** must: a) provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority; and b) be developed in accordance with administering authority's guideline *Preparation of water management plans for mining activities* and include: i. a study of the source of contaminants; ii. a water balance model for the site; iii. a water management system for the site; iv. measures to manage and prevent saline drainage; v. measures to manage and prevent acid rock drainage; vi. contingency procedures for emergencies; and vii. a program for monitoring and review of the effectiveness of the Water Management Plan.
F35	The Water Management Plan required by condition **F33** must be reviewed each calendar year and a report prepared by an appropriately qualified person. The report must: a) assess the plan against the requirements under condition **F34**; b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and c) identify any amendments made to the Water Management Plan following the review.

F36	The environmental authority holder must attach to the review report required by condition **F35** a written response to the report and recommended actions, detailing the actions taken or to be taken by the environmental authority holder on stated dates: a) to ensure compliance with this environmental authority; and b) to prevent a recurrence of any non-compliance issues identified.
F37	The review report required by condition **F35** and the written response to the review report required by condition **F36** must be submitted to the administering authority with the subsequent annual return under the signature of the appointed signatory for the annual return.
F38	**Saline drainage** The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
F39	**Acid rock drainage** The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
F40	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the mining lease to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
F41	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition **F40**; and b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions **F33** to **F37** inclusive, for the purpose of ensuring water does not become mine affected water.
F42	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.
F43	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.

Schedule G: Structures	
Condition number	**Condition**
G1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person, in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*, at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) prior to any change in its purpose or the nature of its stored contents.
G2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.
G4	**Design and construction of a regulated structure** Conditions **G5** to **G9** inclusive do not apply to existing structures. *NOTE: Construction of a dam includes modification of an existing dam – see definitions.*
G5	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*. *NOTE: Certification of design and construction may be undertaken by different persons.*
G6	Construction of a regulated structure is prohibited unless the environmental authority holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this environmental authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*, and must be recorded in the Register of Regulated Structures.

G8	Regulated structures must: a) be designed and constructed in accordance with and conform to the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635); b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i. floodwaters from entering the regulated dam from any watercourse or drainage line; and ii. wall failure due to erosion by floodwaters arising from any watercourse or drainage line. c) for regulated dams associated with a failure to contain – seepage, have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and b) construction of the regulated structure is in accordance with the design plan.
G10	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless the environmental authority holder has submitted to the administering authority: a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition **G6**; b) a set of 'as constructed' drawings and specifications; c) certification of those 'as constructed drawings and specifications' in accordance with condition **G9**; d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan; e) the requirements of this environmental authority relating to the construction of the regulated structure have been met; f) the environmental authority holder has entered the details, required under this environmental authority, into the Register of Regulated Structures; and g) there is a current operational plan for the regulated structures.
G11	For existing structures that are regulated structures: a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the environmental authority holder must submit to the administering authority within **twelve (12) months** of the commencement of this condition a copy of the certified system design plan including that structure; and b) there must be a current operational plan for the existing structures.

G12	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G13	**Mandatory Reporting Level** Conditions **G14** to **G17** inclusive only apply to regulated structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
G14	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that, during routine inspections of that dam, it is clearly observable.
G15	The environmental authority holder must, as soon as practical and within **forty-eight (48) hours** of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
G16	The environmental authority holder must immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G17	The environmental authority holder must record any changes to the MRL in the Register of Regulated Structures.
G18	**Design Storage Allowance** The environmental authority holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to **1 July** of each year.
G19	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
G20	The environmental authority holder must notify the administering authority as soon as possible and within **forty-eight (48) hours** of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year.
G21	The environmental authority holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G22	**Annual inspection report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.

G23	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.
G24	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.
G25	The environmental authority holder must: a) within **twenty (20) business days** of receipt of the annual inspection report, provide to the administering authority: i. the recommendations section of the annual inspection report; and ii. if applicable, any actions being taken in response to those recommendations; and b) if, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the environmental authority holder, provide this to the administering authority within **ten (10) business days** of receipt of the request.
G26	**Transfer arrangements** The environmental authority holder must provide a copy of any reports, documentation and certifications prepared under this environmental authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G27	**Decommissioning and rehabilitation** Dams must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition **G28**; or b) be left in-situ for a beneficial use provided that: i. it no longer contains contaminants that will migrate into the environment; and ii. it contains water of a quality that is demonstrated to be suitable for its intended beneficial use; and iii. the administering authority, the environmental authority holder and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).

G28	After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria: a) the landform is safe for humans and fauna; b) the landform is stable with no subsidence or erosion gullies for at least three (3) years; c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated d) not allowing for acid mine drainage; or e) there is no ongoing contamination to waters (including groundwater); f) rehabilitation is undertaken in a manner such that any actual or potential acid sulphate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the *Instructions for the treatment and management of acid sulfate soils (2001)*; g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class; h) for land that is not being cultivated by the landholder: i. groundcover, that is not a declared pest species is established and self-sustaining ii. vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining, and iii. the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the mining activity(ies). i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of mining activities being completed.
G29	**Register of Regulated Structures** A Register of Regulated Structures must be established and maintained by the environmental authority holder for each regulated structure.
G30	The environmental authority holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated structure is submitted to the administering authority.
G31	The environmental authority holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition **G10** and **G11** has been achieved.
G32	The environmental authority holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
G33	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the environmental authority holder, or their delegate, as being accurate and correct.
G34	The environmental authority holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.

G35	**Transitional arrangements** All existing structures that have not been assessed in accordance with either, the Manual or the former *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams*, must be assessed and certified in accordance with the Manual within **six (6) months** of amendment of the environmental authority adopting this schedule.
G36	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in **Table G1 (Transitional Requirements for Existing Structures)**, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.
G37	**Table G1 (Transitional Requirements for Existing Structures)** ceases to apply for a structure once any of the following events has occurred: a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or b) it has been decommissioned; or c) it has been certified as no longer being assessed as a regulated structure.
G38	Certification of the transitional assessment required by **G35** and **G36** (as applicable) must be provided to the administering authority within **six (6) months** of amendment of the environmental authority adopting this schedule.

Table G1 (Transitional Requirements for Existing Structures)

Transition period required for existing structures to achieve the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*			
Compliance with Criteria	**High**	**Significant**	**Low**
>90% and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70% to ≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50 to ≤70%	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50%	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing)	Review consequence assessment every 5 years.

Schedule H: Sewage Treatment	
Condition number	**Condition**
H1	**Treated sewage effluent** The cumulative total daily peak design capacity of the sewage treatment plant/s must not exceed 1500 equivalent persons (EP). Small package plants and/or septic systems, each with a daily peak design capacity less than 21EP, are not included in the cumulative total daily peak design capacity.
H2	Treated sewage effluent must not be directly released from the sewage treatment plant/s to any waters. *Note: 'waters' does not include structures associated with the mine affected water management system.*
H3	Treated sewage effluent may be: a) released to the mine affected water management system for mixing with other mine affected water; b) released to land via a sub-surface infiltration trench; c) irrigated or sprayed for dust suppression or firefighting or evaporation; or d) removed as waste.
H4	Treated sewage effluent that is released in accordance with condition **H3(a)** and has mixed with other mine affected water must be managed as mine affected water in accordance with the conditions of this environmental authority.
H5	Treated sewage effluent that is released in accordance with condition **H3(b)** or **H3(c)** must be carried out in a manner such that: a) vegetation is not damaged; b) there is no surface ponding of effluent; and c) there is no run-off of treated sewage effluent to waters.
H6	Treated sewage effluent released in accordance with condition **H3(a)** or **H3(b)** or **H3(c)** from any sewage treatment plant that has a daily peak design capacity of greater than 21EP must be monitored: a) at the point where the treated sewage effluent is released from the sewage treatment plant/s; b) for the quality characteristics specified in **Table H1 (Treated Sewage Effluent Monitoring Requirements)**; and c) at the frequency specified in **Table H1 (Treated Sewage Effluent Monitoring Requirements)**.

Table H1 (Treated Sewage Effluent Monitoring Requirements)

Quality Characteristic	Units	Monitoring Frequency
5-day Biochemical Oxygen Demand (uninhibited)	mg/L	Monthly
pH	pH units	Monthly
Thermotolerant coliforms	Colonies per 100mL	Monthly
Total nitrogen	mg/L	Monthly
Total phosphorus	mg/L	Monthly

H7	If treated sewage effluent is being released in accordance with condition **H3(c)**: a) the results of monitoring in accordance with condition **H6** must not exceed the release limits specified in **Table H2 (Treated Sewage Effluent Contaminant Release Limits)**; and b) the release must not cause spray drift or over spray to any sensitive place or commercial place.
H8	If the release limits specified in **Table H2 (Treated Sewage Effluent Contaminant Release Limits)** are exceeded in accordance with condition **H7(a)**, the environmental authority holder must notify the administering authority in accordance with conditions **A7** and **A8**.

Table H2 (Treated Sewage Effluent Contaminant Release Limits)

Quality Characteristic	Release Limit	Units	Limit Type
5-day Biochemical Oxygen Demand (uninhibited)	50	mg/L	Maximum
pH	6.0 to 9.0	pH units	Range
Thermotolerant coliforms, based on the average of a minimum of five samples collected	1000	Colonies per 100mL	Maximum

Schedule I: Groundwater	
Condition number	**Condition**
I1	The holder of this environmental authority must not release contaminants to groundwater.
I2	**Groundwater Monitoring and Management Program** A Groundwater Monitoring and Management Program must be: a) developed by an appropriately qualified person; and b) implemented by the environmental authority holder for all stages of mining activities.
I3	The Groundwater Monitoring and Management Program required by condition **I2** must: a) identify potential groundwater impacts due to the mining activities; b) include a site conceptual groundwater model; c) describe the sampling and monitoring methodology; d) detail an appropriate quality assurance and quality control program; and e) provide the process for notifying the administering authority and investigating exceedances in accordance with conditions **I4-I5.**
I4	**Groundwater Monitoring** Groundwater quality and standing water levels must be monitored: a) at the locations and at the frequencies specified in **Table I1 – Groundwater Monitoring Program**; and b) for the quality characteristics specified in **Table I2 – Groundwater Trigger Levels**.
I5	If the groundwater level or contaminant triggers defined in **Table I2 - Groundwater Trigger Levels** are exceeded on **three (3)** consecutive monitoring occasions, then the environmental authority holder must notify the administering authority via WaTERS within **twenty-four hours** of receiving the results.
I6	**Trigger investigation** If monitoring results from the compliance bores specified in **Table I1 – Groundwater Monitoring Program**, exceed any of the groundwater level or contaminant triggers defined in **Table I2 - Groundwater Trigger Levels** on **three (3)** consecutive sampling occasions the environmental authority holder must complete an investigation within **fourteen (14) days** of receiving the results to determine if the exceedance is a result of: a) activities authorised under this environmental authority; or b) natural variation; or c) neighbouring land use resulting in groundwater impacts.

I7	The holder of this environmental authority must provide a report of the investigation to the administering authority via WaTERS within **fourteen (14) days** of completion of the investigation under **condition I6**.
I8	If the investigation under condition **I6** determines that the **three (3)** consecutive exceedances were the result of activities authorised under this environmental authority, then a further investigation must be completed within **twenty-eight (28) days** of provision of the report under I7. The investigation must determine the source, cause and extent of contamination (environmental harm) and implement appropriate mitigation and management measures to address any groundwater contamination and prevent recurrence of groundwater contamination. The further investigation report must be provided to the administering authority via WaTERS within **twenty-eight (28) days** of completion.
I9	The Groundwater Monitoring and Management Program must be reviewed by **31 November 2023** and thereafter every **two (2) years** by an appropriately qualified person. The review report must: a) analyse the results of groundwater monitoring to: i. describe any impacts to groundwater levels and groundwater quality due to the mining activity; ii. determine trends in groundwater levels and groundwater quality; b) assess any differences between the groundwater level impact predicted and actual impacts for corresponding periods in the most current numerical groundwater model; and c) provide recommendations to the environmental authority holder to address the findings of parts (a) and (b) of the review.
I10	Within **twenty (20) business days** of receiving the review report required by condition **I9**, the environmental authority holder must provide to the administering authority: a) the review report; b) if applicable, any actions being taken by the environmental authority holder to address the recommendations of the review report; and c) if action is not being taken to address a recommendation, the environmental authority holder must provide justification for not taking action.
I11	Annual groundwater monitoring data must be submitted to the administering authority via WaTERS by **30 September** each calendar year.
I12	**Bore construction** The construction, management, maintenance and decommissioning of groundwater monitoring bores must be undertaken in a manner that: a) prevents contaminants entering the groundwater; b) ensures the integrity of the bores to obtain representative groundwater samples from the target aquifer; and c) maintains the hydrogeological environment within the aquifer.

I13	The environmental authority holder must provide written confirmation to the administering authority that compliance bores OBS15, OBS16, OBS17 and OBS18 are installed and confirm the locations to be specified in **Table I1 – Groundwater Monitoring Program** no later than **30 May 2024**.
I14	By **30 May 2024** (or as otherwise agreed by administering authority), the holder of this environmental authority must: a) provide values to replace all 'TBC' in **Table I1 – Groundwater Monitoring program** to the administering authority; and b) Confirm the background water level (RL) for each bore in **Table I2 - Groundwater Trigger Levels** to measure drawdown.

Table I1 – Groundwater Monitoring Program

Monitoring Bore	Hydrogeological unit	Surface RL (mAHD)	Screened interval RL (mbg)	Location (GDA94)		Monitoring Frequency
				Easting	Northing	
Interpretation Bores						
OBS4 (MP11)	Rewan Group	229.3	62-65	626685	7562094	Quarterly
Compliance Bores						
OBS1 (MP7)	RCM Interburden	193.18	21-24	630111	7554627	Quarterly
OBS2 (MP8)	RCM Interburden	215.7	42-45	631405	7557531	Quarterly
OBS5 (MP12)	Alluvium	194.4	13-16	626050	7557202	Quarterly
OBS10	Leichhardt	194.36	56-59	627784	7556229	Quarterly
OBS8	Tertiary Unconsolidated Sand	192.94	8.9-11.9	631867	7553655	Quarterly
OBS15	Alluvium/Tertiary	TBC	TBC	TBC	TBC	Quarterly
OBS16	Permian	TBC	TBC	TBC	TBC	Quarterly
OBS17	Alluvium/Tertiary	TBC	TBC	TBC	TBC	Quarterly
OBS18	Permian	TBC	TBC	TBC	TBC	Quarterly
OBS19	TBC	TBC	TBC	TBC	TBC	Quarterly

Table I2 - Groundwater Trigger Levels

Quality Characteristic	Units	Trigger Levels				
		OBS4 (MP11)	OBS1 (MP7)	OBS2 (MP8)	OBS5 (MP12)	OBS10
Water Level	RL	Monitored for interpretative reasons only – no triggers apply	Greater than 2m from background excluding changes from pumping of licenced bores			
pH	pH units		6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
Electrical Conductivity	µS/cm		16,000	16,000	34,350	16,000
Sulfate	mg/L		398	398	1,860	398[1]
Dissolved Aluminium	mg/L		0.055	0.055	0.070	0.066[1]
Dissolved Antimony	mg/L		0.009[1]	0.009[1]	0.009[1]	0.009[1]
Dissolved Arsenic	mg/L		0.013	0.013	0.013	0.013[1]
Dissolved Iron	mg/L		1.3	2.0	1.4	0.7[1]
Dissolved Mercury	mg/L		0.0006	0.0006	0.0006	0.0006[1]
Dissolved Molybdenum	mg/L		0.034	0.034	0.034	0.034[1]
Dissolved Selenium	mg/L		0.011	0.011	0.011	0.011[1]
Dissolved Silver	mg/L		0.001[1]	0.001[1]	0.001[1]	0.001[1]
TPH C6-C10	µg/L		20	20	20	20
TPH >C10-C40	µg/L		100	100	100	100

NOTES:

1. *Fewer than the recommended 18 data points have been used to derive these trigger levels, therefore the adopted trigger levels are considered as interim and may require subsequent revision.*

END OF CONDITIONS

Definitions

Key terms and/or phrases used in this document are defined in this section. Environmental authority holders should note that where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

Acceptance criteria means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly disturbed by the mining activities. Acceptance criteria may include information regarding:

a) vegetation establishment, survival and succession;

b) vegetation productivity, sustained growth and structure development;

c) fauna colonisation and habitat development;

d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;

e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;

f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;

g) resilience of vegetation to disease, insect attack, drought and fire; and

h) vegetation water use and effects on ground water levels and catchment yields.

Acid rock drainage means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

Administering authority is the agency or department that administers the environmental authority provisions under the *Environmental Protection Act 1994*.

Airblast overpressure means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

Alternative arrangement in relation to a sensitive place or a commercial place, means:

a) A written agreement:
   i. between the environmental authority holder and a third party;
   ii. that identifies a particular type(s) of environmental nuisance;
   iii. about the way in which the particular environmental nuisance impact(s) will be dealt with;
   iv. at a particular location; and
   v. for a defined period of time.

b) An alternative arrangement must make clear to the third party that by entering in to the agreement that:
   i. their place will be excluded as a sensitive place or commercial place; and
   ii. the consequences of exclusion as a sensitive place or commercial place.

Note: An alternative arrangement may include, but is not limited to, details of the nuisance abatement measures to be implemented, provision of alternative accommodation, or agreement between the parties that the location will not be considered a sensitive place or commercial place for the purposes of the Environmental Authority, for the duration of the alternative arrangement. The written agreement may be in any form, with some examples being a lease, or an agistment, or a conduct and compensation agreement under the *Mineral Resources Act 1989*.

Annual exceedance probability or AEP means the probability that at least one event in excess of a particular magnitude will occur in any given year.

Annual inspection report means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan):

a) against recommendations contained in previous annual inspections reports;

b) against recognised dam safety deficiency indicators;

c) for changes in circumstances potentially leading to a change in consequence category;

d) for conformance with the conditions of this authority;

e) for conformance with the 'as constructed' drawings;

f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems); and

g) for evidence of conformance with the current operational plan.

ANZECC means the Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000

Appropriately qualified person means 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 relative to the subject matter using the relevant protocols, standards, methods or literature.

Assessed or assessment by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

a) exactly what has been assessed and the precise nature of that determination;

b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

Associated works in relation to a dam, means:

a) operations of any kind and all things constructed, erected or installed for that dam; and

b) any land used for those operations.

Authority means an environmental authority or a development approval.

Bed and banks for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

Beneficial use in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

a) of benefit to that owner in that it adds real value to their business or to the general community;

b) in accordance with relevant provisions of the *Environmental Protection Act 1994*;

c) sustainable by virtue of written undertakings given by that owner to maintain that dam; and

d) the transfer and use have been approved or authorised under any relevant legislation.

Biosolids means the treated and stabilised solids from sewage.

Blasting means the use of explosive materials to fracture:

a) rock, coal and other minerals for later recovery; or

b) structural components or other items to facilitate removal from a site or for reuse.

Bulk rubber means tyres, conveyor belt, and other similar rubber waste.

Certification in relation to regulated structures, means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* or this environmental authority, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A).

Certifying, certify or certified have a corresponding meaning as 'certification' in relation to regulated structures.

Chemical means:

a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)*; or

b) a dangerous good under the dangerous goods code; or

c) a lead hazardous substance within the meaning of the Workplace Health and Safety Regulation 1997; or

d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or

e) any substance used as, or intended for use as:

   i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or

   ii. a surface active agent, including, for example, soap or related detergent; or

   iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or

   iv. a fertiliser for agricultural, horticultural or garden use; or

f) a substance used for, or intended for use for:

   i. mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

   ii. manufacture of plastic or synthetic rubber.

Commercial place means:

a) A work place that is used as:
   i. an office; or
   ii. a place of business; or
   iii. a place used for commercial purposes.

b) Despite paragraph (a), the following places are not commercial places:
   i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or
   ii. places that are part of the mining activity; or
   iii. employees accommodation or public roads; or
   iv. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.

c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a commercial place for the purposes of that type(s) of environmental nuisance, however remains a commercial place for the purpose of other types of environmental nuisances.

Consequence in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

Consequence category means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

Construction or constructed in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

Contaminate means to render impure by contact or mixture.

Contaminated means the substance has come into contact with a contaminant.

Contaminant can be

a) a gas, liquid or solid; or

b) an odour; or

c) an organism (whether alive or dead), including a virus; or

d) energy, including noise, heat, radioactivity and electromagnetic radiation; or

e) a combination of contaminants.

Control measure means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

Dam means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

Dam crest volume means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

Design plan is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

Design storage allowance or DSA means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

Designer for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

Disturbance of land includes:

a) compacting, removing, covering, exposing or stockpiling of earth;

b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;

c) carrying out mining within a watercourse, waterway, wetland or lake;

d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;

e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased; or

f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of disturbance:

a) areas off lease (e.g. roads or tracks which provide access to the mining lease);

b) areas previously disturbed which have achieved the rehabilitation outcomes;

c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective due to circumstances beyond the control of the mine operator (such as climatic conditions);

d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner; or

e) disturbance that pre-existed the grant of the tenure.

Dwelling means any of the following structures or vehicles that is principally used as a residence:

a) a house, unit, motel, nursing home or other building or part of a building; or

b) a caravan, mobile home or other vehicle or structure on land; or

c) a water craft in a marina.

Effluent means treated waste water released from sewage treatment plants.

Emergency action plan means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact.

EPBC means the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

EPBC Poitrel Mine Approval 2004/1770 means the referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999, reference number 2004/1170.*

End of pipe means the location at which water is released to waters or land.

Environmental authority means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

Environmental authority holder means the holder of this environmental authority.

Environmentally relevant activity means an environmentally relevant activity as defined under section 18 of the *Environmental Protection Act 1994*.

ERC decision means a decision made by the administering authority under section 300 of the *Environmental Protection Act 1994* about the estimated rehabilitation cost for a resource activity.

ERC period for the estimated rehabilitation cost for a resource activity, means:

a) if a PRCP schedule applies for the activity, the period of between 1 and 5 years stated in the application for an ERC decision under section 298(2)(b); or

b) if the activity is a petroleum activity that is an ineligible ERA, other than a petroleum activity to which a plan of operations applies, or the activity relates to a 1923 Act petroleum tenure granted under the Petroleum Act 1923, the period of between 1 and 5 years stated in the ERC decision about the estimated rehabilitation cost; or

c) if a plan of operations applies for the activities, the plan period for the plan of operations; or otherwise, the total period during which the resource activity is likely to be carried out under the environmental authority for the activity.

Estimated rehabilitation cost (ERC) for a resource activity, see section 300(2) of the *Environmental Protection Act 1994*.

Existing authority has the meaning in section 94 of the *Environmental Offsets Act 2014*.

Existing structure means a structure that was in existence prior to 7 August 2014.

Extreme storm storage means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Floodwater means water overflowing, or that has overflowed, from waters, river, creek, stream, lake, pond, wetland or dam onto or over riparian land that is not submerged when the watercourse or lake flows between or is contained within its bed and banks.

Flowable substance means matter or a mixture of materials that can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

Foreseeable future is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

General waste means waste other than regulated waste.

Hazardous waste means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

Highwall Mining (HWM) is a method for recovering coal by boring, or cutting, into a coal seam from a face exposed by an existing excavation.

Holder, for a mining tenement, means a holder of the tenement under the *Mineral Resources Act 1989*, and the holder of the associated environmental authority under the *Environmental Protection Act 1994*.

Hydraulic performance means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

Inert waste means bricks, pavers, ceramics, concrete, glass, steel, or similar waste that does not biodegrade or decompose.

Infrastructure means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long-term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the mining leases or the background land owner.

$L_{A\ eq,\ adj,\ 1\ hour}$ means an A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within a 1 hour period has the same mean square sound pressure of a sound that varies with time.

$L_{A\ 1,\ adj,\ 10\ mins}$ means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response.

Lake includes:

a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and

b) the bed and banks and any other element confining or containing the water.

Land in the "land schedule" of this document means land excluding waters and the atmosphere.

Land use describes the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

Levee means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

Low consequence dam means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635).*

Mandatory reporting level or MRL means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Manual means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Matters of state environmental significance or MSES has the meaning in schedule 2 of the *Environmental Offsets Regulation 2014*.

Maximum extent of impact means the total, cumulative, residual extent and duration of impact to a prescribed environmental matter that will occur over a project's life after all reasonable avoidance and reasonable on-site mitigation measures have been, or will be, undertaken.

mbgl means metres below ground level.

mg/L means milligrams per litre.

Mechanically reprocessing waste includes mechanically crushing, milling, grinding, shredding or sorting waste, whether or not for the purpose of recycling the waste.

Mine affected water means the following types of water:

a) pit water, tailings dam water, processing plant water;

b) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;

c) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage runoff containing sediment only, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;

d) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;

e) groundwater from the mine's dewatering activities; or

f) a mix of mine affected water (under any of paragraphs (a) to (e)) and other water.

Mineral means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes:

a) clay if mined for use for its ceramic properties, kaolin and bentonite;

b) foundry sand;

c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from;

d) limestone if mined for use for its chemical properties;

e) marble;

f) mineral oil or gas extracted or produced from shale or coal by in situ processes;

g) peat;

h) salt including brine;

i) shale from which mineral oil may be extracted or produced;

j) silica, including silica sand, if mined for use for its chemical properties; or

k) rock mined in block or slab form for building or monumental purposes.

But does not include:

a) living matter;

b) petroleum within the meaning of the *Petroleum Act 1923*;

c) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form; or

d) water.

Mining activities means the activities:

a) authorised as per the definition in section 110 of the *Environmental Protection Act 1994*; and

b) all environmentally relevant activities authorised under this environmental authority; and

c) waste activities.

Modification or modifying (see definition of 'construction').

Natural flow means the flow of water through waters caused by nature.

Notice of election has the meaning in section 18(2) of the *Environmental Offsets Act 2014.*

Noxious means harmful or injurious to health or physical wellbeing.

Offensive means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

Operational plan includes:

a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance); and

b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

Peak particle velocity or ppv means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mm/s).

Prescribed environmental matters has the meaning in section 10 of the *Environmental Offsets Act 2014*, limited to the matters of State environmental significant listed in schedule 2 of the *Environmental Offsets Regulation 2014*.

Protected area means:

a) a protected area under the *Nature Conservation Act 1992*; or

b) a marine park under the *Marine Parks Act 1992*; or

c) a World Heritage Area.

Progressive rehabilitation means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

Receiving environment, in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

a) a watercourse;

b) groundwater;

c) land; and

d) sediments.

Receiving waters means the waters into which this environmental authority authorises releases of mine affected water.

Reference site (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

Register of Regulated Structures includes:

a) date of entry in the register;

b) name of the dam, its purpose and intended/actual contents;

c) the consequence category of the dam as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*;

d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all document lodged as part of a design plan for the dam;

e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;

f) for the regulated dam, other than in relation to any levees –

i. the dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;

ii. coordinates (latitude and longitude in GDA64) within five metres at any point from the outside of the dam including its storage area

iii. dam crest volume (megalitres);

iv. spillway crest level (metres AHD).

v. maximum operating level (metres AHD);

vi. storage rating table of stored volume versus level (metres AHD);

vii. design storage allowance (megalitres) and associated level of the dam (metres AHD);

viii. mandatory reporting level (metres AHD);

g) the design plan title and reference relevant to the dam;

h) the date construction was certified as compliant with the design plan;

i) the name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;

j) details of the composition and construction of any liner;

k) the system for the detection of any leakage through the floor and sides of the dam;

l) dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;

m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority; and

n) dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

Regulated dam means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Regulated structure includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.

Regulated waste is defined in the *Environmental Protection Regulation 2008*.

Rehabilitation means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

Rejects means:

a) breaker rejects; or

b) coarse rejects; or

c) mid/fine size rejects; or

d) tailings that have been dewatered; or

e) any combination of rejects (under any of paragraphs a to d).

Representative means a sample set that covers the variance in monitoring or other data due to either natural changes or operational phases of the mining activities.

Reprocessing includes:

a) recycling; or

b) mechanical treatment; or

c) thermal treatment; or

d) biological treatment; or

e) chemical treatment.

Residual void means an open pit resulting from the removal of ore and/or waste rock that will remain following the cessation of all mining activities and completion of rehabilitation processes.

Resource activity is an activity that involves

a) a geothermal activity; or

b) a GHG storage activity; or

c) a mining activity; or

d) a petroleum activity.

Saline drainage is the movement of waters, contaminated with salt, as a result of the mining activity.

Scheme fund means the scheme fund established under section 24 of the *Mineral and Energy Resources (Financial Provisioning) Act 2018*.

Self-sustaining means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

Sensitive place means:

a) Any of the following:

i. a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

ii. a motel, hotel or hostel; or

iii. an educational institution; or

iv. a medical centre or hospital; or

v. a protected area; or

vi. a public park or gardens.

b) Despite paragraph (a), the following places are not sensitive places:

i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or

ii. a mining camp (i.e. accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority), whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the environmental authority holders for the mining project, or a related company; or

iii. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.

c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a sensitive place for the purposes of that type(s) of environmental nuisance, however remains a sensitive place for the purpose of other types of environmental nuisances.

Sewage means the used water of persons to be treated at a sewage treatment plant.

Significant residual impact has the meaning in section 8 of the *Environmental Offsets Act 2014*.

Spillway means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

Stable in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

Stormwater means all surface water runoff from rainfall.

Structure means dam or levee.

Sub-surface disturbance means the excavation below natural ground level for the removal of overburden and coal, and does not mean excavation associated with water management structures or other infrastructure.

Suitably qualified and experienced person in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and has demonstrated competency and relevant experience:

a) for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design.

b) for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

Surface disturbance means all disturbance, including excavation associated with water management structures or other infrastructure, other than sub-surface disturbance.

System design plan means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

Tailings means fines from mineral processing that have not been dewatered.

The Act means the *Environmental Protection Act 1994*.

Void means any constructed, open excavation in the ground.

Waste as defined in section 13 of the *Environmental Protection Act 1994*.

Waste activities means receiving, storing, disposing, treating, or reprocessing wastes, and does not include composting.

Waste and resource management hierarchy has the meaning given by section 9 of the *Waste Reduction and Recycling Act 2011*.

Water quality means the chemical, physical and biological condition of water.

Watercourse has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means a river, creek or stream in which water flows permanently or intermittently:

a) in a natural channel, whether artificially improved or not; or

b) in an artificial channel that has changed the course of the watercourse.

Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

Waters includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

WaTERS means the Water Tracking and Electronic Reporting System.

Wet season means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination, this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

µg/L means micrograms per litre.

µS/cm means microsiemens per centimetre.

END OF DEFINITIONS

Figure 1 (Authorised Surface and Sub-Surface Disturbance Areas and Highwall Mining Area)

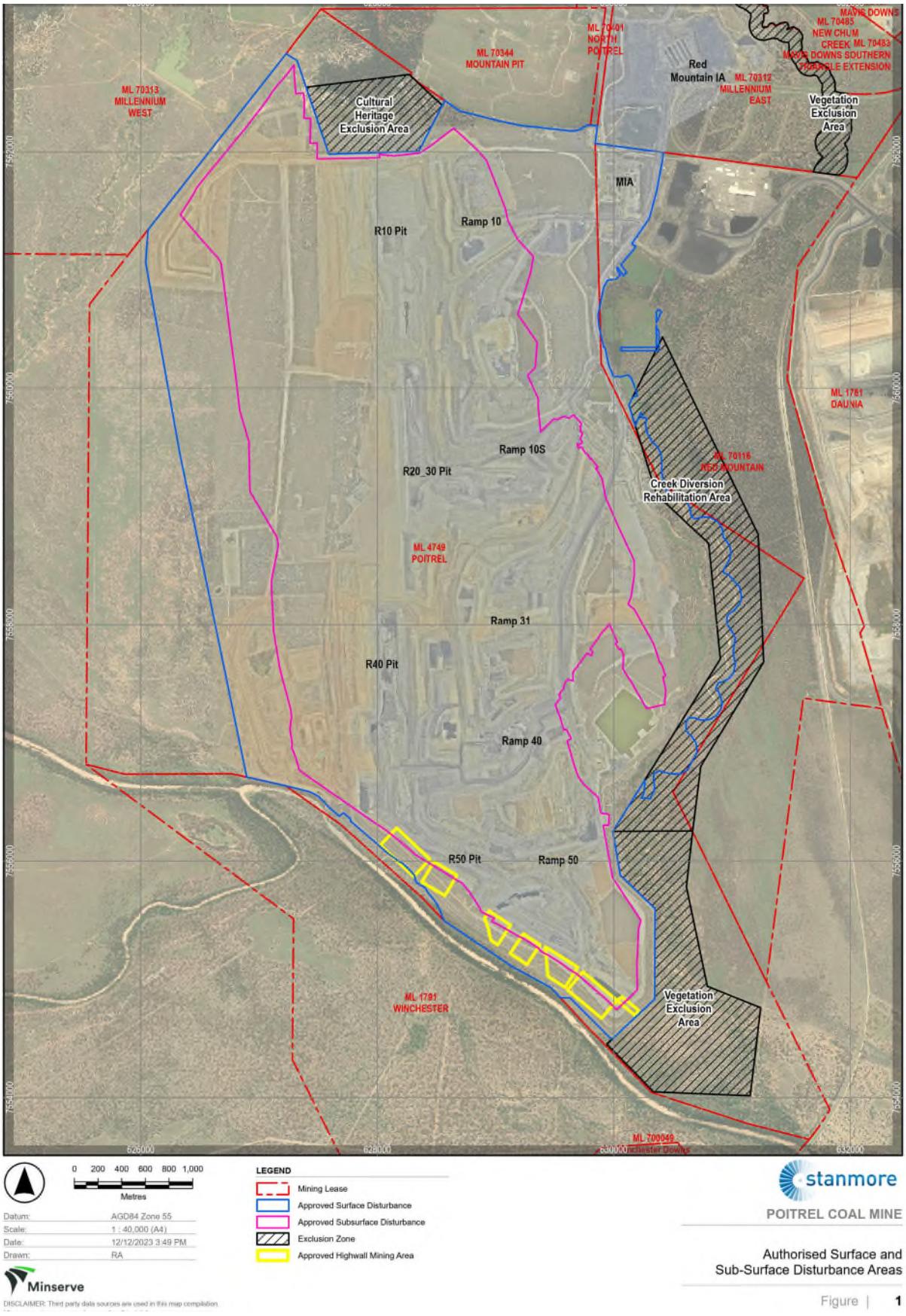
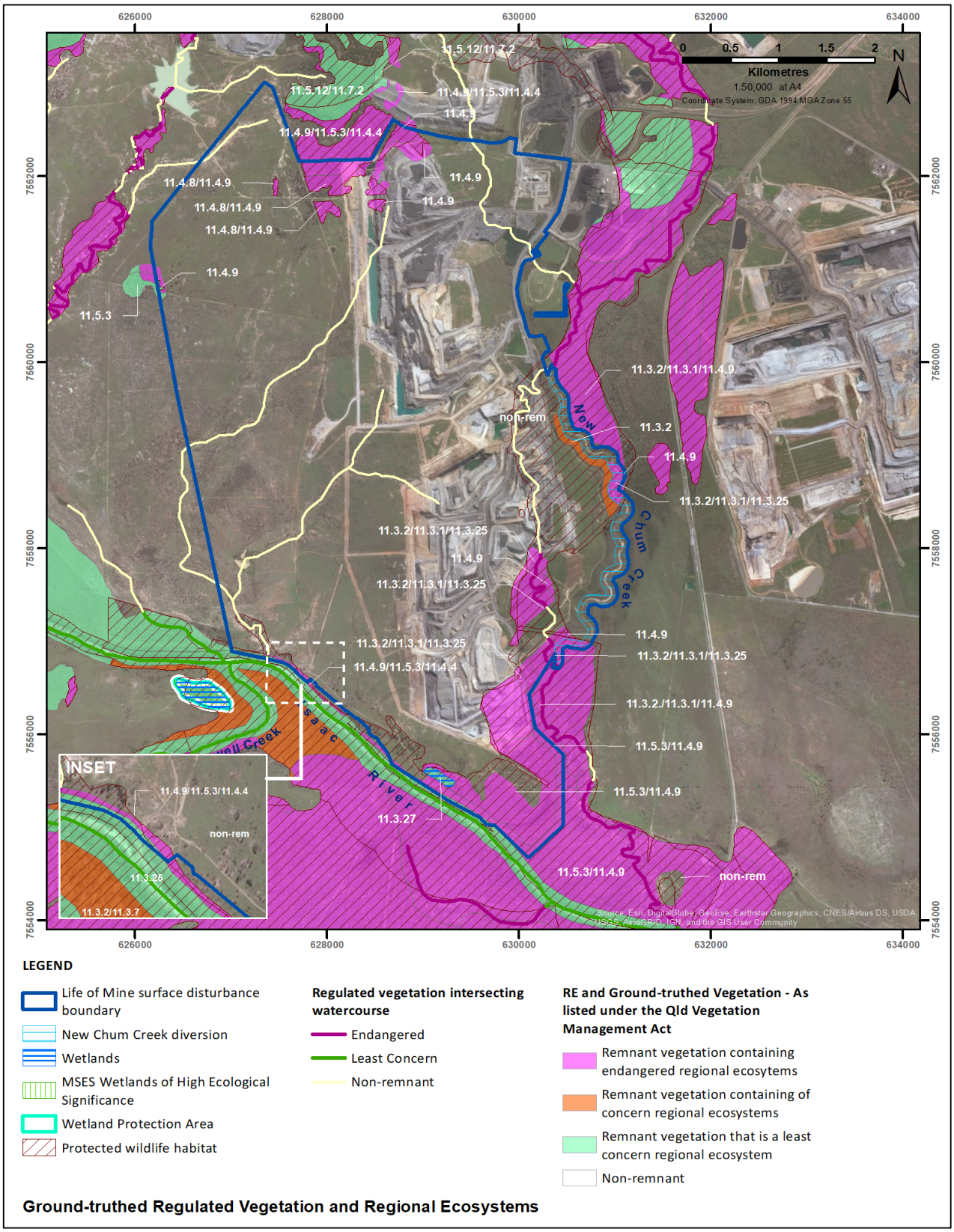


Figure 2 (Ground-truthed Regulated Vegetation and Regional Ecosystems)



LEGEND

- Life of Mine surface disturbance boundary
- New Chum Creek diversion
- Wetlands
- MSES Wetlands of High Ecological Significance
- Wetland Protection Area
- Protected wildlife habitat

Regulated vegetation intersecting watercourse

- Endangered
- Least Concern
- Non-remnant

RE and Ground-truthed Vegetation - As listed under the Qld Vegetation Management Act

- Remnant vegetation containing endangered regional ecosytems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Non-remnant

Ground-truthed Regulated Vegetation and Regional Ecosystems

END OF ENVIRONMENTAL AUTHORITY

Appendix 2 Progressive Rehabilitation and Closure Plan Transition Notice and Extension Notice

Notice

Environmental Protection Act 1994

Progressive rehabilitation and closure plan transition notice

This statutory notice is issued by the administering authority[1] under section 754 of the Environmental Protection Act 1994 *to advise you that you must submit a proposed Progressive rehabilitation and closure plan (PRC plan).*

BHP Billiton Mitsui Coal Pty Ltd
Level 14, 480 Queen Street
BRISBANE CITY QLD 4000

Email: peter.conway@bhp.com; trudy.mazucco@bhp.com

Attention: Peter Conway & Trudy Mazucco

Our reference: EPML00963013

Transition Notice for a PRC plan

1 Environmental authority details

Environmental authority EPML00963013 dated 29 July 2020 issued to BHP Billiton Mitsui Coal Pty Ltd.

Land description: ML4749 and ML70116.

2 Required action

The holder(s) of environmental authority EPML00963013 must submit a proposed PRC plan that meets the requirements in sections 126C and 126D of the *Environmental Protection Act 1994,* pursuant to section 754 of the *Environmental Protection Act 1994*. The holder(s) must submit the proposed PRC plan to the administering authority, by **1 July 2023**.

3 Transitional provisions

Pursuant to the transitional provisions in section 754(3) of the *Environmental Protection Act 1994*, the holder(s) of the environmental authority is/are not required to comply with the requirements under section 126C(1)(g) or (h), or 126D(2) or (3) of the *Environmental Protection Act 1994* if–

(a) an outcome for the land has been identified under a land outcome document; and

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

A land outcome document is defined under section 750 of the *Environmental Protection Act 1994*.

[1] The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

Queensland Government

Section 126C(1)(g) or (h), or 126D(2) of the *Environmental Protection Act 1994* require reasons and evidence to be provided to support a proposed non-use management area.

Section 126D(3) of the *Environmental Protection Act 1994* provides for any void that is contained wholly or partly in a flood plain to be rehabilitated to a stable condition.

In accordance with section 754(4) of the *Environmental Protection Act 1994*, if a land outcome document does not state sufficient detail to identify either the location or area of the land to which the outcome relates, the proposed PRC plan must state–

(a) if the area is not identified — how the total area of the land to which the outcome relates will be minimised; and

(b) if the location is not identified — how the mining environmental authority holder will ensure the location of the land to which the outcome relates minimises risks to the environment.

4 Supporting information

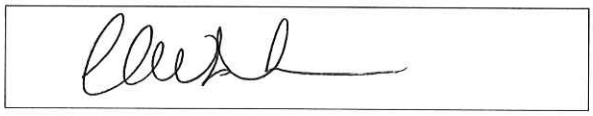
As detailed in section 2 of this notice, your PRC plan and associated PRCP schedule is required to address the relevant legislative requirements.

Please refer to the guideline Progressive Rehabilitation and Closure Plans (ESR/2019/4964) for more information about the requirements of the PRC plan and associate PRCP schedule, and the assessment process.

5 Consultation

The administering authority recommends that you request a pre-lodgement meeting to discuss the requirements of the proposed PRC plan in more detail. To request a pre-lodgement meeting, please completed and lodge the form 'Application for pre-lodgement services' (ESR/2015/1664) to arrange a meeting.

Should you have any questions in relation to this notice, please contact Alison Sinclair on telephone 0436 693 333.



Signature

3 December 2020

Date

Chris Wake
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Coal Business Centre
Department of Environment and Science
PO Box 3028, Emerald QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Notice

Environmental Protection Act 1994

Progressive rehabilitation and closure plan transition notice

This amended statutory notice is issued by the administering authority[1] under section 24AA if the Acts Interpretation Act 1954 and section 754 of the Environmental Protection Act 1994 to advise you that you must submit a proposed Progressive rehabilitation and closure plan (PRC plan).

Stanmore SMC Pty Ltd
Level 32, 12 Creek St
BRISBANE CITY QLD 4000
By email transmission only

Email: kylie.catterall@stanmore.net.au

Attention: Kylie Catterall

Our reference: EPML00963013

Transition Notice for a PRC plan

1 Environmental authority details

Environmental authority EPML00963013 dated 12 July 2022 issued to Stanmore SMC Pty Ltd

Land description: ML4749 and ML70116.

2 Required action

The holder(s) of environmental authority EPML00963013 must submit a proposed PRC plan that meets the requirements in sections 126C and 126D of the *Environmental Protection Act 1994,* pursuant to section 754 of the *Environmental Protection Act 1994*.

The original transition notice issued on 3 December 2020 required the holder to submit the proposed PRC plan to the administering authority by 1 July 2023. This time period has been amended. The holder(s) must now submit the proposed PRC plan to the administering authority by **1 July 2024.**

3 Transitional provisions

Pursuant to the transitional provisions in section 754(3) of the *Environmental Protection Act 1994*, the holder(s) of the environmental authority is/are not required to comply with the requirements under section 126C(1)(g) or (h), or 126D(2) or (3) of the *Environmental Protection Act 1994* if–

[1] The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

Queensland Government

(a) an outcome for the land has been identified under a land outcome document; and

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

A land outcome document is defined under section 750 of the *Environmental Protection Act 1994*.

Section 126C(1)(g) or (h), or 126D(2) of the *Environmental Protection Act 1994* require reasons and evidence to be provided to support a proposed non-use management area.

Section 126D(3) of the *Environmental Protection Act 1994* provides for any void that is contained wholly or partly in a flood plain to be rehabilitated to a stable condition.

In accordance with section 754(4) of the *Environmental Protection Act 1994*, if a land outcome document does not state sufficient detail to identify either the location or area of the land to which the outcome relates, the proposed PRC plan must state–

(a) if the area is not identified — how the total area of the land to which the outcome relates will be minimised; and

(b) if the location is not identified — how the mining environmental authority holder will ensure the location of the land to which the outcome relates minimises risks to the environment.

4 Supporting information

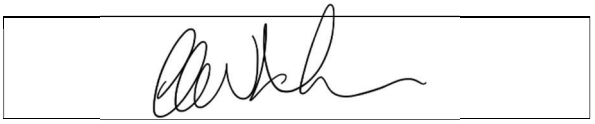
As detailed in section 2 of this notice, your PRC plan and associated PRCP schedule is required to address the relevant legislative requirements.

Please refer to the guideline Progressive Rehabilitation and Closure Plans (ESR/2019/4964) for more information about the requirements of the PRC plan and associate PRCP schedule, and the assessment process.

5 Consultation

The administering authority recommends that you request a pre-lodgement meeting to discuss the requirements of the proposed PRC plan in more detail. To request a pre-lodgement meeting, please completed and lodge the form 'Application for pre-lodgement services' (ESR/2015/1664) to arrange a meeting.

Should you have any questions in relation to this notice, please contact Luke Taylor on telephone number (07) 4987 9335.



Signature

25/10/2022

Date

Chris Wake
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Coal Business Centre
Department of Environment and Science
PO Box 3028, Emerald QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Appendix 3 Hydrogeology Assessment (3 May 2024)

Poitrel Mine

PRCP Hydrogeology Assessment

Stanmore Resources

Prepared by:

SLR Consulting Australia

Level 16, 175 Eagle Street, Brisbane QLD 4000,
Australia

SLR Project No.: 620.31445.00000

3 May 2024

Revision: 01

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	3 May 2024	Jade Darvell / Maryam Kahe	Derwin Lyons	Derwin Lyons
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Stanmore Resources (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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Appendices

Appendix A Recovery Model Starting Heads

1.0 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Stanmore Resources Limited (Stanmore) to undertake a hydrogeological assessment supporting the Poitrel Mine (PTM) Progressive Rehabilitation and Closure Plan (PRCP). This hydrogeological assessment is undertaken in accordance with the relevant requirements of the Queensland Government Department of Environment and Science (DES) Guideline: Progressive Rehabilitation and Closure Plans (DES Reference: ESR/2019/4964, version 3.00, effective 4 April 2023) - "the Guideline" and will be integrated into the design of the rehabilitation strategies and selection of Post Mining Land Uses (PMLUs) and Non-Use Management Areas (NUMAs) within the Poitrel PRCP.

PTM is located 20 km southwest of Coppabella and 20 km southeast of Moranbah, approximately 140 km south-west of Mackay in the northern Bowen Basin, Queensland (**Figure 1-1**).

PTM operates under Environmental Authority (EA) EPML00963013. The following ML's intersect the EA (**Figure 1-1**):

- ML4749
- ML70116

PTM has a strike extent of 6 km north to south (**Figure 1-2**). The mine comprises a series of open-cut pits, and shares process and rail loading facilities with neighbouring Millennium Mine to the immediate north of PTM. Daunia Mine is located immediately to the east of PTM. Mining commenced at PTM in 2006 and has included the extraction of coal through open cut strip mining from a series of pits that progress in a general east to west direction (**Figure 1-2**). Mining activities to date have resulted in a continuous but partially backfilled void that includes a series of mining areas, which (from north to south) are designated Ramp 10, Ramp 30 and Ramp 40.

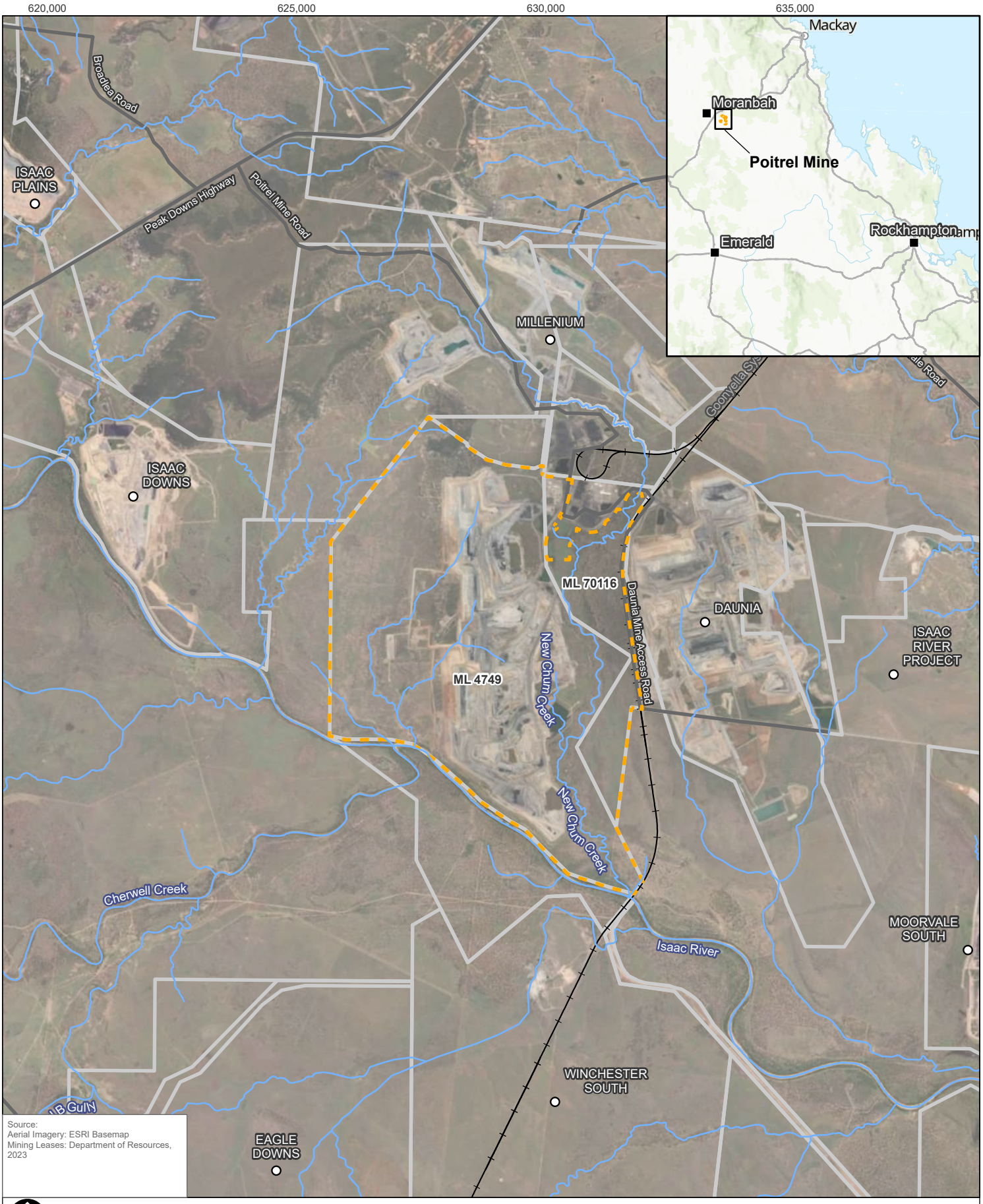
The most recent hydrogeological study relevant to the PTM PRCP is that undertaken for the PTM Highwall Mining Project (the HWM Project) EA amendment. That body of work has been drawn upon as directly relevant to this hydrogeological assessment, including the development of updated conceptual and numerical groundwater models for PTM as documented within SLR (2023a) and SLR (2023b) respectively.

For the purposes of this report:

- The PTM Area is synonymous with the PTM EA boundary (i.e. the area subject to EA EPML00963013) and is shown on **Figure 1-1**.
- The "Study Area" refers to the general regional area surrounding the PTM Area considered in detail within this assessment, necessary to inform the understanding of the regional scale groundwater system.

1.2 Final Landform

The post-mining final landform relevant to this hydrogeological assessment was provided by Stanmore and is shown as **Figure 1-3**. The final landform contains a single residual final void along the western and southern margins of the PTM Area, with the remaining mining areas subject to spoil backfill and rehabilitation.



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.31445.00000
Date Drawn:	28-Mar-2024
Drawn by:	RB

LEGEND

- Surrounding Mine
- Railway
- Road
- Watercourse
- Project Area
- Mining Lease

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

POITREL MINE LOCATION

SLR

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FIGURE 1-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F01_1_Poitrel Mine Location

Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.31445.00000
Date Drawn:	28-Mar-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Mining Lease
- Future Pit Extent
- Current Pit Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

MINING AREAS

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FIGURE 1-2

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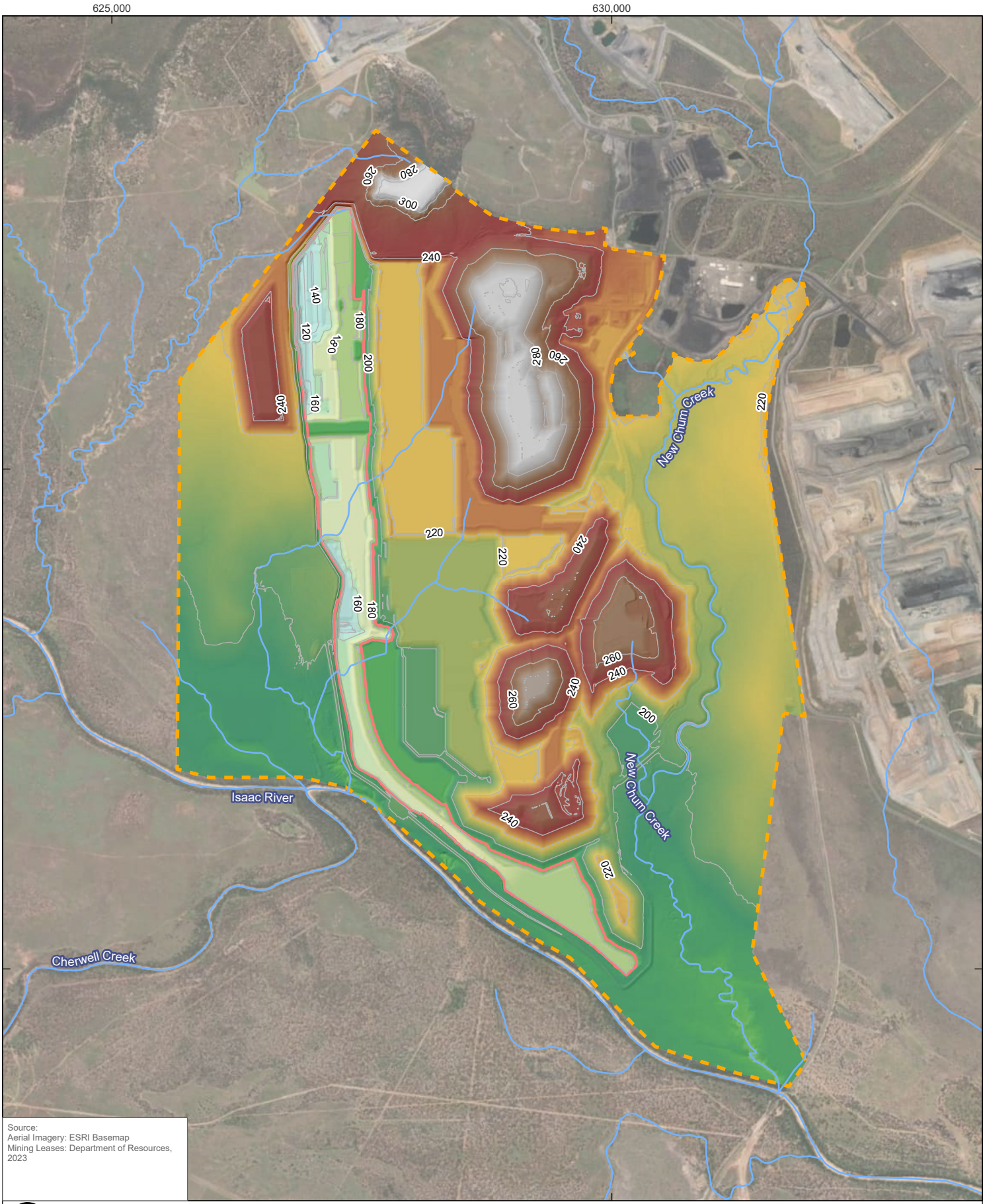

Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	30-Apr-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Void Extent
- Topographic Contour (20mAHD)

Final Landform Elevation (mAHD)

320

99

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

POST MINING LANDFORM

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FIGURE 1-3

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1.3 Objectives

The main objective of the hydrogeological assessment is to assess the potential groundwater related impacts at PTM at completion of mining and until conditions stabilise post rehabilitation (i.e. groundwater equilibrium). A focus of the hydrogeological assessment is demonstrating suitability of the final landform for the intended PLMUs with respect of the PTM groundwater system. As such, the key specific objectives adopted in this assessment from which to demonstrate this suitability are:

- That the final landform is non-polluting with respect to groundwater:
- Final voids are demonstrated to be sinks for groundwater, including groundwater contained within spoil.
- Final void lake levels remain below shallow groundwater levels, i.e. there is sufficient inwards head gradients from the shallow groundwater system to the lakes to negate risk of void water discharge to the shallow groundwater system.
- That there are minimal additional impacts to groundwater receptors post-closure caused by the final landform that have not already occurred as a result of approved mining:
    - Little to no additional groundwater drawdown at potential Groundwater Dependent Ecosystem (GDE) locations that has not already occurred as a result of approved mining.
    - Little to no additional groundwater drawdown at anthropogenic bore users that has not already occurred as a result of approved mining.

1.4 Guideline Criteria

As discussed above, this hydrogeological assessment is undertaken in accordance with the relevant requirements of the Guideline: Progressive Rehabilitation and Closure Plans. **Table 1-1** provides a cross reference table for the Guideline requirements as they pertain to this hydrogeology assessment.

Table 1-1 Guideline Requirements

Guideline Requirement	Section of this Report
Section 3.6.1 General rehabilitation practices – Hydrogeology	
Determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards	**Section 4.0** **Section 4.2**
Locating groundwater recharge and discharge locations locally and regionally	**Section 4.2**
Groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs)	**Section 4.4**
Current and potential future uses of groundwater including existing groundwater extraction bores	**Section 4.4.3** **Section 4.5.1**
Groundwater flow direction and velocity, including field tests to determine hydraulic conductivity	**Section 4.2** **Section 4.3**
The development of potentiometric mapping and hydro stratigraphic cross sections	**Section 4.2** **Section 5.0**
Groundwater modelling to determine contaminant transport and potential changes to groundwater level from dewatering or waste storage.	**Section 6.0**

2.0 Physical Setting

2.1 Climate

The climate of the Study Area is sub-tropical, with a distinct wet and dry season. The Queensland government operates a database of long-term climate data termed SILO (Scientific Information for Land Owners) with interpolation across a state wide grid based on observation stations (Queensland Government, 2024).

Historical climate data was obtained for the period from January 1970 to January 2024 from the SILO database for the grid point closest to the PTM Area (latitude -22.05, longitude 148.25) (**Table 2-1**). The SILO database provides the most comprehensive long-term dataset and is therefore the most useful for assessing long term rainfall and evaporation trends in the vicinity of the PTM Area.

Long-term average monthly rainfall, Moreton's areal actual evapotranspiration and Class A Pan evaporation from SILO is presented in **Table 2-1**. The Study Area is characterised by a long-term average rainfall of approximately 591 mm per year, with wetter conditions during the summer months of December, January and February and relatively dry conditions during the remainder of the year. As shown in **Figure 2-1** average monthly evaporation and evapotranspiration exceed rainfall in all months. Within the Study Area, the highest rate of evapotranspiration occurs along creek lines, where the water table is closer to ground surface and deeper-rooted vegetation is present.

To place rainfall over the years into an historical context, cumulative rainfall departure (CRD) was calculated for the full data period (**Figure 2-2**). This is a summation of the monthly departures of rainfall from the long-term average monthly rainfall. A rising slope in the CRD plot indicates periods of rainfall above the long-term average, as is the case from March 2022 to January 2023, whereas a falling slope indicates periods when rainfall is below the long-term average (e.g. May 2017 to May 2021). Rainfall volumes over the more recent period of the record (i.e. January 2023 to January 2024) have been lower than average, as is indicated by the falling slope in the CRD (**Figure 2-2**).

In addition, the CRD is used to assess the recharge of groundwater via rainfall. Where observed groundwater level trends mimic the pattern of the CRD curve, it is considered that natural fluctuations in the groundwater table can result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation can reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, as illustrated by the CRD. The CRD and observed groundwater levels are discussed as a means to characterise climatic conditions within the assessment of groundwater levels (see **Section 4.2**).

Table 2-1 Total Monthly Rainfall, Evaporation and Evapotranspiration (January 1970 to January 2024) - SILO

Average Total Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	103	90	64	33	33	22	23	22	11	32	67	91	591
Evaporation (class A Pan) (mm)	219	179	183	146	118	95	105	135	175	217	226	236	2,032
Evapotranspiration (Moreton's areal actual) (mm)	143	125	124	89	59	41	45	66	86	108	120	138	1,143

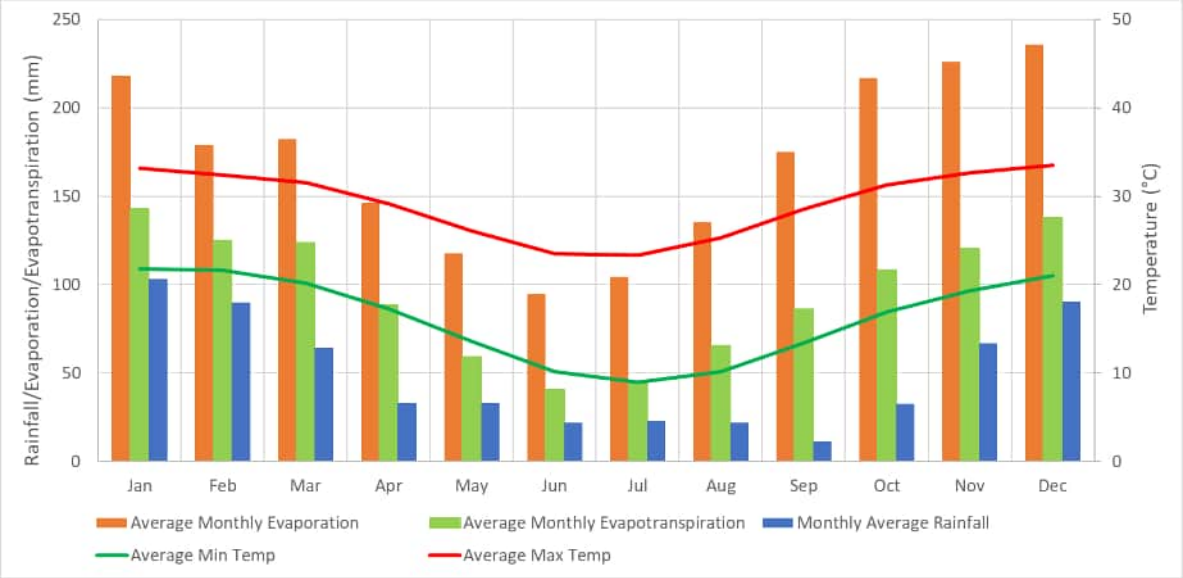


Figure 2-1 Average Monthly Evaporation, Evapotranspiration, Rainfall and Temperature (January 1970 to January 2024) - SILO

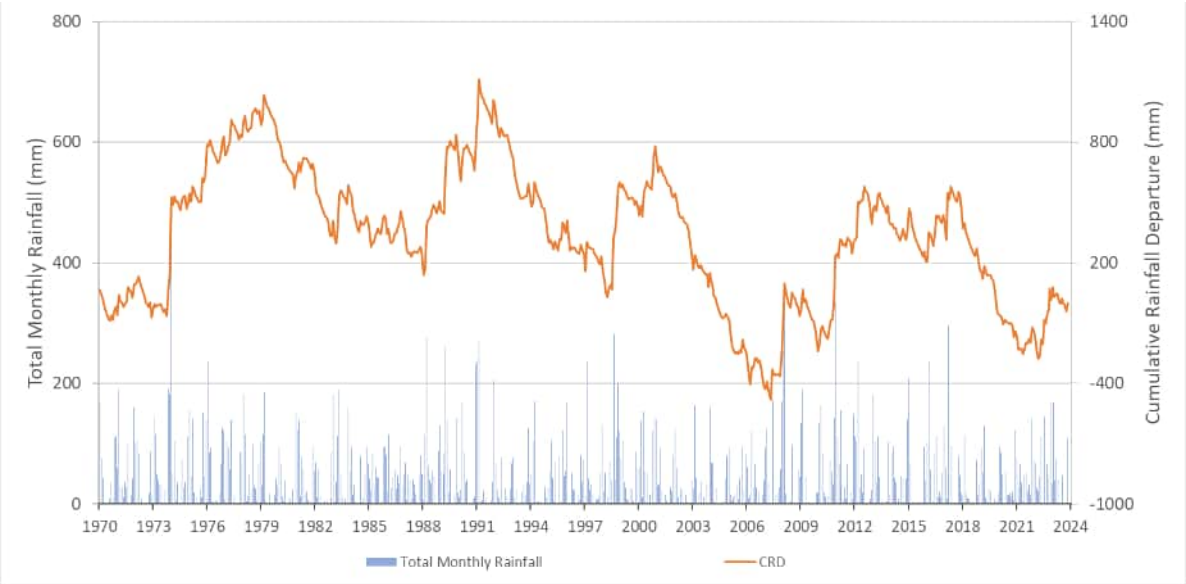


Figure 2-2 Cumulative Rainfall Departure and Total Monthly Rainfall – SILO

2.2 Topography and Drainage

PTM is located in the Isaac River drainage sub-basin of the Isaac-Connors surface water catchment, a sub-catchment of the upper Fitzroy Basin. The topography of the PTM Area generally slopes south-southeastwards towards the Isaac River, and regionally slopes towards the southeast. Topographic elevations of the PTM Area range from above 250 mAHD at the northern extent of PTM to 185 mAHD adjacent the Isaac River at the southeast end of PTM.

The Isaac River is the major drainage feature of the region and flows from northwest to southeast along the southern boundary of the PTM Area (**Figure 2-5**). Several minor tributaries join the Isaac River in the vicinity of PTM, including Cherwell Creek near the southwestern boundary of the site, and New Chum Creek which has been diverted as part of the PTM operation and now runs down the eastern portion of the site. Several smaller ephemeral streams also traverse the PTM site from west to east. The Isaac River (in the vicinity of the PTM Area) and tributaries including New Chum Creek are ephemeral and only flow briefly after rainfall. After significant rainfall, water can remain temporally in ponds on the Isaac River that are used as livestock water sources.

The closest Department of Regional Development, Manufacturing and Water (DRDMW) gauging station is the Isaac River at Deverill (station 130410A), located approximately 15 km downstream of the PTM Area. **Table 2-2** presents a summary of the stream gauge station data, derived from the DRDMW Water Monitoring Information Portal (WMIP).

Figure 2-3 presents daily mean stream discharge at the Isaac River at Deverill station (130410A) from 1968 to January 2023, compared against daily rainfall. The graphs show that flows within the Isaac River are typically ephemeral, with short-duration flows generally occurring over the summer months.

Based on daily flow data since 1968, **Figure 2-4** shows that the Isaac River flows only 27 percent of the time, with only 11 percent probability of flows exceeding 100 ML/day. Less than 1 percent of readings exceed 10,000 ML/day, which includes more recent high flow/flood events that occurred in in 2008 (January and February), 2010 (December), 2012 (March), 2016 (February), 2017 (March) and 2021 (January).

Table 2-2 DRDMW Stream Gauging Station Data – Isaac River at Deverill (130410A)

Station Location	Number	Distance from PTM	Zero-gauge Elevation (mAHD)	Mean Flow (ML/day)	Max Flow (GL/day)	Max Flow Date
Isaac River at Deverill	130410A	15 km downstream (southeast)	169.30	439	228	Mar 1988

ML/day = megalitres per day, GL/day = gigalitres per day.

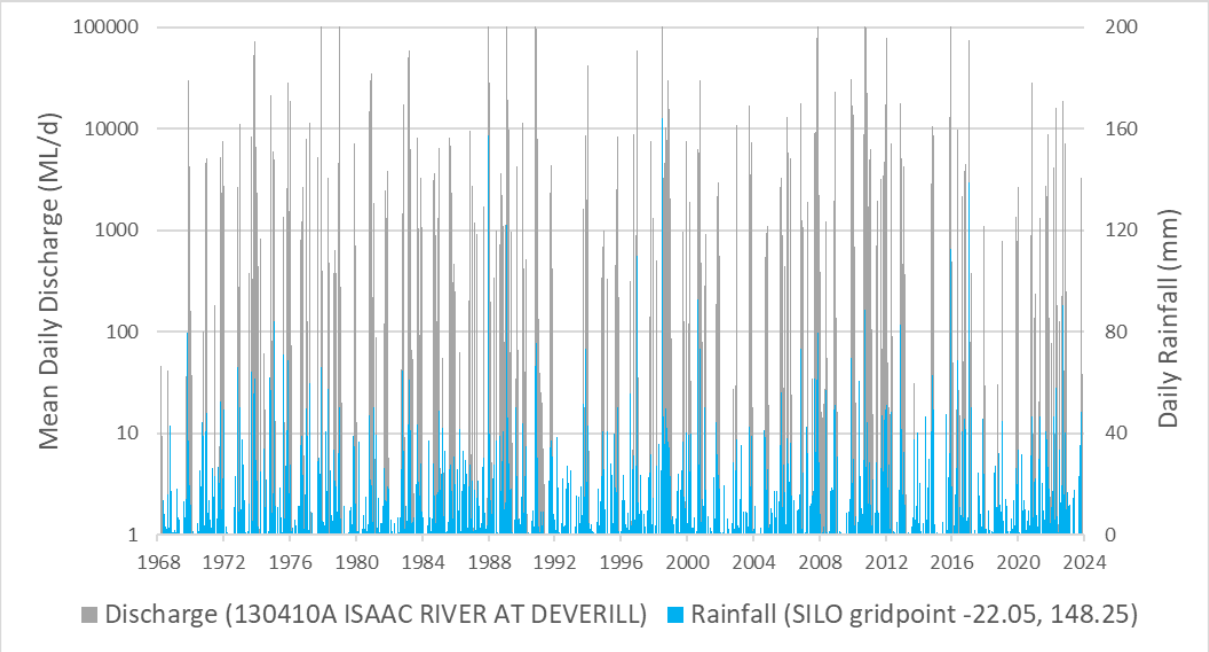


Figure 2-3 Daily Rainfall and Mean Stream Discharge at Isaac River (Station 130410A)

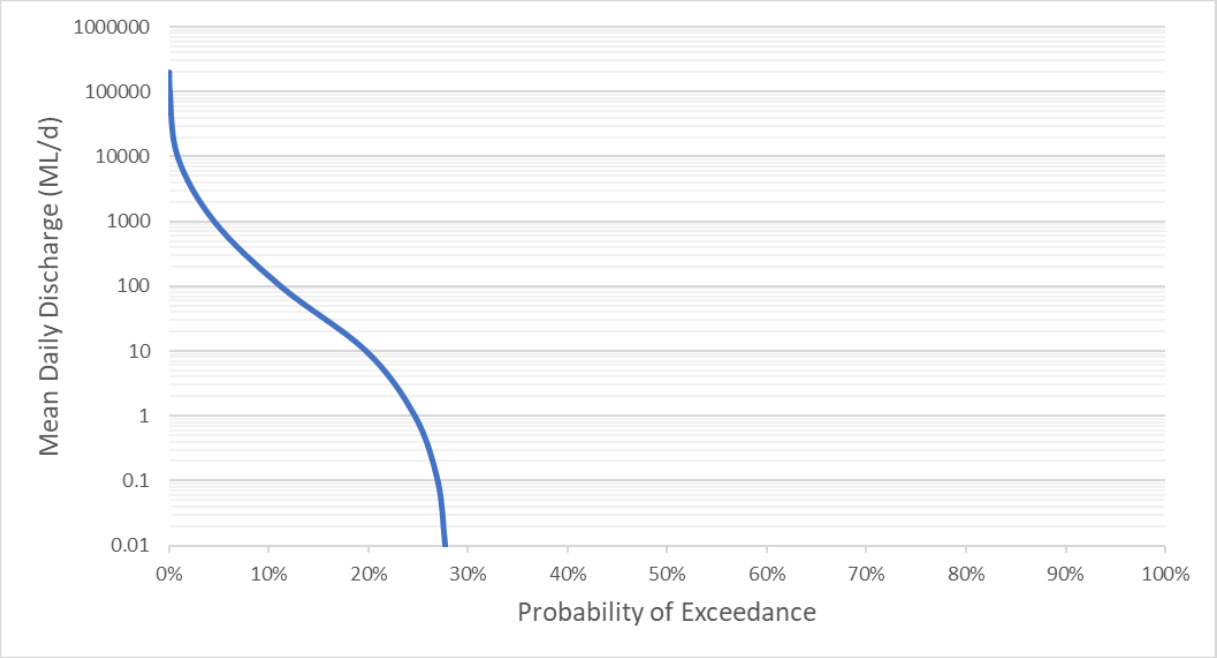
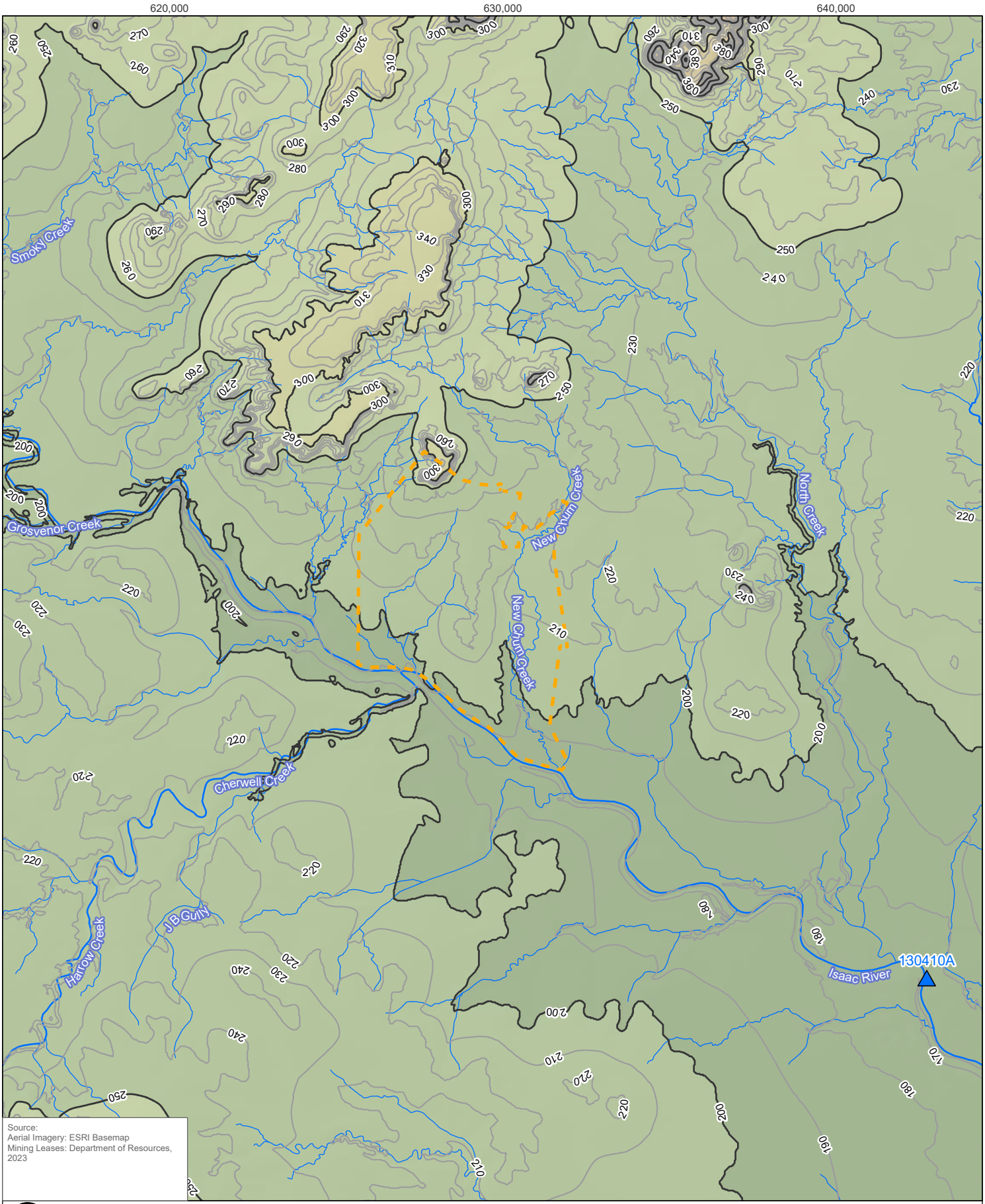


Figure 2-4 Stream Discharge Duration Curve (Station 130410A)



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.31445.00000
Date Drawn:	28-Mar-2024
Drawn by:	RB

LEGEND

- DRDMW Gauging Station
- Major Watercourse
- Minor Watercourse
- Topographic Contour (20m)
- Topographic Contour (5m)
- Project Area

Elevation (mAHD)

- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

TOPOGRAPHY AND DRAINAGE

SLR

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FIGURE 2-5

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F02_5_Topography and Drainage

2.3 Poitrel Mining

This section outlines the historical mine progression and future mining plan at PTM, as relevant to assessing the effect of PTM on the groundwater system. This is considered important since post-closure groundwater conditions assessed in the PRCP will in part be dictated by the conditions that are present as a result of existing mining activities at the time of closure.

2.3.1 Historical Mining Activities

PTM has been in operation since 2006. Mining has targeted the Leichhardt and Vermont Seams of the Rangal Coal Measures and has progressed in a general east to west direction. Mining activities to date have resulted in a continuous partially backfilled void that includes a series of mining areas, which (from north to south) are designated Ramp 10, Ramp 30 and Ramp 40. **Figure 2-6** provides a locality plan and timing for historic PTM mining, based on aerial imagery analysis developed for the PTM numerical groundwater model (see **Section 6.0**), noting that there may be an associated time-based error of approximately 1-2 years (SLR, 2023c). In all mining areas, spoil is deposited to the east of the active mine void adjacent to the pit ramps.

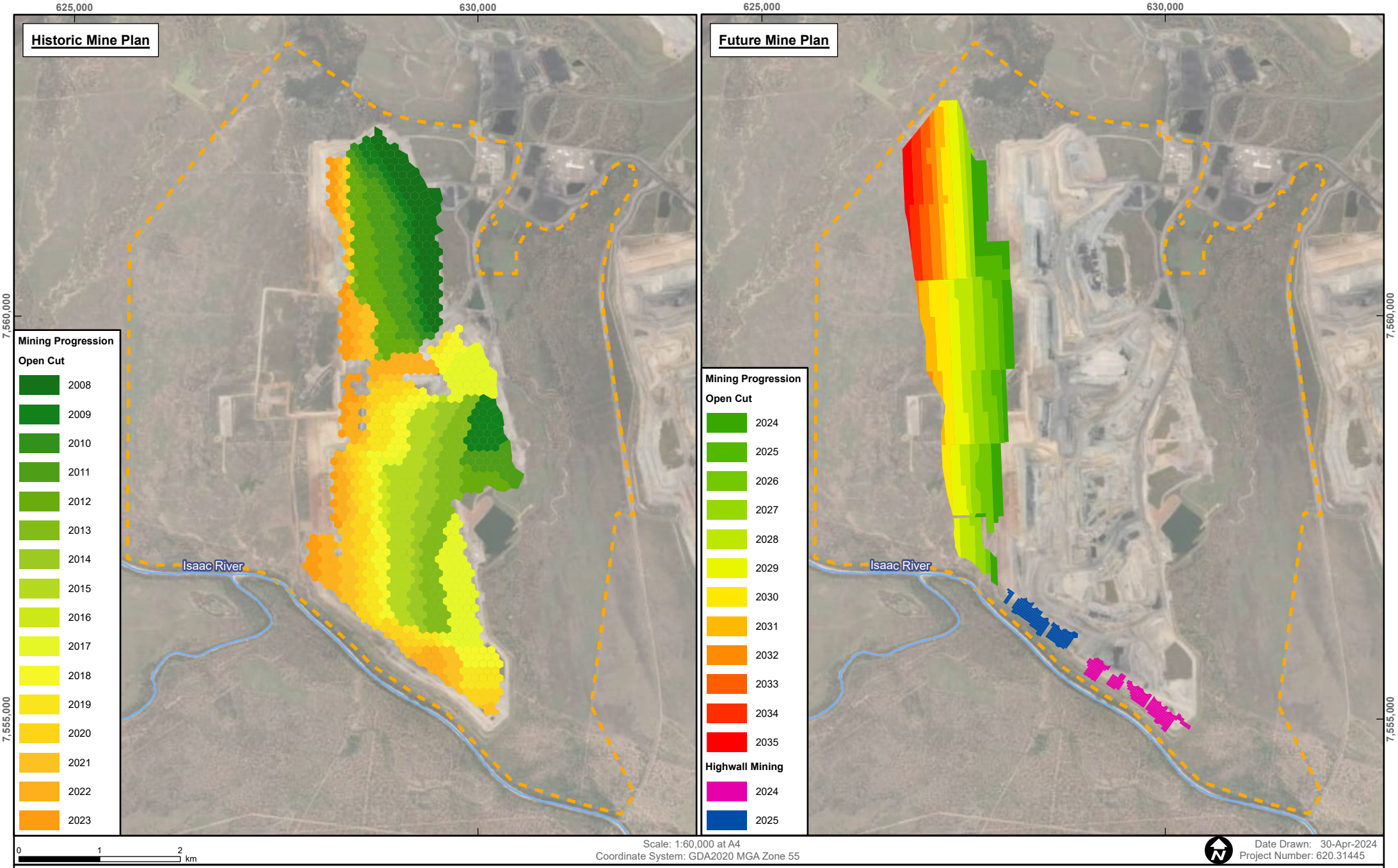
2.3.2 Future Mining Activities

Mining at PTM is expected to continue on the current approved operations until 2035. The current mine plan, with polygons indicating timing for mine strip extraction is provided on **Figure 2-6**. This involves continued open-cut mining targeting the Leichhardt and Vermont Seams of the Rangal Coal Measures, which generally dip from east to west, with basal depth of mine void increasing in conjunction with the dipping geology. Also shown on **Figure 2-6** is the recently approved extent of highwall mining at the southern extent of PTM. Highwall mining activities involve auger drives into the open pit highwall to extract coal from behind the highwall without opening further surface disturbance. Two years of highwall mining is planned, commencing 2024.

2.3.3 Mine Groundwater Inflow

Take of groundwater from the Rangal Coal Measures coincident with mining activities (i.e. take of associated water) is authorised by Water Licence 607187 under the Water Act. Conservatively estimated water take between 2016 and 2021 has averaged 517 ML/year with passive groundwater inflow to pits is the only form of groundwater take at PTM (AQ2, 2021). There is no active dewatering via production bores to facilitate mining or provide water supplies.

Groundwater inflow to the PTM pits generally occurs as damp or low flow seeps in the mining faces, making the direct measurement of the groundwater inflow virtually impossible (AQ2, 2021). Most of the groundwater inflow evaporates directly from the mining face and any remaining groundwater pools at the base of pits. This water is then left to evaporate, or is pumped out of the pit, along with any captured surface water runoff. At PTM, this is observed to be in very small volumes. Any groundwater pumped from the pits is transferred into three on-site water storages and incorporated into the mine water management system.



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POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

HISTORICAL AND FUTURE MINE PROGRESSION

FIGURE 2-6

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3.0 Geology

3.1 Regional Geology

PTM is located in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km^2. The Bowen Basin is a north-northwest to south-southeast oriented basin and contains the largest coal reserves in Australia. The southern half of the Bowen Basin is covered by the Surat Basin, and the Galilee Basin exists to the west (Geoscience Australia, 2017).

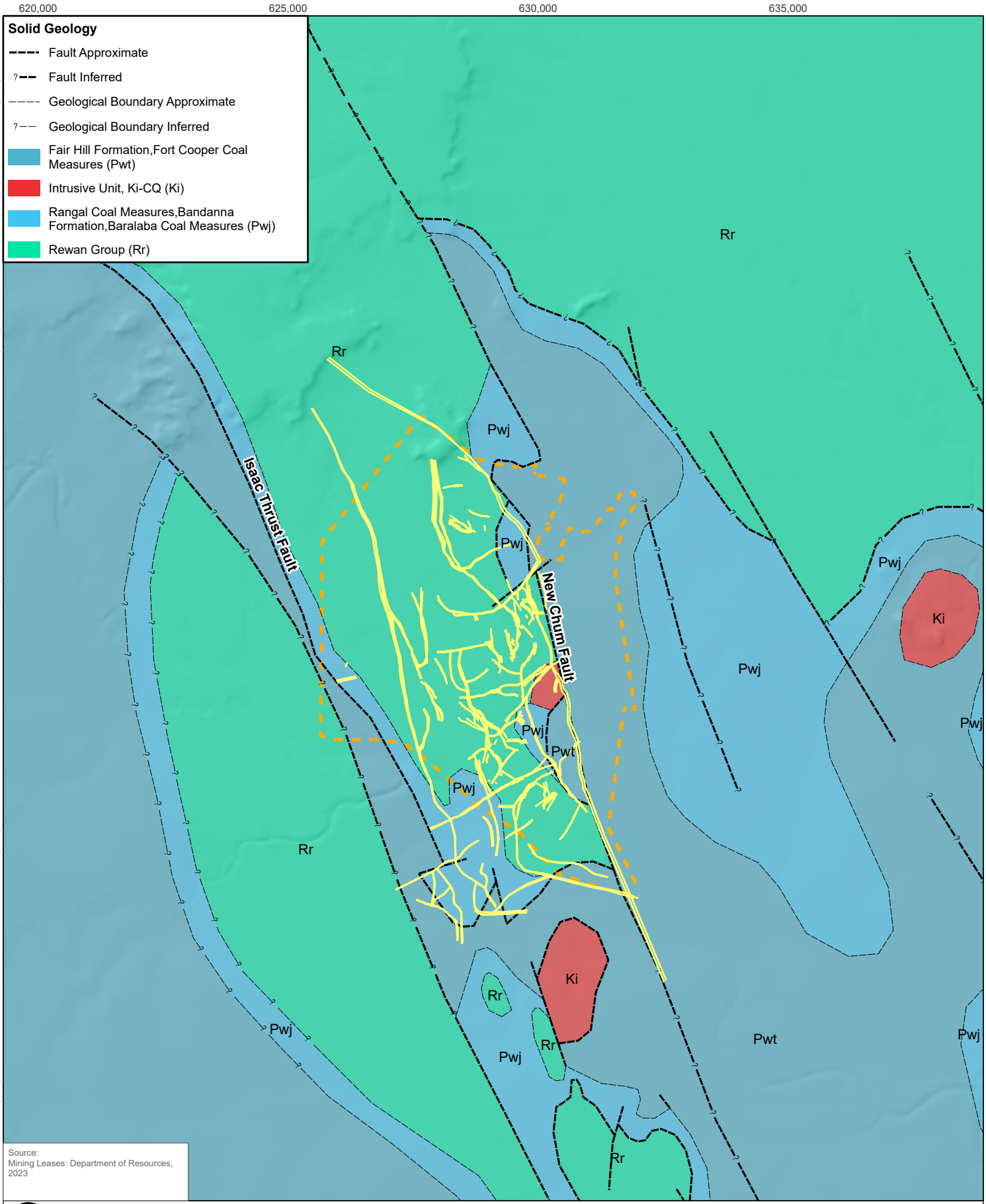
Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which is comprised of generally fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Moranbah Coal Measures, Fort Cooper Coal Measures and Rangal Coal Measures. The Permian strata occur at outcrop on the eastern and western edges of the Basin and are generally unconformably overlain by the Triassic aged terrestrial sedimentary rocks of the Rewan Group. The economic coal seams that are targeted by PTM are contained in the Late Permian Rangal Coal Measures.

The Permian and Triassic units are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (i.e. Isaac River and its main tributaries). Volcanic intrusions and extrusions (i.e. basalt) are also present within the region.

The generalised regional stratigraphy is summarised in **Table 3-1**. The solid geology is presented in **Figure 3-1** based on the 1:500k solid geology outcrop mapping of the Bowen Basin. The surficial geology is shown in **Figure 3-2** and is based on the Clermont (SF5511) and St Lawrence (SF5512) 1:250k geological maps, as compiled within the Queensland Geology Detailed Surface Mapping (DNRME, 2017).

Table 3-1 Regional Stratigraphy

Period		Stratigraphic Unit		Description	Distribution
Cainozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand and gravel.	Surficial cover localised in the vicinity of the PTM Area along Isaac River and its unnamed tributaries, and Cherwell Creek.
		Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qr, Qr\b and TQa)		Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts and muds derived from weathered basalts.	Surficial cover throughout much of PTM and surrounding areas.
		Duaringa Formation (Tu)		Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite and basalt.	Present to south and east of Study Area.
Triassic		Mimosa Group	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	Isolated outcrop to the far south-east of the Study Area.
			Rewan Group (Rr) (Rewan Formation and Sagittarius Sandstone)	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.	Outcrops or subcrops within the PTM Area.
Permian	Late	Blackwater Group	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone and mudstone.	Within the PTM Area; shallowest Permian unit at PTM.
			Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff.	Within the PTM Area; underlies Rangal Coal Measures at PTM.
			Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone and coal.	Within PTM Area; underlies Fort Cooper Coal Measures at PTM.
	Early to Middle	Back Creek Group (Pb)		Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies PTM; Outcrops west of the Study Area.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.31445.00000
Date Drawn:	28-Mar-2024
Drawn by:	RB

LEGEND

Local scale fault

Project Area

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

SOLID GEOLOGY

SLR

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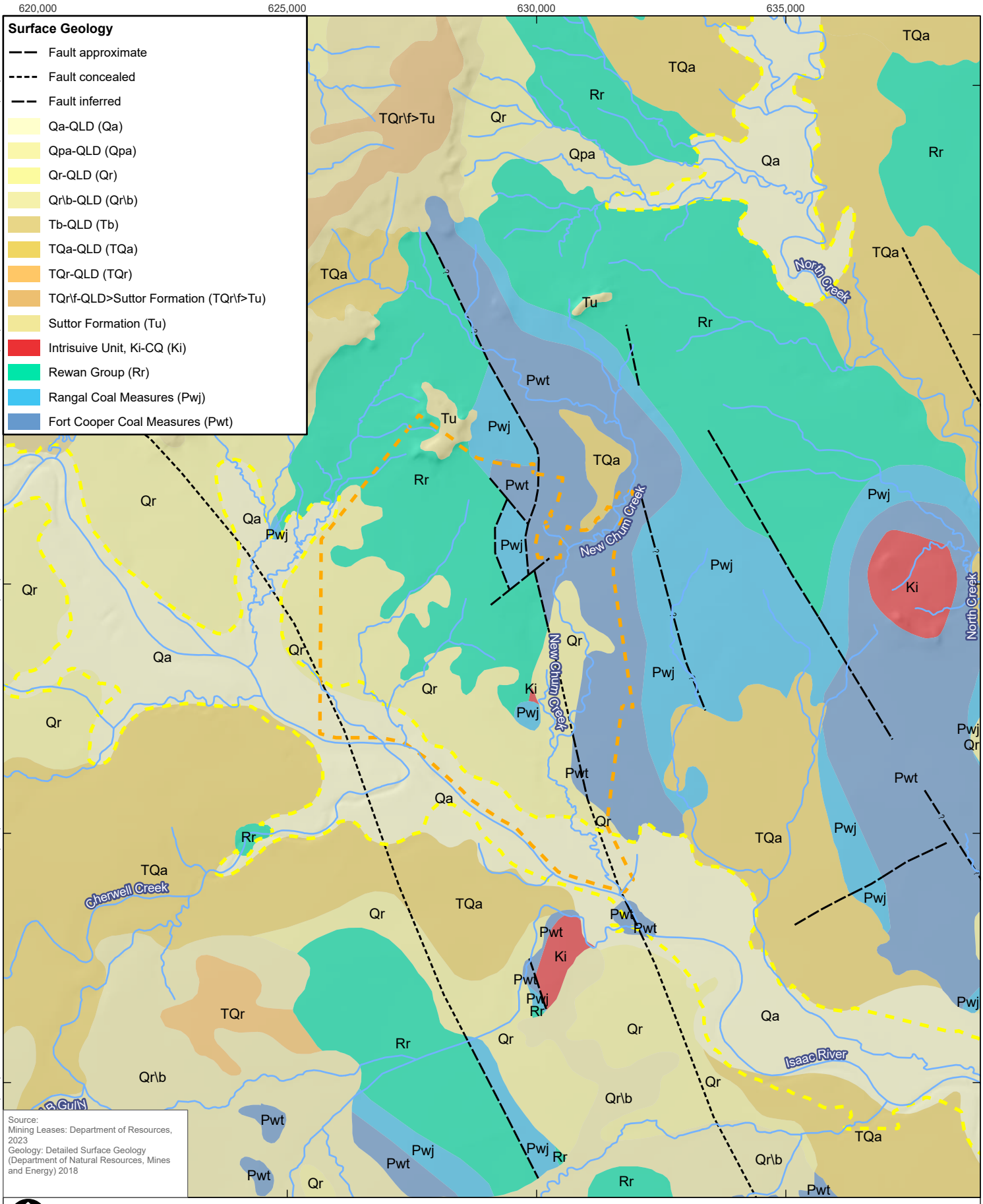
FIGURE 3-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F03_1_Solid Geology



Source:
Mining Leases: Department of Resources, 2023
Geology: Detailed Surface Geology (Department of Natural Resources, Mines and Energy) 2018

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.31445.00000
Date Drawn:	30-Apr-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Alluvium Refined Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

SURFACE GEOLOGY

SLR

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FIGURE 3-2

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F03_2_Surface Geology

3.1.1 Structural Geology

The Permian coal measures at PTM have undergone extensive deformation, including folding and faulting, and there are local and regional faults generally trending north-west to south-east (Advisian, 2018). The faults in the region are generally a product of compressive tectonic forces towards the west and southwest, resulting in thrusting and gentle folding of the strata.

The strata in the vicinity of the PTM Area is heavily influenced by a series of major north-northwest to southeast trending thrust faults. These fault series are associated with back thrust faults (BHP, 2019) that form the western and eastern limits of the PTM deposit (i.e. Isaac Thrust Fault and New Chum Fault respectively; **Figure 3-1**), as well as northeast to southwest trending normal faults, and minor cross cutting southwest-northeast trending local scale faults. Advisian (2018) reports that these features control the depth and occurrence of coal deposits at PTM and subsequently form the boundary of the operational mining areas. The faults with throws greater than 5 m allow the deposit to be divided into a series of mining areas based on faulted blocks (Advisian, 2018).

Three sets of folds are also observed at PTM (BHP, 2019):

- Large wavelength gentle regional folds that have been displaced by numerous faults;
- Fault related folds, which propagate as hanging-wall anticlines in response to the thrust faults movements; and
- Pop-up anticlines, which are due to the activity of a thrust and an associated back thrust.

3.2 Local Geology

The geology of the PTM Area is discussed in **Sections 3.2.1** to **3.2.3** below.

3.2.1 Cainozoic Sediments

Cainozoic aged (Tertiary to Quaternary) sediments at and surrounding PTM include geologically recent alluvium associated with the Isaac River and its tributaries, overlying weathering derived colluvium and undifferentiated Tertiary sediments which are collectively termed Regolith in many recent studies and this report.

3.2.1.1 Isaac River Alluvium

State (Queensland Government) detailed surface geology mapping (refer **Figure 3-2**) shows that immediate vicinity of the PTM Area, Quaternary alluvium is localised along the Isaac River and tributaries, including Cherwell Creek, and a smaller unnamed tributary immediately west of the PTM Area. Revised mapping extents of the Isaac River alluvium as identified from geophysical surveys, slope break analysis and soil mapping for the Winchester South Project (SLR, 2020) is presented on **Figure 3-2** as a dashed yellow line.

Existing approved mining operations at PTM directly intersect the Isaac River alluvium, with aerial imagery indicating that the footprint of the current mine pit disturbance area extends up to approximately 450 m into the mapped extent of the alluvium along the southern margin of PTM.

Quaternary alluvium deposits are described as unconsolidated sequences of clay, silt, sand and gravel sediments which are generally less than 20 m in thickness (AGE, 2013) and are limited to the lower topographic areas at the southern extent of PTM near to the Isaac River. Advisian (2018) report that the alluvial deposits are thickest in the immediate vicinity of the Isaac River. This is in agreement with the study by AGE (2019), who also report that there are sporadically dispersed deeper sections of the alluvium elsewhere that tend to be

associated with paleochannel systems incised into the bedrock (i.e. earlier river channels). Towards the edge of the alluvial plain, away from the current main channel the sediments mainly comprise clay and silt associated with floodplain deposits. A conceptual representation of the alluvial facies is provided as **Figure 3-3**.

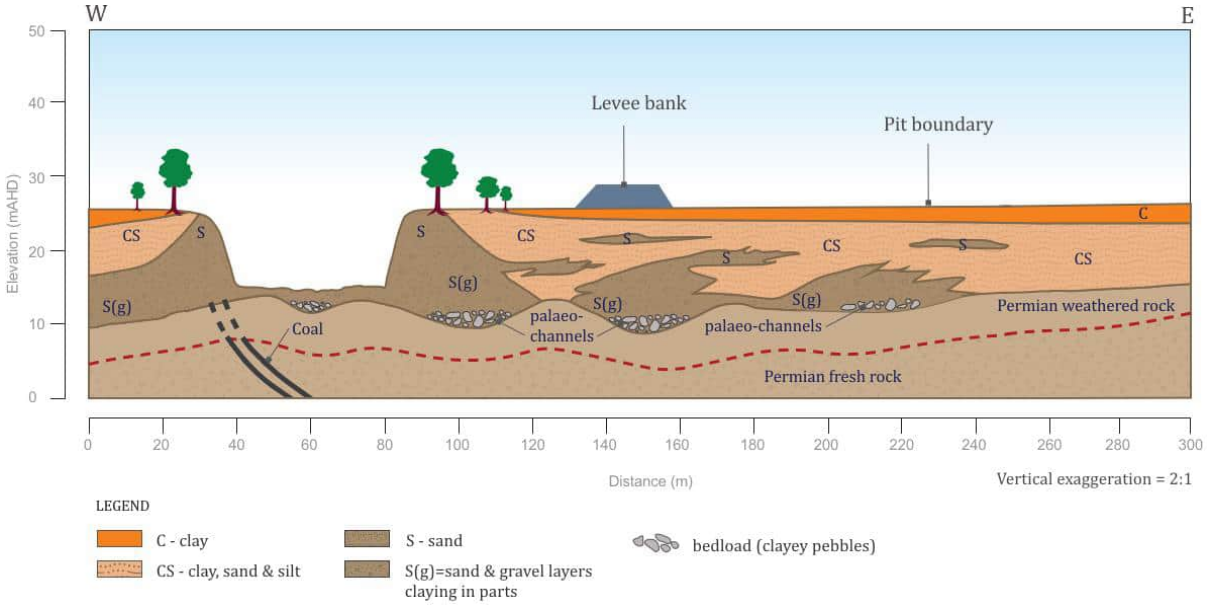


Figure 3-3 Conceptualisation of Isaac River Alluvium Facies (AGE, 2019)

Review of PTM groundwater bore and coal resource exploration drill logs for the PTM Highwall Mining Project groundwater assessment (SLR, 2023a) shows that the alluvium thickens on the southern side of the Isaac River. Furthermore, the modern river channel is not centred within the alluvial depositional area but is located towards its northern margin. This is particularly the case at the confluence of the Isaac River and its tributary Cherwell Creek, where the alluvial depositional area broadens to the southwest around Cherwell Creek. Further east, drill logs show that the alluvium is relatively thin (typically 2 – 8 m thickness) and variably comprised of clay, clayey sand, and some occasional coarser sand (SLR, 2023a).

Recent EA groundwater bore drilling results at PTM (SLR, 2024) showed that from a total of six (6) drillholes along the southern boundary of the PTM Area within the mapped alluvium footprint, only three (3) intersected coarser grained sand or gravel alluvial sediments, with the other three (3) intersecting clay dominated alluvium. OBS15, located furthest west, showed only 3 m of Isaac River alluvium (sandy clay) above Tertiary (weathered sandstone). OBS17, located further east, showed the Isaac River alluvium to have a thickness of 9 m comprised of sandy clay and clay, overlying Tertiary (weathered sandstone). OBS18, located east of OBS17, showed 11 m thickness of Isaac River alluvium comprising sandy clay, overlying Tertiary (weathered sandstone). A 17 m intersection of alluvium overlying Tertiary siltstone was made at the failed drillhole OBS18(F) adjacent OBS17, with 6 m of clayey sand and gravel located at the base of the alluvial intersection. The deeper and coarser grained intersections, interspersed with thin clay dominated alluvium with apparently rapid lateral changes in facies, support the presence of paleochannels within the broader alluvial footprint (refer **Figure 3-3**).

The alluvial heterogeneity can also be seen from bore logs from historical PTM bores, for example by comparing OBS8 located within the mapped extents of the Isaac River alluvium and historical bore MB20PTM05 drilled in 2020, which was plugged and abandoned when the alluvium was found to be dry. OBS8 showed alluvial deposits to be 8m thick, comprising

clay and sandy clay. MB20PTM05A showed only a 1 m thickness of alluvial sand, overlaying 5 m of mudstone interpreted to be highly weathered Triassic strata.

Drilling logs from the geotechnical standpipe installation in 2022 across the extent of the HWM Project show the alluvium and underlying Tertiary sediments in all seven drillholes is comprised of between 9 and 20 m of red-brown clay, overlain by 2 to 4 m of topsoil. That is, across the HWM Project, those seven drilling logs record no intersection of coarser grained alluvial sediments. Other coal exploration drillholes also show that the alluvium is poorly developed in the south of PTM, ranging in thickness from <1 to 8 m but up to 14 m (generally thickening to the southeast) and comprising clay, sandy clay and some clayey sand. Gravelly intersections are rare in exploration drillholes and tend to be encountered at the southwestern margins of the alluvial depositional area, where the alluvium is thicker (SLR, 2023a).

Overall, review of PTM groundwater bore and exploration drill logs in the mapped area of alluvium along Isaac River, shows the alluvium to be highly heterogenous in terms of both its stratigraphy and total thickness.

3.2.1.2 Quaternary and Tertiary Sediments (Regolith)

The surficial material covering much of the broader Study Area comprises Cainozoic (Quaternary to Tertiary) aged sediments, including alluvium, colluvium, and semi-consolidated undifferentiated sediments collectively termed Regolith in many previous studies. The Regolith also includes older alluvial (TQa) sediments that are distributed extensively across the Study Area. Based on geological logs, the Regolith comprises a heterogeneous distribution of fine to coarse grained sand, clay, sandstone and claystone. At the adjacent Daunia Mine, the Tertiary material is approximately 8 m thick, directly overlying the weathered top of the Permian strata (SLR, 2023a).

Exploration drilling undertaken for the HWM Project in the southern part of PTM show that the unconsolidated to semi-consolidated Tertiary sediments underly the Quaternary alluvium to depths of 6 m in the northwest of the HWM Project, approaching 12 m depth in the southeast of the HWM Project. These drillholes show the Tertiary sediments to be comprised of clay, clayey sand and sand in the vicinity of the HWM Project. Exploration drillholes also show that the unconsolidated Tertiary sediments generally become more prominent south of the HWM Project and the Isaac River, where they reach depths of up to 18m and overlie the weathered Rangal Coal Measures. Drilling logs from the geotechnical standpipe piezometer drilling program across the HWM Project show that the Tertiary sediments (and overlying alluvium) in all seven drillholes is comprised of between 9 and 20 m of red-brown clay, overlain by 2 to 4 m of topsoil.

Recent EA groundwater bore drilling results at PTM (SLR, 2024) along the southern margin of PTM showed the Tertiary units to be between 3 and 22 m thick, with the variable thickness apparently related to the degree of Quaternary paleochannel incision/thickness of overlying Quaternary alluvium. In this drilling, the semi-consolidated Tertiary sediments were found to consist dominantly of low strength weathered siltstone and fine grained sandstone.

3.2.2 Triassic Rewan Group

The Triassic sedimentary strata include the Rewan Group, which unconformably overlies the Permian coal measures as in-fill material. The Rewan Group regionally comprises Late Permian to Early Triassic strata with pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerates. The Rewan Group is extensive over the central and northern parts of the PTM Area, outcropping and sub-cropping in a number of areas. Where intersected within the PTM Area the unit is generally comprised of a well consolidated green-brown sandstone.

3.2.3 Permian Coal Measures

Coal resources at PTM are contained within the ~100 m thick Rangal Coal Measures (RCM) of the Permian Blackwater Group, which is underlain by the Fort Cooper Coal Measures and overlain in part by the Triassic Rewan Group.

The Late Permian RCM are the shallowest coal measures comprising light grey, cross-bedded, fine to medium grained labile and well cemented sandstones, grey siltstones, mudstones, shale and coal seams. The Leichhardt and Vermont Seams occur within the RCM and are the target seams for PTM mining.

Advisian (2018) report that the Leichhardt Seam at PTM typically comprises 4-6 m of coal and separates into two coal mining horizons - the 'Leichhardt Bottoms' typically 3.5 m thick and the 'Leichhardt Tops', typically 2 m thick. A third seam, the Lower Leichhardt Seam (LB) exists in the northern part of the deposit, where a dirt band up to 4 m thick splits it from the residual Leichhardt Seam. In southern end of PTM, the Leichhardt Tops and Bottoms coalesce to form the 'L13' seam, which is a target of the HWM Project.

The Vermont Seam comprises the 2 m to 3 m thick Upper Vermont (VU) seam, subdivided into the Upper Vermont 1 (VU1) and Upper Vermont 2 (VU2) and the 1 to 3 m thick, high ash Lower Vermont Seam. VU1 is the basal seam mined at PTM. The interburden (siltstone, mudstone and sandstone) thickness between the Leichhardt Seam and Vermont Upper Seam ranges from 12 to 24 m but is generally around 14 to 20 m.

In the PTM Area and immediate surrounds, the top of the Permian geology is subject to significant weathering to depths of between 13 and 18 m, generally taken to indicate the depth of the pre-mining water table.

The Fort Cooper Coal Measures (FCCM) conformably underlie the RCM. The transition between the RCM and the FCCM is marked by the Yarrabee Tuff marker bed comprised of weak, brown tuffaceous claystone. The Moranbah Coal Measures (MCM) underlie the FCCM.

4.0 Hydrogeology

Based on the understanding of the geological setting presented in **Section 3.0** the hydrogeological regime relevant to PTM comprises the following key hydrogeological units:

- Cainozoic Sediments –
    - Quaternary alluvium – unconfined aquifer where sparsely saturated (water-bearing strata of permeable rock, sand, or gravel) localised along the Isaac River and effectively in direct hydraulic connection with the underlying Regolith unit;
    - Quaternary to Tertiary alluvium, colluvium and weathered units (collectively termed Regolith) – unconfined and largely unsaturated unit bordering alluvium and effectively in direct hydraulic connection with the alluvium;
- Triassic Rewan Group – Considered a regional scale aquitard, however, some saturated more hydraulically conductive horizons exist within, particularly within the upper weathered zone.
- Permian Coal Measures - Coal seams of this unit form the primary regional aquifer. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden.

This section discusses each of the hydrogeological units relevant to PTM, covering groundwater distribution, flow, recharge and discharge, hydraulic properties, groundwater quality, and groundwater use. There is somewhat limited groundwater monitoring data within the PTM Area. To offset this, data from adjacent mines and projects, as well as publicly available regional data, has been incorporated into the following sections to complement site data in characterisation of the hydrostratigraphic units.

4.1 PTM Groundwater Monitoring

PTM groundwater monitoring network details and data availability is provided in **Table 4-1** and locations shown on **Figure 4-1**.

As shown in **Table 4-1**, the groundwater monitoring network at PTM includes 22 current and historical dedicated groundwater monitoring bores. Data availability for some bores is limited in more recent years, as bores have become dry and/or been mined through as a result of planned and approved mining activities, and monitoring has focussed on the bores where compliance reporting is mandated through either the PTM EA or the PTM Water License.

- Eight bores installed into the shallow unconsolidated Cainozoic Sediments (five currently active).
- Two bores installed into the weathered Rewan Group (active).
- Four bores installed into the Leichhardt Seam of the Permian Coal Measures (three currently active).
- Three bores installed into the Vermont Seam of the Permian Coal Measures (two currently active).
- Four bores installed into the interburden of the Permian Coal Measures (three currently active).

It is noted that following a review of drilling data and the site geology model during production of this report, bore OBS4 in the northwest of PTM has been reassigned from being screened in Fort Cooper Coal Measures to the Rewan Group (see conceptual sections provided in **Section 5.0**).

As shown on **Figure 4-1** there are two additional locations (MB20PTM05A – Cainozoic, and MB20PTM01T – Rewan Group) where groundwater bores were attempted to be installed, however were plugged and abandoned due to the target formation interpreted as being dry at the time of drilling.

Additionally, seven geotechnical standpipe piezometers were installed in 2022 in the south PTM Area for the HWM Project. Although not specifically installed for the purposes of environmental groundwater monitoring, the data from these piezometers is a useful addition to the monitoring data collected from the PTM groundwater bores in regards to characterising the groundwater system, particularly in terms of identifying where the groundwater table lies with respect of the interface between the shallow Cainozoic sediments and the underlying Permian strata.

In early 2024, a five bore groundwater drilling campaign was completed to satisfy the recently amended EA related to the approval of the HWM Project. The drilling campaign included the installation of three shallow Cainozoic aquifer monitoring bores and two Range Coal Measures monitoring bores, along the southern margin of PTM. Groundwater level monitoring of the new EA bores had only just commenced at the time of this report, with groundwater quality monitoring yet to be undertaken. The available data has been considered in this report where relevant.

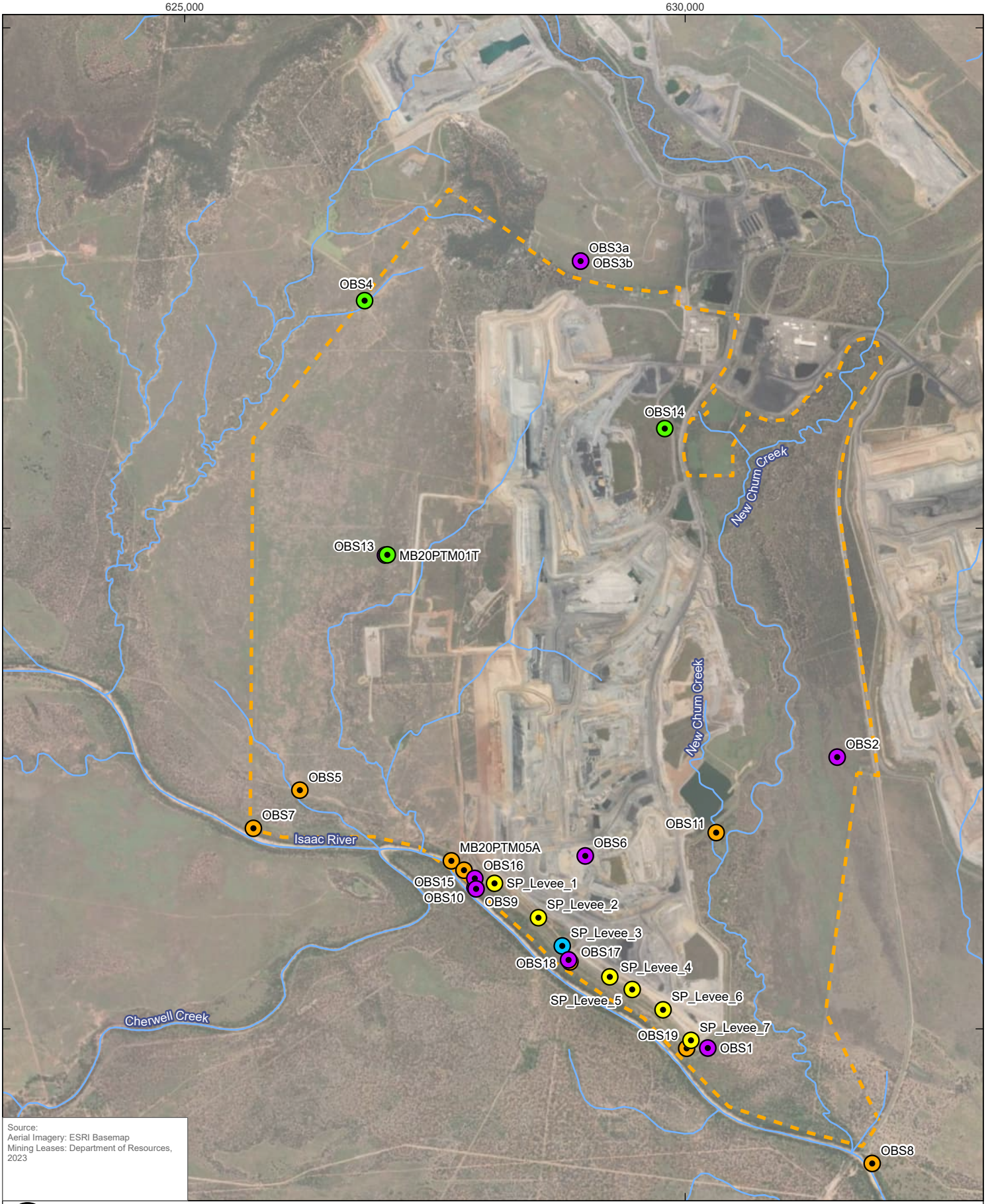
Table 4-1 PTM Groundwater Monitoring Network

Bore	Easting[1]	Northing[1]	GL (mAHD)	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
OBS5	626149	7557383	194.82	195.43	16	13 - 16	Cainozoic (Alluvium)	Active	23-04-2008	18-10-2023	23-04-2008	18-10-2023
OBS7	625684	7557000	198.3	198.92	16	8 - 14	Cainozoic (Tertiary Unconsolidated Sand)	not monitored	28-10-2015	24-10-2017	-	-
OBS8	631867	7553655	194.94	195.61	20.5	8.9 - 11.9	Cainozoic (Tertiary Unconsolidated Sand)	not monitored	08-12-2015	24-10-2017	-	-
OBS11	630313	7556960	202.68	203.27	16	2.5 - 12	Cainozoic (Unconsolidated Sand)	Active	27-08-2015	18-10-2023	27-08-2015	18-10-2023
MB20PTM05A	627549	7556496	-	-	30	-	Cainozoic (Alluvium)	Plugged & Abandoned	-	-	-	-
OBS19	630014	7554804	194.14	194.87	15	12.25 – 14.5	Cainozoic (Alluvium)	Active	09-04-2024	09-04-2024	-	-
OBS15	627789	7556583	199.7	200.53	23	19 - 22	Cainozoic (Tertiary weathered sandstone)	Active	09-04-2024	09-04-2024	-	-
OBS17	628848	7555667	193.53	194.14	11.2	7.5 – 10.5	Cainozoic (Alluvium and Tertiary weathered sandstone)	Active	09-04-2024	09-04-2024	-	-
OBS4	626796	7562273	229.61	230.1	71	62 - 65	Rewan Group	Active	25-03-2008	18-10-2023	25-03-2008	18-10-2023
OBS14	629794	7560995	236.1	236.64	29	21 - 27	Rewan Group (weathered)	Active	24-01-2021	18-10-2023	24-01-2021	18-10-2023
MB20PTM01T	626909	7559553	-	-	32	-	Rewan Group	Plugged & Abandoned	-	-	-	-
OBS1	630225	7554807	193.47	194.04	27	21 - 24	Permian (Interburden)	Active	06-02-2008	07-11-2023	06-02-2008	07-11-2023
OBS2	631518	7557713	216.09	216.66	48	42 - 45	Permian (Interburden)	Active	06-02-2008	07-11-2023	06-02-2008	07-11-2023
OBS10	627899	7556410	194.52	195.23	65.75	56 - 59	Permian (Leichhardt Seam)	Active	27-08-2015	07-11-2023	27-08-2015	07-11-2023

Bore	Easting[1]	Northing[1]	GL (mAHD)	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
OBS12	627013	7559732	209.77	210.34	73	67 - 73	Permian (Leichhardt Seam)	Active	24-01-2021	18-10-2023	24-01-2021	18-10-2023
OBS13	627005	7559730	209.91	210.52	114	108 - 111	Permian (Vermont Seam)	Active	19-07-2021	18-10-2023	19-07-2021	18-10-2023
OBS9	627914	7556397	203.19	203.87	48	41.9 - 47.9	Permian (Interburden)	Active	27-08-2015	07-11-2023	27-08-2015	07-11-2023
OBS3a	628671	7562193	242.7	-	51	45 - 48	Permian (Vermont Seam)	Not monitored (dry)	14-02-2010	05-09-2012	14-02-2010	14-02-2010
OBS3b	628671	7562193	242.7	-	36	30 - 33	Permian (Leichhardt Seam + Siltstone)	Not monitored (dry)	14-02-2010	05-09-2012	14-02-2010	14-02-2010
OBS6	629001	7556726	204.91	205.53	36.5	30.5 - 33.5	Permian (Leichhardt Seam)	Destroyed	06-02-2008	06-10-2010	06-02-2008	06-10-2010
OBS16	627897	7556501	199.77	200.44	75	65 - 71	Permian (Leichhardt Seam)	Active	09-04-2024	09-04-2024	-	-
OBS18	628834	7555687	193.93	194.58	46	36 - 42	Permian (Vermont Seam)	Active	09-04-2024	09-04-2024	-	-
SP_Levee_1	628094	7556452	197.17	197.88	50	8.3 - 49.3	Permian	Active	06-10-2022	17-03-2023	-	-
SP_Levee_2	628533	7556109	196.04	196.82	54	8.2 - 53.2	Permian	Active	06-10-2022	17-03-2023	-	-
SP_Levee_3	628771	7555827	195.29	196.04	54	8.3 - 53.3	Cainozoic	Active	06-10-2022	17-03-2023	-	-
SP_Levee_4	629246	7555518	194.44	195.17	57	8.3 - 56.3	Permian	Active	06-10-2022	17-03-2023	-	-
SP_Levee_5	629470	7555392	193.91	194.67	54	8.2 - 53.2	Permian	Active	06-10-2022	17-03-2023	-	-

Bore	Easting[1]	Northing[1]	GL (mAHD)	TOC (mAHD)	Depth (mBGL)	Screened Interval (mBGL)	Monitored Unit	Status	Data Availability (dates)			
									min WL	max WL	min WQ	max WQ
SP_Levee_6	629778	7555189	194.65	195.45	59	7.2 - 58.2	Permian	Active	06-10-2022	17-03-2023	-	-
SP_Levee_7	630057	7554884	194.39	195.19	74	8.2 - 73.2	Permian	Active	06-10-2022	17-03-2023	-	-

1 Coordinates GDA94 Zone 55



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	30-Apr-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area

Monitoring Site

- Cainozoic
- Cainozoic (Geotechnical Standpipe)
- Permian
- Permian (Geotechnical Standpipe)
- Rewan

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

PTM GROUNDWATER MONITORING NETWORK

SLR

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FIGURE 4-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_1_PTM Groundwater Monitoring Network

4.2 Groundwater Distribution, Flow, Recharge and Discharge

4.2.1 Cainozoic Sediment Aquifer

At PTM, the unconsolidated alluvial sediments of the Isaac River, other Cainozoic sediments (e.g. Tertiary sediments), and weathered regolith, generally function as one interconnected hydrogeologic unit, though with significant heterogeneity given the lithological and stratigraphic distinctions within.

4.2.1.1 PTM Monitoring Bores

There is limited historic groundwater monitoring data available from the Cainozoic sediments at PTM due to the sporadic occurrence of saturation within this unit. There are five current and historic PTM monitoring bores installed into the Cainozoic sediments with records prior to 2024 (**Figure 4-1**). Four of these bores are installed into the unco of the Isaac River (OBS5, OBS7, OBS8 and SP_Levee_3), and one (OBS 11) installed into the sediments of New Chum Creek. Historic water level monitoring data from these bores is presented on **Figure 4-2**. A further three bores monitoring the Cainozoic sediments along the southern boundary of PTM were recently installed (SLR, 2024) with resulting groundwater level data also presented on **Figure 4-2**.

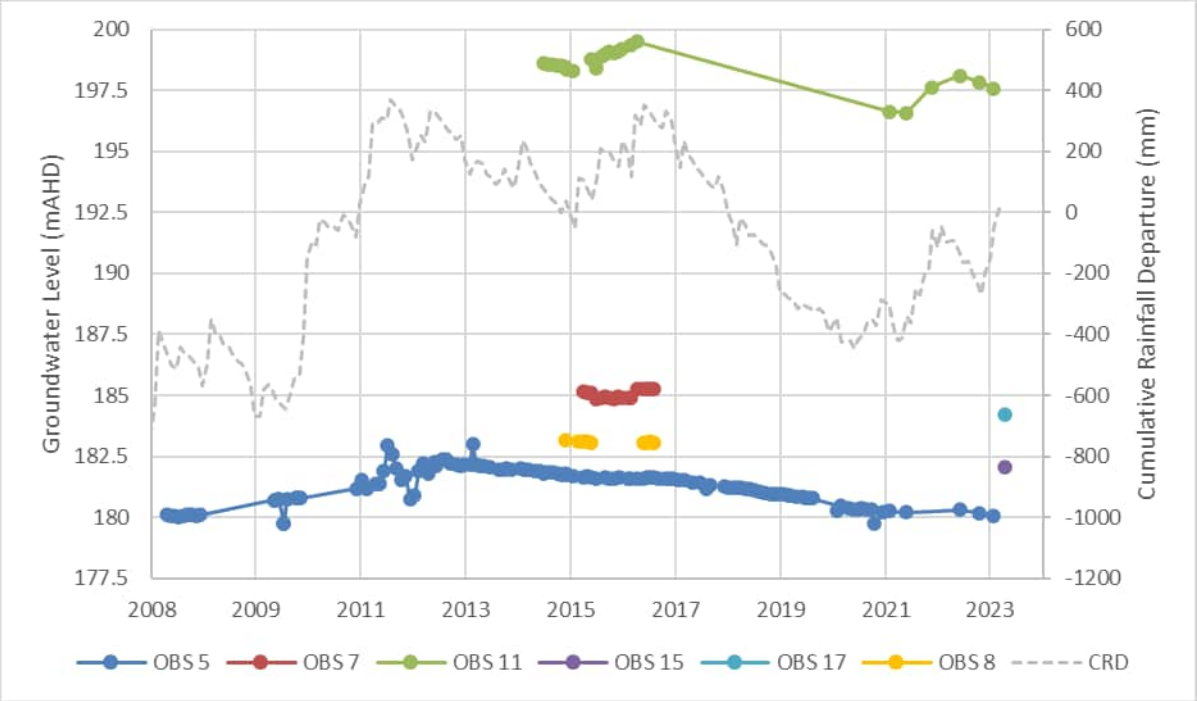


Figure 4-2 PTM Monitoring Bore Hydrograph – Cainozoic Sediment Aquifer

As shown on **Figure 4-2**, OBS5 demonstrates an increasing trend before 2013 and marginal long term declining trend since 2014, with both the pre-2013 and post-2014 water level following general rainfall trends. Although groundwater levels at OBS5 appear to follow long term rainfall trends, mining influence may be at least partially responsible for the post-2014 groundwater level decline of approximately 2 m over 10 years. The short monitoring records for OBS7 and OBS8 show relatively stable water levels with slight increases that appear to follow rainfall trends, nothing that monitoring ceased at these bores when they became ‘dry’ in 2017. Monitoring data from OBS11 also appears to show a response to rainfall trends.

Groundwater levels over the 2016 to 2017 period, when the greatest number of bores were concurrently monitored, suggest that the groundwater flow direction in the Cainozoic sediments is consistent with that of the Isaac River (i.e. 185 mAHD at OBS7 and 183 mAHD at OBS8). Groundwater levels at OBS11 (198 to 199 mAHD) suggest a north to south groundwater flow direction towards OBS8, consistent with the New Chum Creek surface water flow direction.

Groundwater levels recorded in the three recently installed EA monitoring bores along the southern boundary of PTM range between 184.2 mAHD (OBS17) and 182.1 mAHD (OBS15), with OBS19 reported as 'dry' (**Figure 4-2**). It should be noted that only one water level measurement is available at these bores at the time of this report and therefore it can not yet be confirmed that the bores have completely stabilised after drilling, or that these water levels can yet be considered completely reliable.

4.2.1.2 Other PTM Data

Of the seven standpipe piezometers installed for the HWM Project in 2022 (**Figure 4-1**), only one (SP_Levee_3) intercepted shallow groundwater above the Permian coal measures. Groundwater inflow at this location was initially encountered at 6 mBGL during drilling, however following stabilisation, levels were indicated to be approximately 18 mBGL (177.8 mAHD, **Figure 4-2**).

Recent hand augering investigations along the Isaac River at the southern boundary of PTM intersected alluvial water directly adjacent to and within the river bed channel but not outside of the channel (3D Environmental, 2024). This alluvial water was intersected at between 1.5 and 1.7 m depth below the river bed, showing that the alluvial water is disconnected from the river bed and there is no baseflow occurring.

4.2.1.3 Other non-PTM Data

Groundwater level data is also available from several bore censuses previously conducted for projects near PTM (see **Section 4.5.1** and **Figure 4-15**). SLR (2020) report analysis of groundwater level data from three of these bores installed into the Isaac River alluvium downstream (southeast) of the PTM Area. Groundwater elevations within these bores range between approximately 171 to 179 mAHD (14 to 16 mBGL), with the higher groundwater elevations recorded in the bores positioned further upstream. Given that the interpreted thickness of the alluvium around PTM is generally only up 14 m (and not exceeding 20 m), these results suggest very limited saturation. This is in agreement with the sporadically dry nature of drillholes historically intersecting the alluvium in the PTM Area.

SLR (2020) also report that the regolith is considered to be largely unsaturated, with saturation restricted to lower elevations along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek). Flow within the regolith, where saturated, is a reflection of topography, with flow direction towards nearby drainage lines.

4.2.1.4 Potentiometric Surface Mapping

A potentiometric surface for the Isaac River alluvium near PTM (downstream) was developed by SLR (2020) using a combination of water levels from the Winchester South, Moorvale South and Olive Downs Projects. A potentiometric surface for the alluvium, developed by AGE (2019) is also available for upstream of PTM. Groundwater modelling results presented in SLR (2020 and 2021) also provide potentiometric surfaces for the alluvium. An updated potentiometric surface for the Isaac River alluvium has been developed using data from the PTM monitoring bores as discussed above, plus the information from SLR (2020 and 2021) (**Figure 4-3**).

As shown in **Figure 4-3**, groundwater level flow direction in the Isaac River alluvium is southeasterly, concurrent with that of the Isaac River. Alluvial groundwater elevations range from around 185 mAHD near the southwest corner of the PTM Area, down to approximately 180 mAHD at the southeast corner, downstream of the Isaac River. Local scale modification of the groundwater flow patterns are evident in the vicinity of existing approved PTM operations. This is supported by groundwater modelling results presented in SLR (2020 and 2021a) which show similar patterns adjacent PTM, suggesting a local scale influence of PTM mining activities on the alluvial groundwater system.

Along with historic drilling and bore monitoring results previously discussed, comparison of the potentiometric surface developed for the alluvium with the interpreted geologic thickness in the PTM area support the concept of limited alluvial saturation. The comparison also suggests that local scale groundwater flow patterns in the vicinity of approved operations are not solely related to direct interception of alluvial groundwater by PTM operations, but rather are likely related to flow paths that occur via the underlying Tertiary/weathered strata; that is, the alluvium and underlying Tertiary/weathered units (“Regolith”) function as a hydraulically connected groundwater unit. Minor direct interception of alluvial groundwater by existing PTM operations cannot however be ruled out, given that the southern extent of open pit mining overlaps with the mapped extent of alluvium. It is also worth noting that similar northwards flow patterns in the alluvium were reported by AGE (2019) at the southern part of the Isaac Downs Project west of PTM, before any mining had occurred. AGE (2019) report that this is anomalous with respect to anticipated regional groundwater flow in the alluvium, and that this could be related to local changes in permeability and recharge.

4.2.1.5 Recharge and Discharge

Recharge to the alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow subsurface. In support of this, alluvial groundwater levels at some Winchester South Project monitoring bores generally show trends similar to rainfall. Groundwater within the Isaac River alluvium is discharged as evapotranspiration from riparian vegetation along the Isaac River, as well as potential baseflow contributions after significant rainfall and flood events. Groundwater discharge from the Isaac River alluvium also occurs through the use of privately-owned bores within the region. Geological logs in the Study Area indicate the alluvium is underlain by low hydraulic conductivity strata, including hydraulically tight claystones, siltstones and sandstones, which restrict the rate of downward leakage to underlying formations. Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period, e.g. pools in the Isaac River and floodplain wetlands occur where clay layers slow the percolation of surface water.

Recharge to the non-alluvial Tertiary sediments and weathered strata (regolith) is restricted by the presence of low hydraulic conductivity material (clays) which limit rainfall infiltration. Groundwater discharge from the regolith occurs primarily via evapotranspiration like the alluvium, with some short term baseflow to streams following wet climatic conditions. Discharge via downwards vertical seepage is limited due to the presence of low hydraulic conductivity materials.

Source:
Mining Leases: Department of Resources, 2023
Geology: Detailed Surface Geology (Department of Natural Resources, Mines and Energy) 2018

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	620.31445.00000
Date Drawn:	30-Apr-2024
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Groundwater Elevation Contour (mAHD)
- Project Area
- Alluvium Refined Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION – UNCONSOLIDATED CAINOZOIC SEDIMENTS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 4-3

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_3_Potentiometric Surface and Groundwater Flow Direction – Unconsolidated Cainozoic Sediments

4.2.2 Triassic Rewan Group

The Rewan Group is considered low yielding, with any groundwater having limited potential for beneficial use due to the typically fine-grained, clay-bound nature of the sediments. Regionally across the Bowen Basin, the Rewan Group is considered an aquitard (OGIA, 2021).

Despite acting as a regional aquitard, there are two active monitoring bores screened in the Rewan Group observing saturated horizons within the PTM Area (**Figure 4-1**). Recent groundwater levels in these bores range between approximately 196 and 222 mAHD (14 to 34 mBGL).

There is only a relatively short (three year) monitoring record available for OBS14, over which groundwater level trends at this bore are relatively stable to slightly increasing in latter time periods. OBS4 has a significantly longer record and shows highly variable levels between 2008 and 2011, thereafter increasing groundwater levels between around 2011 and 2015, before being relatively stable to declining slightly to the present. This could be indicative of a groundwater system recovery response to third party bore pumping or other regional mining activities. It does not however appear to be related to PTM mining, since PTM mining moved closer to the bore after 2011 (refer **Figure 2-6**), after which groundwater levels have increased. It is also noted that the closest mining activities to OBS4 are those associated with the nearby Millennium Mine, not PTM (SLR, 2023c).

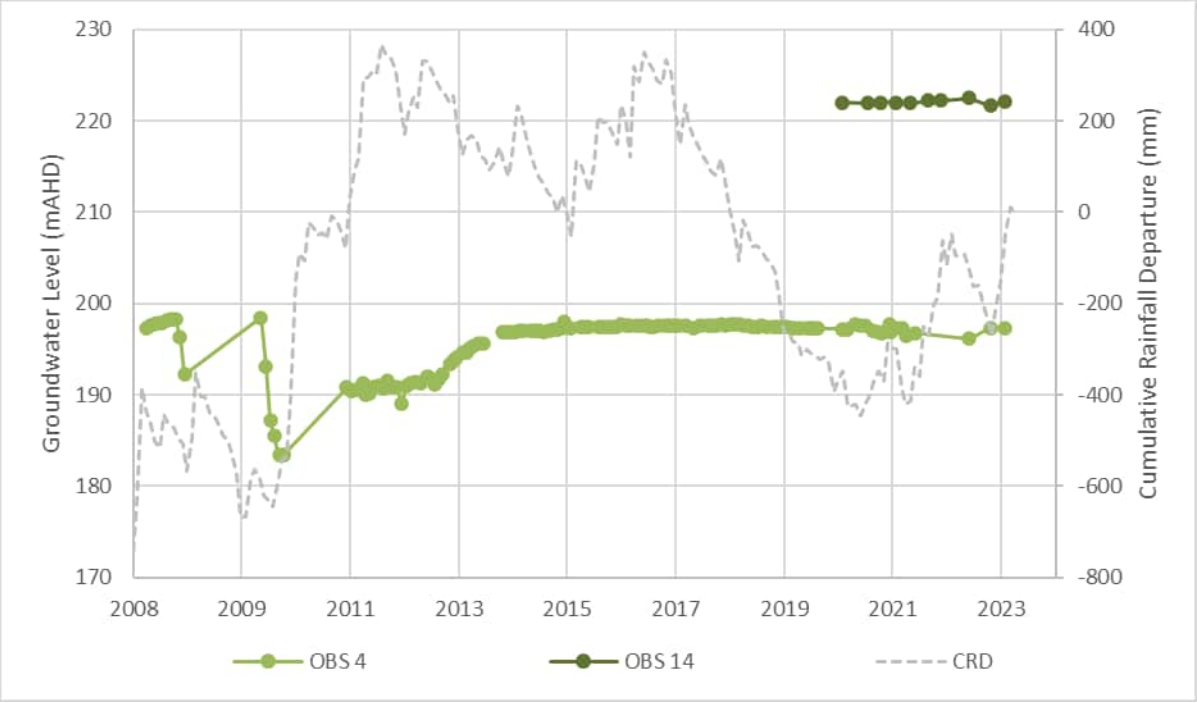


Figure 4-4 PTM Monitoring Bore Hydrograph – Rewan Group

4.2.3 Permian Coal Measures

Groundwater within the Permian coal measures is confined and sub-artesian. Groundwater levels for PTM monitoring network bores screened in the Permian coal measures are presented on **Figure 4-5**.

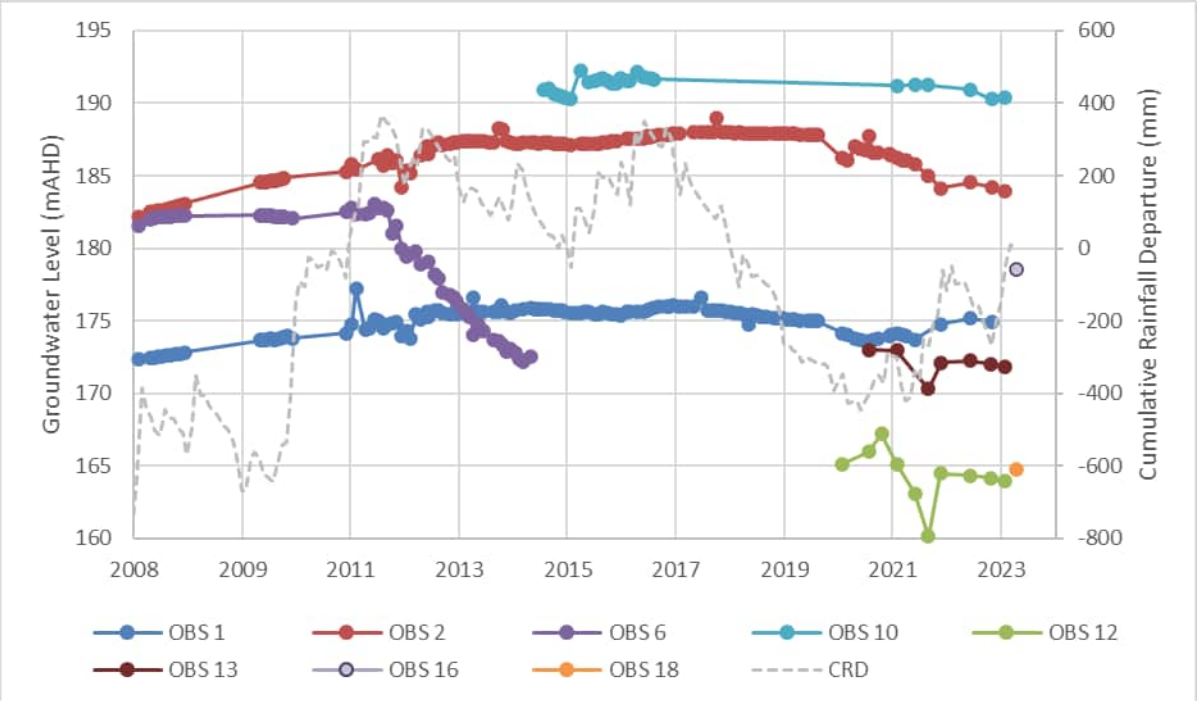


Figure 4-5 PTM Monitoring Bore Hydrograph – Permian Coal Measures

Most Permian bores with long term (pre-2022) monitoring data show relatively stable groundwater levels over the monitoring record, with long term small declines of up to 2 to 3 m, potentially related to PTM mining. OBS1 and OBS2, which have records dating back to 2008, show gradual increasing groundwater levels of up to approximately 5 m between 2008 and 2018, before declining slightly to the present. It is unclear if these increasing groundwater levels are climate related or are a groundwater system recovery response to a cessation of a groundwater system stress prior to the commencement of monitoring and PTM mining activities in 2008. Such stresses may include third party bore pumping or other regional mining activities pre-2008.

Only bore OBS6, screening the Leichhardt Seam and located within the PTM open pit mining footprint, shows a clear response to PTM activities before being mined through in 2015. This bore reported steady drawdown from the end of 2012 onwards, with approximately 9 m total drawdown recorded over the following two and half years before the bore was intersected by mining.

OBS1, located at the southern extent of PTM, shows a slightly declining (~2 m) groundwater level between 2019 and 2022, before recovering coincident with an increase in rainfall trends. OBS2 shows a potentially mining-related decline (~3 m) in groundwater levels from late 2020 through to 2023. Highest recorded groundwater level is at OBS4 (~197 mAHD) in the north of PTM, with the lowest levels at OBS1 (~173 mAHD) in the southeast and at more recently installed bores OBS12 and OBS13 (167 and 172 mAHD respectively) in the west of PTM near current mining activities. A response to mining activities may be apparent in OBS12 and OBS13 around late 2022.

OBS12 (Leichhardt Seam) and OBS13 (Vermont Seam), located in close proximity to each other, demonstrate a large (~5 m) vertical head separation and an upwards hydraulic gradient. This vertical head separation is facilitated by the low vertical hydraulic conductivity of the interburden. This is consistent with what was reported by SLR (2020), where with increased depth of cover and pressure, the hydraulic gradient within the Permian coal measures becomes upwards. This is consistent with a decrease in hydraulic conductivity with depth, as discussed in **Section 4.3**.

Generally speaking, the lack of clear response to mining activities observed within the historic monitoring data for bores outside of the mining disturbance footprint suggests limited hydraulic conductivity, and/or compartmentalisation of the groundwater system as a result of structural controls (i.e. faulting) known to be somewhat significant at PTM (refer **Section 3.1.1**).

A potentiometric surface for the Permian coal measures near PTM was developed by SLR (2023a) (**Figure 4-3**). As shown, the overall groundwater flow direction in the Permian coal measures is from northwest to southeast, with a local inwards flow towards the active pits in the vicinity of PTM and Daunia Mine. Local groundwater flow is therefore towards the active mine pits, whilst regional flow remains towards the southeast. The effect of structural control (i.e. faulting) on the groundwater system is also evident, particularly for the northwest-southeast trending New Chum Fault which separates the PTM and Daunia mining areas and that forms the eastern boundary of PTM.

Recharge to the Permian coal measures occurs where the unit subcrops. Due to the low hydraulic conductivity of the interburden material (refer **Section 4.3**), groundwater largely flows horizontally, along the bedding plane of the coal seams. Groundwater discharge occurs predominantly via evaporation from pit faces in mining operations.

Source:
Mining Leases: Department of Resources, 2023
Geology: Detailed Surface Geology (Department of Natural Resources, Mines and Energy) 2018

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	620.31445.00000
Date Drawn:	01-May-2024
Drawn by:	RB

LEGEND

- Project Area
- Groundwater Elevation Contour (mAHD)

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION – PERMIAN COAL MEASURES

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 4-6

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_7_Potentiometric Surface and Groundwater Flow Direction – Permian Coal Measures

4.2.4 Groundwater Interaction with the Isaac River

In central Queensland, highly seasonal rainfall results in intermittent stream flow, limited groundwater recharge and deep water tables (SLR, 2020). The interaction between the Isaac River and the underlying alluvium therefore depends on climatic conditions and flow within the river (AGE, 2019). In this environment, the most appropriate way to assess surface water and groundwater interaction is by comparing stream stage elevation data (driven by climate conditions) to the underlying groundwater elevation in a nearby monitoring bore.

The closest groundwater monitoring bores installed within the alluvium which are near a surface water gauging station in the vicinity of the PTM Area are two bores located 1.8 km southeast of PTM that form part of the Winchester South Project monitoring network. These bores show groundwater levels of approximately 179 mAHD, in comparison, the elevation of the closest surface water gauging location (500 m downstream) is 187 mAHD. This clearly demonstrates the significant separation of groundwater levels below the river bed (SLR, 2020). AGE (2019) also report that groundwater levels from all alluvial bores at the Isaac Downs Project (immediately west of PTM) were between 1.08 m and 3.90 m below the channel bed immediately prior to river flow conditions. Thus, indicating the water table was below the channel and baseflow conditions did not exist, i.e. losing river conditions prevailed. AGE (2019) also report that groundwater levels in alluvium bores adjacent to the Isaac River were consistently more than 2 m below the surface water level when flowing, and that the depth to water increased with distance from river (i.e. supporting disconnected and losing conditions).

As discussed in **Section 4.2.1**, drilling results from the seven geotechnical standpipe piezometers installed in 2022 indicated that shallow groundwater was only intercepted in one of the seven drillholes. At this location (SP_Levee_3, refer **Figure 4-1**), groundwater inflow was encountered at 6 mBGL during drilling. Monitoring results following standpipe installation at SP_Levee_3 however indicated a groundwater level of approximately 18 mBGL, at the base of the Quaternary/Tertiary intersection, equating to a potentiometric level of approximately 177.8 mAHD (i.e. similar to bore OBS8). In comparison, the bed of the Isaac River closest to SP_Levee_3 lies at an elevation of approximately 182 mAHD, indicating a hydraulic gradient away from the river to the shallow groundwater system; i.e. the shallow groundwater system can not discharge to the river bed given these head elevations. This is further supported by the hand augering investigations along the Isaac River (3D Environmental, 2024), that intersected alluvial water at between 1.5 and 1.7 m depth below surface, showing that the alluvial water is disconnected from the river bed and there is no baseflow occurring. A conceptual cross section through the Isaac River channel demonstrating this relationship is presented as **Figure 4-7**.

The data shows that the Isaac River near the southern boundary of the PTM Area, is largely a losing system with stream-stage above that of the local groundwater levels, resulting in the water draining through the alluvial sediments to the local groundwater system. Occasional very short term periods of baseflow to the Isaac River from the underlying alluvium may only occur after prolonged rainfall events or following flood events as surface water flows recede and shallow groundwater levels are temporarily elevated. Under these conditions, recharged alluvial sediments could drain to the Isaac River as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event.

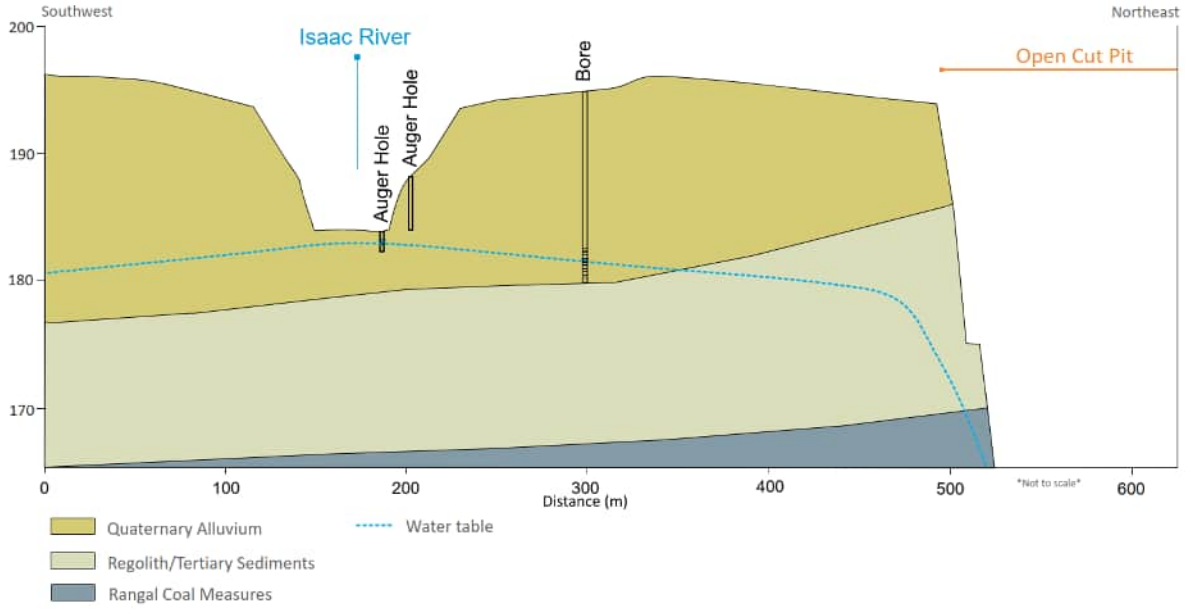


Figure 4-7 Conceptual Cross Section through Isaac River

4.3 Hydraulic Properties

4.3.1 Site-Specific Hydraulic Conductivity Data

Advisian (2018) report that, at the time of their report, site specific aquifer hydraulic testing had not previously occurred at PTM. GHD (2020) undertook hydraulic testing of one bore newly installed into the weathered Rewan Group in the northern part of PTM (MB20PTM04T, now named OBS14 in **Table 4-1**). GHD (2020) note that testing of the other two bores installed at the time into the Permian strata in the western part of PTM (MB20PTM02P and MB20PTM03P, now named OBS12 and OBS13 in **Table 4-1**) was not possible due to very slow recovery rates following drilling, itself considered indicative of very low formation hydraulic conductivity.

Site specific aquifer hydraulic testing in the form of slug (rising and falling head) testing to obtain site specific hydraulic conductivity data was completed by SLR (2023a). A total of 15 bores were subject to testing; 11 in the Permian Coal Measures, two in the weathered Rewan Group and two in the Cainozoic Sediments. A further two bores in the Permian Coal Measures were attempted to be tested, but hydraulic conductivities were so low to as render the tests unsuccessful. A summary of the results are provided as **Table 4-2**.

Table 4-2 Summary of Hydraulic Conductivity Estimates from Site-Specific Testing

Hydrogeologic Unit	Number of Bores Tested	Minimum Hydraulic Conductivity (m/day)	Maximum Hydraulic Conductivity (m/day)	Average Hydraulic Conductivity (m/day)
Cainozoic	2	0.003	0.007	0.006
Rewan	2	0.001	5.03	3.24
Permian	11	0.001	2.80	0.33

The results show a wide range of hydraulic conductivity, with the limited number of Cainozoic Sediments bores showing relatively low hydraulic conductivities typical of clay dominated sediments. Results for the Permian Coal Measures show a three orders of magnitude spread of hydraulic conductivity. Results for the Rewan Group also show a large range, indicative of a higher hydraulic conductivity for the weathered part of the formation.

4.3.2 Regional Hydraulic Conductivity Ranges

A significant record of aquifer hydraulic testing information is available from adjacent and nearby mines and Project sites for the same hydrogeologic units that are found at PTM. Given the similar geologies, this data are considered representative of the hydraulic properties of the units at PTM.

A histogram of the spread of horizontal hydraulic conductivity from the field testing at the adjacent/nearby Daunia Mine, Winchester South Project, Olive Downs Project and Moorvale South Project, is presented in **Figure 4-8**. The results are compared to the range of documented values for the various units in literature. The comparison shows that the field results for the hydrogeologic units within the Study Area and immediate surrounds fall within the range of field data collected through other studies across the Bowen Basin. It is also noted that the results of the site specific testing documented in **Table 4-2** above generally fall within the range of regional and literature values for each unit presented in **Figure 4-8**, indicating the site specific dataset aligns with the regional dataset.

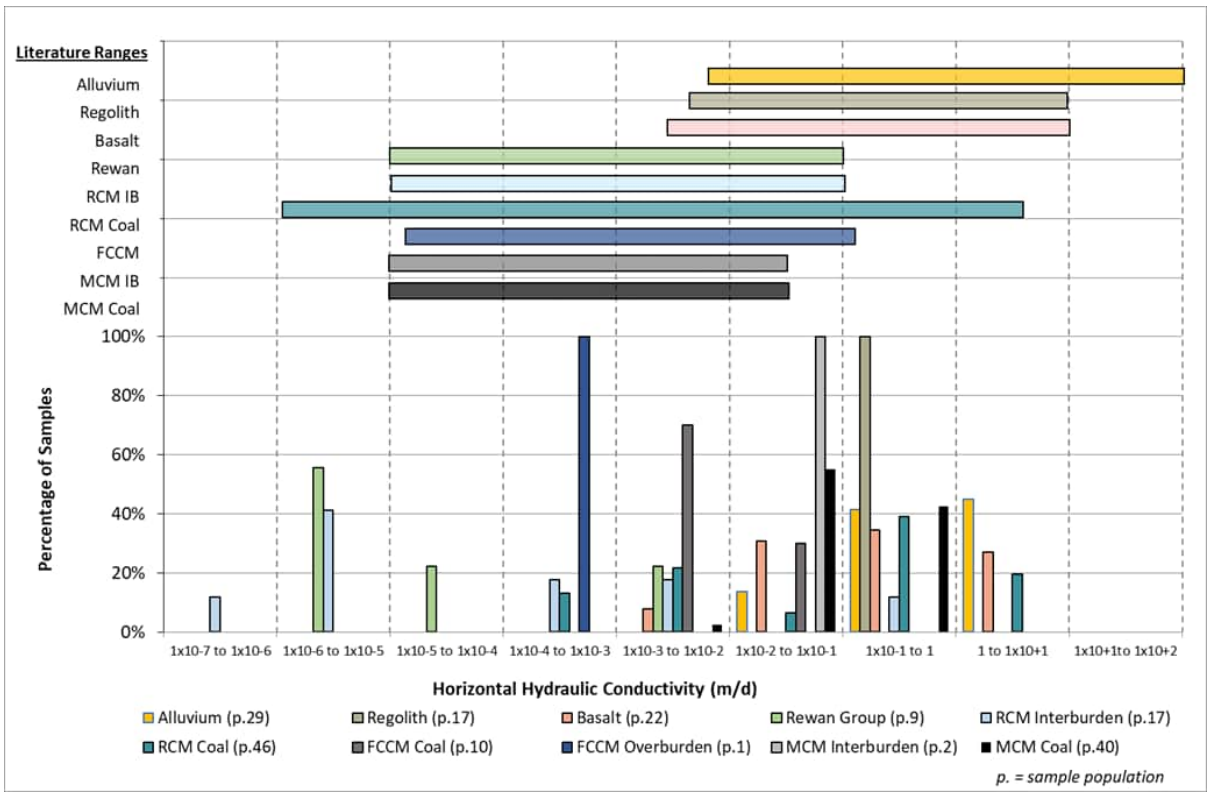


Figure 4-8 Horizontal Hydraulic Conductivity Ranges

4.3.3 Faulting

As discussed in **Section 3.1.1**, there are numerous faults trending northwest-southeast within Permian strata across PTM and the surrounding area.

As identified by Jourde et al. (2002), faulting can result in higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane. However, this can also be dependent on whether faults are currently active (Paul et al., 2009). Faulting has been inactive within the Bowen Basin 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 fractured pore spaces over time through hydrothermal alteration and mineralisation (Uysal et al., 2000). Drill core logs from the Bowen Basin generally show that where fractures and faults have been geologically logged, many fractures are “healed” with calcite and siderite. This indicates that although the system contains a fracture network, many of the existing fractures are cemented, which reduces the effective permeability of the fracture when compared to any open fracture network (SLR, 2020).

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) has developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 4-9**), largely based on Jourde et al. (2002) and Flodin et al., (2001). This conceptualisation provides a means 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.

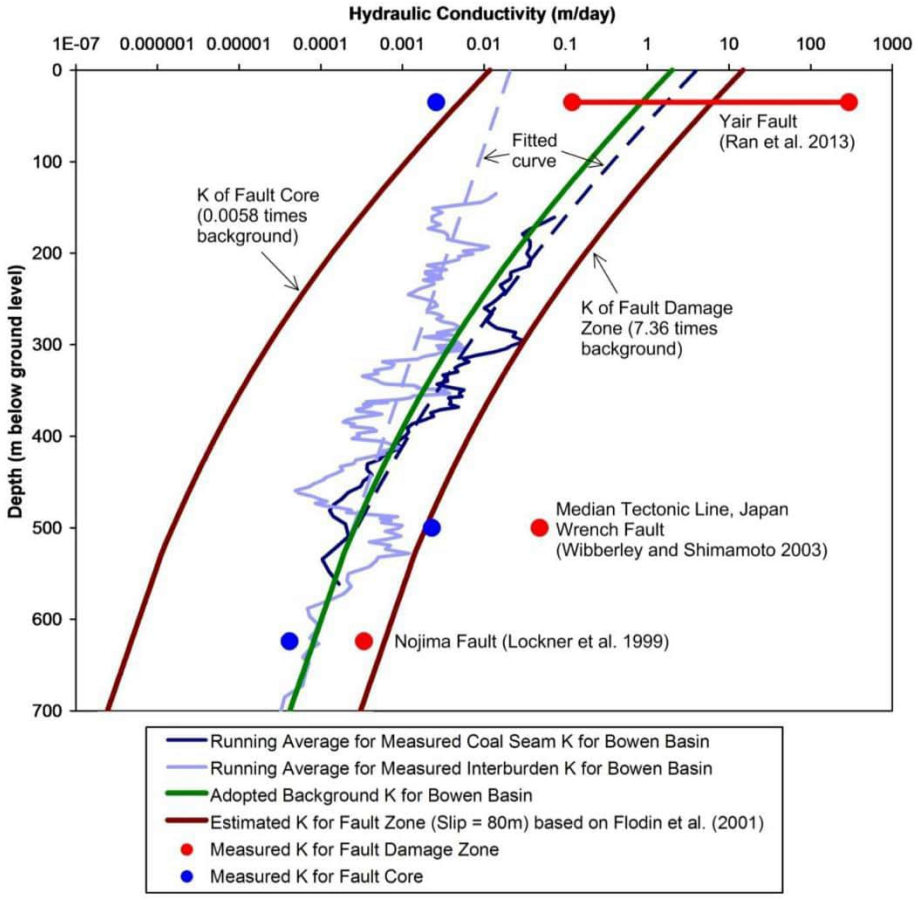


Figure 4-9 Faulting Conceptual Model Developed by Coffey (2014)

Downhole hydraulic testing was conducted in the Permian coal measures for the Winchester South Project immediately south of PTM. Fault zones were confirmed to be intersected at these drillholes due to the presence of fracturing, calcite infills, and slickensides in core obtained from the drillholes, all of which are considered an indicative marker of faulting. Testing results showed relatively low hydraulic conductivity values ranging from 6.93 x 10^{-5}

to 2.07 x 10^{-3} m/day, and in line with those presented in **Figure 4-9**. These properties indicate that the faulting zones intercepted and tested are 'healed' and not pathways for preferential groundwater flow.

Laboratory geotechnical analysis of core samples of interburden immediately above and below coal seams proximal to a fault zone has previously been undertaken in support of groundwater assessments in the Study Area (e.g. SLR, 2020). The samples recorded vertical hydraulic conductivity (Kv) of 50% to 160% of horizontal hydraulic conductivity (Kh); i.e. although some samples show a typical Kv of somewhat less than Kh, some samples also suggest greater Kv than Kh which may be indicative of preferential vertical flow pathways associated with faulting. However, it was also noted that these areas of increased Kv are limited vertically, with samples collected from the same drillhole at horizons further above and below the fault zone (interburden and Rewan Group) returning a lower Kv of between 11% and 76% of Kh.

The impact of faults on groundwater flow within the Study Area was also assessed as part of the Bowen Gas Project (Arrow Energy, 2012). Kinnon (2010) assessed the movement of water and gas across a series of faults in the Bowen Basin using stable isotope and water quality analysis to assess zones of potential recharge, water mixing and flow pathways. Higher gas production rates were also observed on either side of a major fault, with differences in isotopic compositions of produced water for wells north and south of the major fault line at similar depths, implying little communication across the fault boundary, and suggesting that the fault acts as a horizontal permeability barrier to water and gas flow. The results of the study showed that compartmentalisation was evident and that this was due to the structural geology (faulting) in the basin.

4.4 Baseline Water Quality

4.4.1 Groundwater Typing

The proportions of major anions and cations were used to determine the hydrochemical facies of groundwaters sampled at PTM. The anion-cation balance, pH and EC of historical data from PTM monitoring bores is displayed on the Durov diagrams in **Figure 4-10** to **Figure 4-12**. The diagrams are split by aquifer, including bores in the Cainozoic Sediments (**Figure 4-10**), Rewan Group (**Figure 4-11**) and Permian Coal Measures (**Figure 4-12**). Generally speaking, there is a high degree of observed variability in groundwater quality between hydrostratigraphic units, and between individual bores within individual hydrostratigraphic units.

Groundwater quality from two bores screened in the Cainozoic Sediments shows a Na-Cl groundwater type with pH range from weakly acidic to weakly alkaline and an EC range from 13,800 to 29,800 µS/cm (**Figure 4-10**).

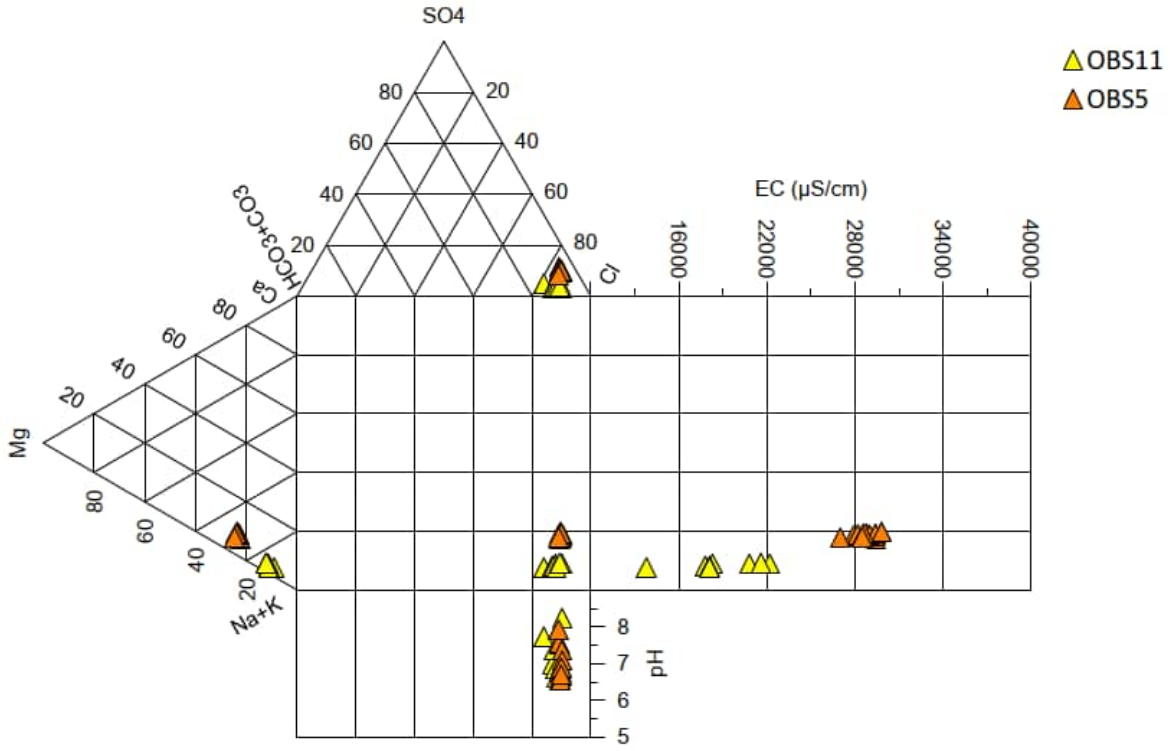


Figure 4-10 Durov Diagram – Cainozoic Sediments

Groundwater quality from two bores screened in the Rewan Group shows a Na-Cl groundwater type with pH range from weakly acidic to weakly alkaline and an EC range from 8,500 to 12,800 µS/cm (**Figure 4-11**).

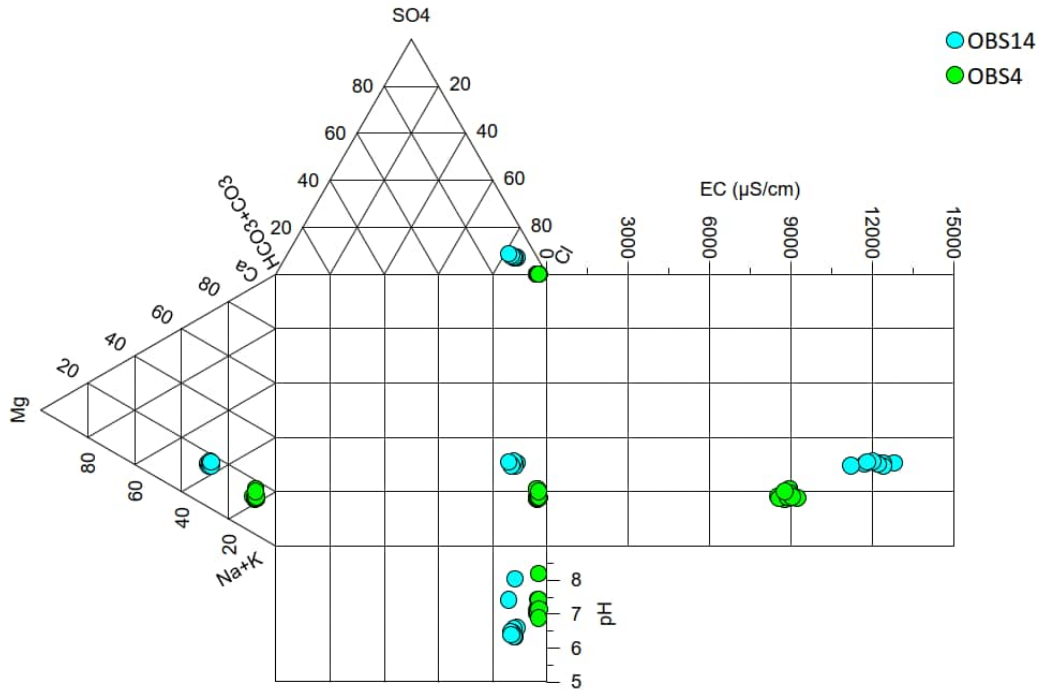


Figure 4-11 Durov Diagram – Rewan Group

Groundwater quality sampling from bores screened in the Permian Coal Measures indicate that groundwaters are generally Na-Cl groundwater type, consistent with bores screened in the Cainozoic Sediments and Rewan Group. Exceptions to this include OBS2 and OBS10 which plot as Na-HCO3 water type, potentially indicative of recharge and younger waters. The data from this aquifer shows a pH ranging from weakly acidic to alkaline and an EC range from 830 to 30,500 µS/cm (**Figure 4-12**).

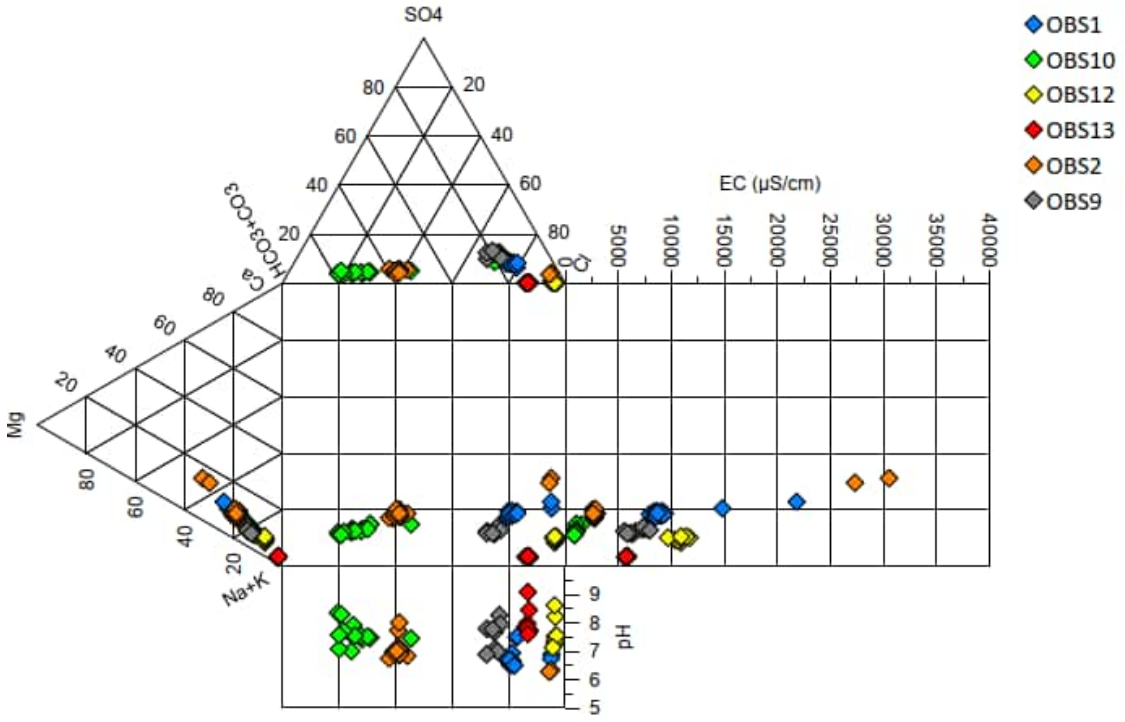


Figure 4-12 Durov Diagram – Permian Coal Measures

4.4.2 Salinity

Salinity is a key constraint to water management and groundwater use by receptors and can be described by total dissolved solid (TDS) concentrations. **Figure 4-13** presents the TDS data associated with groundwaters screened in the various hydrostratigraphic units for PTM monitoring bores.

The graph shows that available data from two bores in the Cainozoic Sediments record TDS ranging from saline to highly saline, with an average TDS of 16,961 mg/L and range between 7,550 mg/L and 26,500 mg/L.

Groundwater in the Rewan Group ranges from moderately saline to highly saline, with an average TDS of 6,725 mg/L and range between 4,910 and 20,400 mg/L.

Within the Permian Coal Measures, bores that screen the Leichhardt and Vermont Seams record groundwater ranging from brackish to saline, with an average TDS of 6,687 mg/L and range between 506 and 7,210 mg/L. Groundwater from bores in the Permian interburden ranges from moderately saline to highly saline, with an average TDS of 3,984 mg/L and range between 1,570 and 21,400 mg/L.

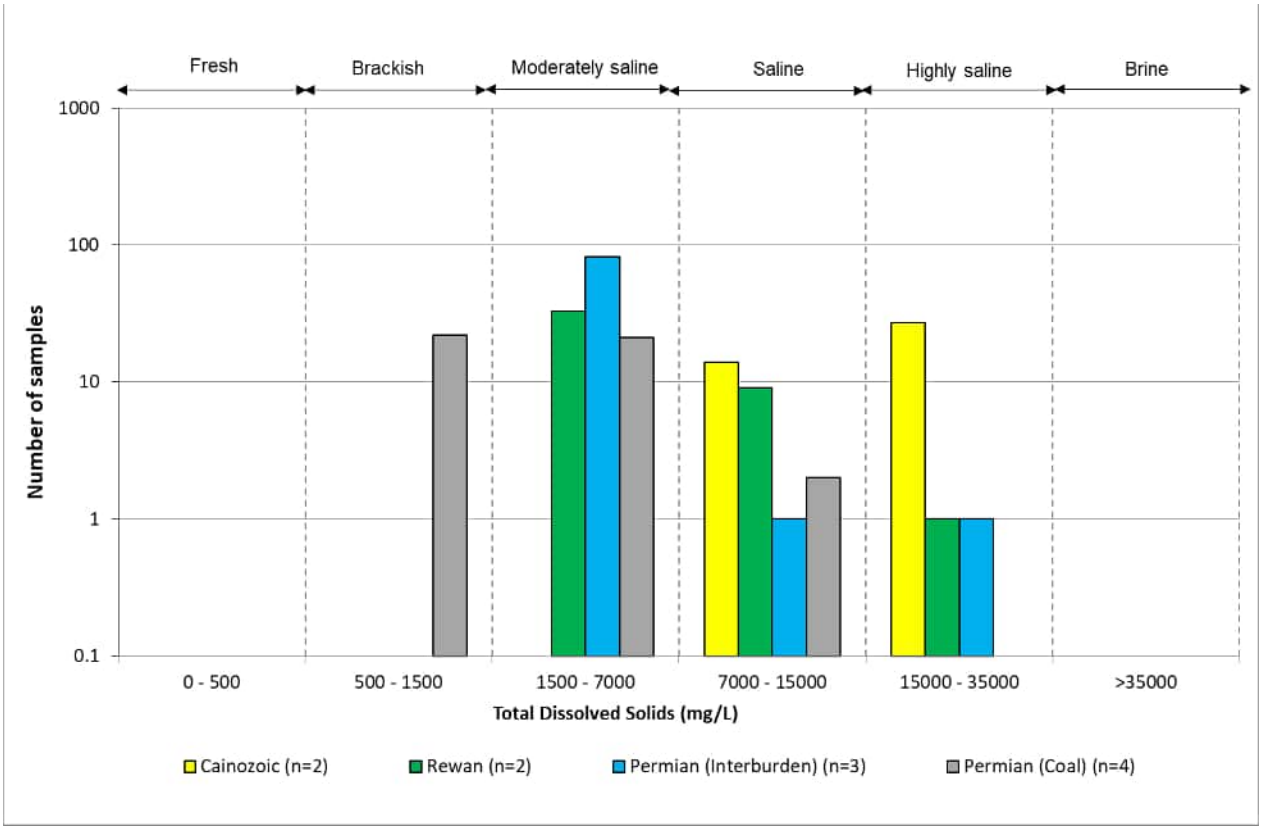


Figure 4-13 Salinity Ranking by Hydrostratigraphic Unit

Note: n = number of bores

4.4.3 Beneficial Groundwater Use

The PTM Area lies within the Isaac Connors Groundwater Management Area (GMA) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011 (**Figure 4-14**). The Isaac Connors GMA consists of the following:

- Groundwater Unit 1, containing the aquifers of the Quaternary alluvium associated with the Isaac Conners Alluvium sub-area; and
- Groundwater Unit 2, containing all subartesian aquifers within the Highlands GMA other than the aquifers included in Highlands Groundwater Unit 1.

Groundwater resources at PTM are also scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity), as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EVs) for these groundwaters are:

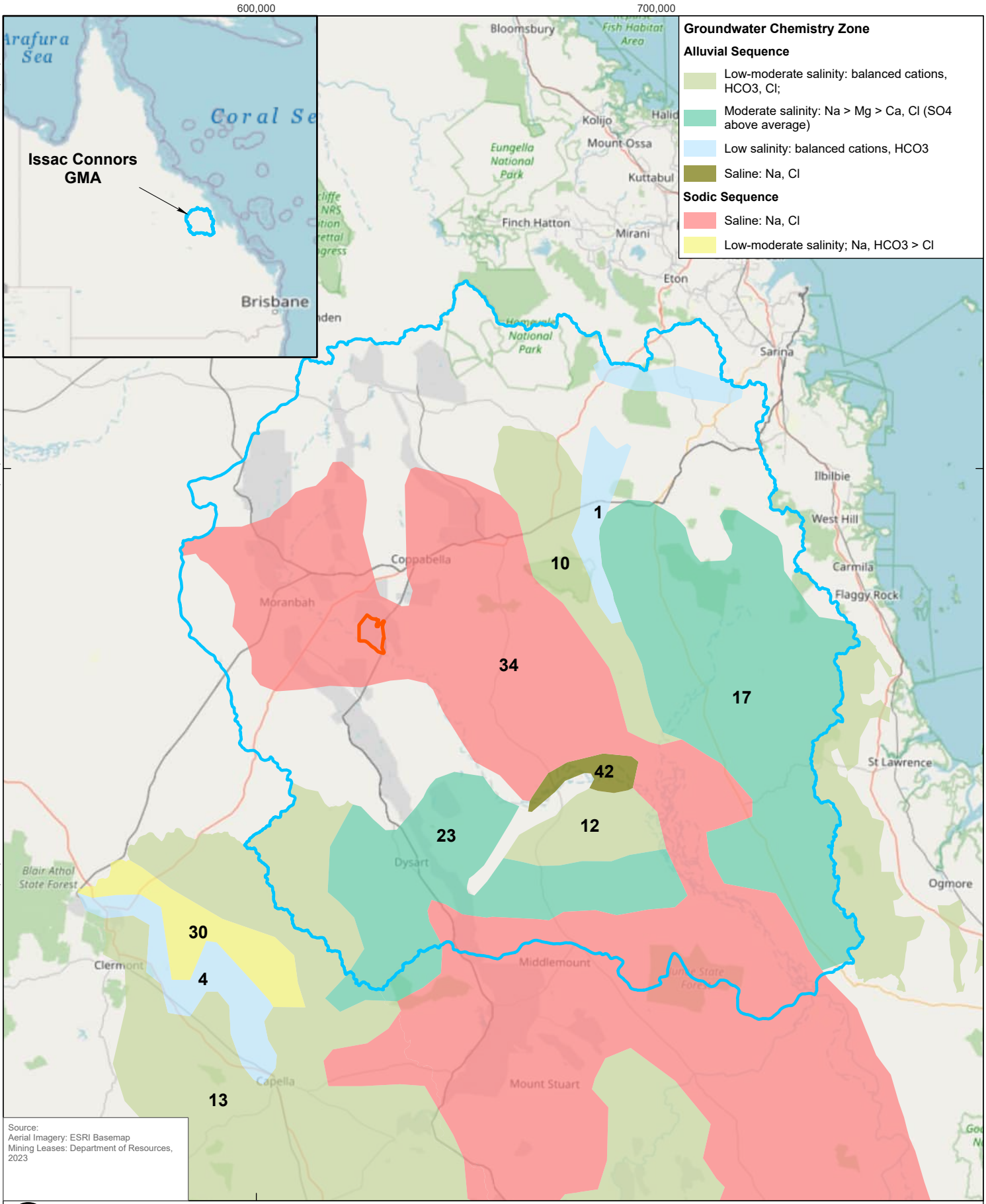
- Biological integrity of aquatic ecosystems;
- Human use EVs:
    - Suitability of water supply for irrigation;
    - Farm water supply/use;
    - Stock watering;
    - Primary recreation;

- Drinking water supply;
- Cultural and spiritual values.

The EPP Water and Wetland Biodiversity provides water quality objectives (WQOs) for the scheduled EVs in WQ1310. WQOs are long-term goals for water quality management and the purpose of the WQOs is to support and protect EVs. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural, economic).

Where groundwater quality analysis results exceed a particular WQO for a particular EV, it is considered indicative that the groundwater may be unsuitable for supporting that particular EV.

The WQ1310 WQOs for groundwater relevant to PTM are shown **Table 4-3**.



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 10 20 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,250,000 at A4
Project Number:	620.31445.00000
Date Drawn:	02-Apr-2024
Drawn by:	RB

LEGEND

- Project Area
- Isaac Connors Groundwater Management Area (GMA)

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

ISAAC CONNORS GROUNDWATER MANAGEMENT AREA, FITZROY BASIN GROUNDWATER ZONES, AND CHEMISTRY ZONES

SLR

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FIGURE 4-14

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_14_Isaac Connors GW Area, Fitzroy Basin GW Zones, and Chemistry Zones

Table 4-3 Water Quality Objectives for Isaac Sub-basin Environmental Values

Water Quality Indicator	Unit	ADWG Guidelines[1]		Isaac River Sub-basin EVs[2]		
		Health	Aesthetic	Irrigation	Stock	Aquatic 95%[3]
pH	-		6.5 to 8.5			6.5 to 8.5
Aluminium	mg/L		0.2		5	0.055
Calcium	mg/L				1000	
Chloride	mg/L		250			
Magnesium	mg/L				2000	
Manganese	mg/L	0.5	0.1	10		1.9
Sodium	mg/L		180			
Sulfate	mg/L				1000	
Zinc	mg/L		3			0.008
Arsenic	mg/L	0.01		2	0.5	0.024
Cadmium	mg/L	0.002			0.01	0.0002
Chromium	mg/L	0.05			1	0.001
Cobalt	mg/L			0.1	1	
Copper	mg/L	2	1		1	0.0014
Lead	mg/L	0.01			0.1	0.0034
Mercury	mg/L	0.001			0.002	0.0006
Nickel	mg/L	0.02			1	0.011
Selenium	mg/L	0.01			0.02	0.005
Silver	mg/L	0.1				0.05

1. NHMRC, NRMMC (2011) Australian Drinking Water Guidelines
2. Table 2, Table 9, Table 10 and Table 11 of DEHP (2011) Isaac River Sub-basin Environmental Values and Water Quality Objectives
3. ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)

The EPP Water and Wetland Biodiversity also provides limited WQOs specifically for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs vary across the Fitzroy Basin and are defined on the basis of groundwater Chemistry Zones. The applicable Chemistry Zone for PTM is Isaac Groundwater (Zone 34; Sodic Sequence - Saline: Na, Cl). These WQOs are classified by groundwater depth ('shallow' being <30 m depth, and 'deep' being >30 m depth) and are summarised below. The management intent of each WQO zone is to maintain each of 20th, 50th and 80th percentile values.

Table 4-4 Isaac River Sub-basin Zone 34 WQOs for groundwater resources (aquatic ecosystem protection) (DEHP, 2011)

Water Quality Indicator	Unit	Shallow Groundwater (<30m)			Deep Groundwater (<30m)		
Percentile	-	20th	50th	80th	20th	50th	80th
EC	µS/cm	498	2150	8910	3419	6100	16000
Hardness as $CaCO_3$	mg/L	163	674	2228	359	919	3208
pH	-	7.1	7.75	8.1	7.4	7.8	8.03
Alkalinity	mg/L	154	435	752	156	275	536
Ca	mg/L	18	84	215	46	145	442
Mg	mg/L	27	108	389	35	115	491
Na	mg/L	135	747	1500	480	1100	2565
Cl	mg/L	171	1309	3185	753	1900	5905
SO_4	mg/L	12	140	318	25	138	398
HCO_3	mg/L	187	536	878	188	330	650
NO_3	mg/L	0	0.95	5.3	0.01	2.15	14.92
SiO_2	mg/L	21	36	52	16	25	36
F	mg/L	0.1	0.28	0.5	0.02	0.155	0.4
Fe	mg/L	0	0.03	0.14	0	0.05	0.246
Mn	mg/L	0	0.01	0.16	0	0.05	0.291
Zn	mg/L	0	0.015	0.06	0.01	0.025	0.317
Cu	mg/L	0	0.01	0.03	0.017	0.03	0.03

In order to understand the possible utilisation of groundwater resources within the Study Area, given the scheduled EVs discussed above the available groundwater quality data have been compared to the:

- Australian Drinking Water Guidelines (ADWG) (NRMMC, 2011).
- ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection).
- Isaac River Sub-basin Environmental Values and Water Quality Objectives: stock and irrigation (DEHP, 2011).
- Fitzroy Basin Groundwater Water Quality Objectives: Aquatic ecosystems (Zone 34) (DEHP, 2011).

A comparison of these guidelines to the 80th percentile of available historical water quality data for each PTM monitoring bore is presented as **Table 4-5**.

Available groundwater quality data from two bores in the Cainozoic sediments shows that concentrations from several analytes are generally higher than the Zone 34 Fitzroy Basin WQOs for aquatic ecosystem protection. Cainozoic sediments groundwater data also indicates it is generally not suitable for supporting the Aquatic Ecosystems EV with respect

to cadmium, copper, selenium and zinc. The 80th percentile concentrations of the Cainozoic sediments data also indicate the groundwater is generally unsuitable to support the Drinking Water EV with respect to chloride, sodium, manganese and selenium, and the Stock Watering EV with respect to sulfate and selenium. The 80th Percentile values at the Cainozoic sediments bores did not exceed any of the Irrigation EVs suggesting the Cainozoic sediments groundwater may be suitable for irrigation (**Table 4-5**).

Groundwater quality data from two bores screened in the Rewan Group shows that most analyte concentrations are generally higher than the Zone 34 Fitzroy Basin WQOs for Aquatic Ecosystem protection. The data also indicates it is generally not suitable for supporting the Aquatic Ecosystems EV with respect to chromium, selenium, zinc and pH. The monitoring bore data also suggests that it is generally not suitable for supporting the Drinking Water EV with respect to chloride, sodium, manganese and pH. The 80th Percentile values at the Rewan Group bores did not exceed any of the Stock Watering or Irrigation EVs suggesting the Rewan Group groundwater may be suitable for stock watering and irrigation (**Table 4-5**).

As with the Cainozoic sediments and Rewan Group, Permian monitoring bore data shows concentrations of most analytes are generally higher than the Zone 34 Fitzroy Basin WQOs for Aquatic Ecosystem protection. Permian monitoring bore data generally suggests Permian groundwater at PTM is also unsuitable to support the Drinking Water and Aquatic Ecosystems EVs (**Table 4-5**). The 80th Percentile values at the Permian bores did not exceed any of the Stock Watering or Irrigation EVs suggesting the Permian groundwater may be suitable for stock watering and irrigation.

In summary, the comparison of available groundwater quality data from the PTM monitoring bores shows that groundwater from all hydrostratigraphic units at PTM is unsuitable to support the Aquatic Ecosystems and Drinking Water EVs, but may be suitable for supporting the Irrigation EV (all hydrostratigraphic units) or Stock Watering EVs (Rewan Group and Permian).

Table 4-5 80th Percentile Summary Statistics and Comparison to Guideline Values

Bore	OBS11	OBS5	OBS14	OBS1	OBS4	OBS9	OBS2	OBS6	OBS10	OBS12	OBS13	Drinking Water (Health)	Drinking Water (Aesthetic)	Irrigation	Stock	Aquatic Ecosystems	Zone 34 Shallow <30m	Zone 34 Deep <30m
Depth	<30m	<30m	<30m	<30m	>30m	>30m	>30m	>30m	>30m	>30m	>30m							
Monitored Unit	Cainozioc	Cainozioc	Rewan	Permian	Rewan	Permian	Permian	Permian	Permian	Permian	Permian							
pH (Field)^	6.83 to 7.22	6.79 to 7.2	6.34 to 6.58	6.71 to 7.24	7.01 to 7.97	7.08 to 7.68	6.73 to 7.27	6.82 to 7.0	7.48 to 7.99	7.3 to 7.55	7.73 to 7.99	-	6.5 to 8.5	-	-	6.5 to 8.5	7.1 to 8.1	7.40 to 8.03
EC (Lab) (µS/cm)	21000	30600	12400	8776	8984	7100	2884	5796	2028	11100	5834	-	-	-	-	-	8910	16000
Ca (mg/L)	124	482	427	185	243	90	62	-	17	136	30	-	-	-	1000	-	215	442
Cl (mg/L)	6860	10020	4290	2720	3120	1796	458	-	115	3920	1656	-	250	-	-	-	3185	5905
Mg (mg/L)	308	975	462	216	89	135	76	-	19	92	11	-	-	-	2000	-	389	491
Na (mg/L)	4158	5684	1698	2162	1490	1294	3450	-	303	2080	1200	-	180	-	-	-	1500	2565
SO4 (mg/L)	332	1790	486	376	2	386	577	-	42	1	2	-	-	-	1000	-	318	398
F (mg/L)	1.4	0.62	-	0.2	0.4	0.3	0.4	-	0.6	-	-	-	-	-	-	-	0.5	0.4
HCO3 (mg/L)	1194	1054	718	878	194	788	1105	-	486	251	436	-	-	-	-	-	878	650
NO3 (mg/L)	0.06	0.03	-	1.01	0.08	0.03	0.12	-	0.03	-	-	-	-	-	-	-	5.3	14.92
Total Alkalinity (mg/L)	1044	875	600	751	159	679	914	-	399	209	363	-	-	-	-	-	752	536
Hardness as CaCO3 (mg/L)	771	5265	3009	1333	979	513	4885	-	147	662	115	-	-	-	-	-	2228	3208
Ag (Diss) (mg/L)	0.0005	0.0025	0.0005	0.5	0.0005	0.0005	0.5	-	0.0005	0.0005	0.0005	0.1	-	-	-	0.05	-	-
Al (Diss) (mg/L)	0.008	0.025	0.005	0.005	0.005	0.011	0.005	-	0.024	0.011	0.02	-	0.2	-	5	0.055	-	-
As (Diss) (mg/L)	0.002	0.0025	0.0005	0.0005	0.002	0.004	0.0005	-	0.0005	0.0174	0.0036	0.01	-	2	0.5	0.024	-	-
Cd (Diss) (mg/L)	0.00005	0.00025	-	0.00005	0.00005	0.00005	0.0003	-	0.00005	-	-	0.002	-	-	0.01	0.0002	-	-
Co (Diss) (mg/L)	0.002	0.007	-	0.0005	0.0005	0.0005	0.0005	-	0.0005	-	-	-	-	0.1	1	-	-	-
Cu (Diss) (mg/L)	0.0006	0.0025	-	0.0005	0.0005	0.0005	0.005	-	0.0005	-	-	2	1	-	1	0.0014	0.03	0.03
Cr (Diss) (mg/L)	0.0006	0.0025	-	0.0005	0.003	0.0005	0.0005	-	0.0005	-	-	0.05	-	-	1	0.001	-	-
Fe (Diss) (mg/L)	0.26	1.186	0.064	0.946	2.03	0.664	0.193	-	0.035	0.66	0.154	-	-	-	-	-	0.14	0.246
Hg (Diss) (mg/L)	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	-	0.00005	0.00005	0.00005	0.001	-	-	0.002	0.0006	-	-
Mn (Diss) (mg/L)	0.245	0.6854	-	0.2058	0.517	0.046	0.6452	-	0.061	-	-	0.5	0.1	10	-	1.9	0.16	0.291
Ni (Diss) (mg/L)	0.0014	0.005	-	0.003	0.005	0.002	0.0026	-	0.0005	-	-	0.02	-	-	1	0.011	-	-
Pb (Diss) (mg/L)	0.0005	0.0025	-	0.0005	0.0005	0.0005	0.0005	-	0.0005	-	-	0.01	-	-	0.1	0.0034	-	-
Se (Diss) (mg/L)	0.005	0.025	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	0.01	-	-	0.02	0.005	-	-
Zn (Diss) (mg/L)	0.0338	0.0352	-	0.028	0.022	0.011	0.045	-	0.006	-	-	-	3	-	-	0.008	0.06	0.317

Highlighted values exceed relevant WQO Red highlight = exceeds multiple guideline values ^ = 20th & 80th percentile values Note: Limit of Reporting (LOR) converted to x0.5 as per DES, 2021

4.5 Groundwater Receptors

4.5.1 Anthropogenic

A search of the Queensland Government's Registered Groundwater Bore Database (GWDB) (DRDMW, 2024) and the Bureau of Meteorology's National Groundwater Information System (NGIS) (BoM, 2017) was carried out for registered bores within 5 km of PTM. The search returned 166 bores with registered uses as mine monitoring (119 bores), water supply (26 bores), coal seam gas monitoring (1), decommissioned (15) and unknown (5 bores). The location of private water supply bores (i.e. those 26 bores listed in the GWDB as water supply) and potential water supply bores (i.e. those 5 bores listed as unknown) are shown on **Figure 4-15**.

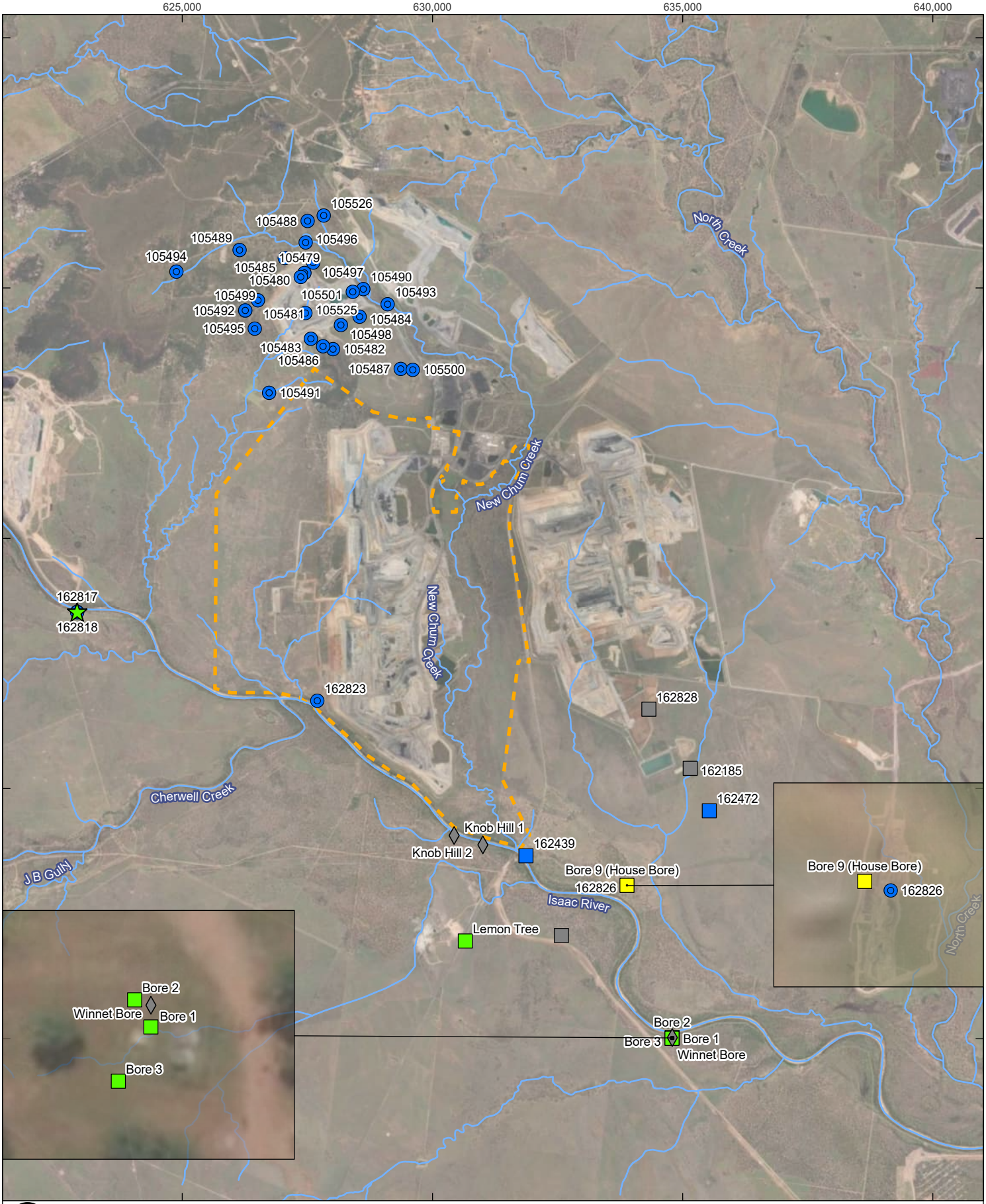
Landholder bore census surveys have been undertaken in the vicinity of PTM by SKM (2008) as part of the PTM Environmental Impact Statement, Golder (2019) and Pembroke (2018) for the Olive Downs Project, for the Isaac Downs Project (AGE, 2019) and for the Winchester South Project (SLR, 2020). These censuses included 15 bores within 5 km of the PTM Area, including identification of 8 unregistered bores (**Table 4-6** and **Figure 4-15**). The location of these unregistered bores are included on **Figure 4-15**.

Table 4-6 Groundwater Bores identified by Bore Census within 5 km of PTM

RN	Bore Name	Easting[1]	Northing[1]	Depth (m)	Purpose	Geology	In use?	Survey
Unregistered	Bore 9 (House Bore)	633886	7553064	-	Domestic	Alluvium	Yes	Olive Downs Bore Census 2017
Unregistered	Lemon Tree	630655	7551954	-	Stock	-	Yes	Olive Downs Bore Census 2017
Unregistered	Bore 1	634791	7550019	-	Stock	-	No	Olive Downs Bore Census 2017
Unregistered	Bore 2	634788	7550024	19.85	Stock	Permian	No	Olive Downs Bore Census 2017
Unregistered	Bore 3	634785	7550009	94	Stock	Permian	No	Olive Downs Bore Census 2017
Unregistered	Knob Hill 1	631005	7553874	-	Unknown	Tertiary	Yes	Winchester South Bore Census/Monitoring (2020)
Unregistered	Knob Hill 2	630431	7554061	-	Unknown	Tertiary	Back-up	Winchester South Bore Census/Monitoring (2020)
Unregistered	Winnet Bore	634791	7550023	-	Unknown	Alluvium	-	Winchester South Bore Census/Monitoring (2020)
162817	5 MILE BORE	622899	7558531	-	Stock	Alluvium, Cainozoic, top of RCM?	Present	Isaac Downs Bore Census 2018

RN	Bore Name	Easting[1]	Northing[1]	Depth (m)	Purpose	Geology	In use?	Survey
162818	5 MILE WINDMILL	622899	7558524	-	Stock	Alluvium, Cainozoic, top of RCM?	Present	Isaac Downs Bore Census 2018
162439	162439	631867	7553655	8.9 - 11.9	Monitoring	Isaac River Alluvium	Yes	Olive Downs Bore Census 2017
2485	2485	632576	7552064	-	Unknown	-	Abandoned/ destroyed?	Olive Downs Bore Census 2017
162828	Turkey Nest Bore	634323	7556584	-	Unknown	-	Present	Olive Downs Bore Census 2017
162185	162185	635149	7555403	120 - 138	Unknown	Rangal Coal Measures	Unknown	Olive Downs Bore Census 2017
162472	162472	635531	7554554	81 - 90	Monitoring	-	Yes	Olive Downs Bore Census 2017

1 GDA94z55
* no bore was located at registered coordinates - Land representative was not aware of bores presence or status



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.31445.00000
Date Drawn:	01-May-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Groundwater Database Bore

Bore Census - Use

- Isaac Downs Bore Census 2018 - Stock
- Olive Downs Bore Census 2017 - Domestic
- Olive Downs Bore Census 2017 - Monitoring
- Olive Downs Bore Census 2017 - Stock
- Olive Downs Bore Census 2017 - Unknown
- Winchester South Bore Census/Monitoring (2020) - Unknown

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PRIVATE BORES

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FIGURE 4-15

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_14_Private Bores

4.5.2 Environmental

4.5.2.1 Groundwater Dependent Ecosystems

National Atlas of Groundwater Dependent Ecosystems

A groundwater dependent ecosystem (GDE) is a natural ecosystem that requires "access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services" (Richardson, S., et al., 2011).

The BoM's National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) (BoM, 2017) classifies ecosystems based on the potential for dependence on groundwater through multiple lines of scientific evidence. Ecosystems have been mapped as either:

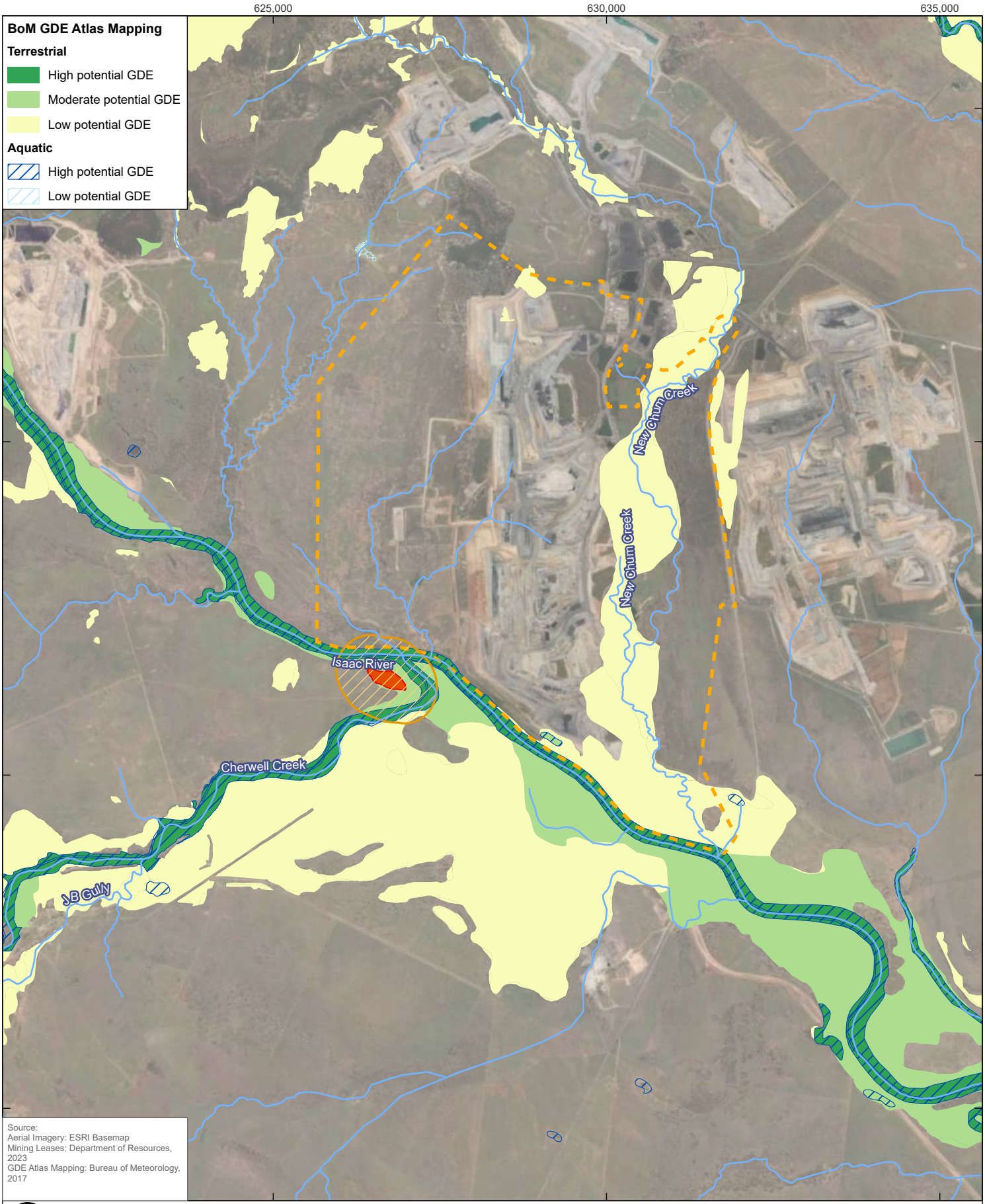
- Known (previously mapped) GDEs;
- High potential for groundwater dependence (indicating a strong possibility the ecosystem is interacting with groundwater);
- Moderate potential for groundwater dependence; or
- Low potential for groundwater dependence (indicating it is relatively unlikely the ecosystem will be interacting with groundwater and will include ecosystems that are not interacting with groundwater).

Desktop mapping of potential aquatic and terrestrial GDEs indicates that areas with possible high, moderate, and low potential for groundwater interaction occur in the vicinity of PTM. These areas are mainly associated with Isaac River, Cherwell Creek and New Chum Creek in the immediate vicinity of PTM (**Figure 4-16**). The GDE Atlas does not show any mapped known GDEs (or springs) within 10km of the PTM Area.

In addition to the GDE Atlas mapping, it is also noted that part of the area mapped as a high potential aquatic GDE along the Isaac River southwest of PTM (adjacent the Cherwell Creek confluence) is mapped as a High Ecological Significance (HES) wetland (**Figure 4-16**). The Map of Queensland wetland environmental values is a statewide statutory map under the EPP (Water and Wetland Biodiversity). It identifies wetlands of high ecological significance (HES) and general ecological significance (GES) across the state. Wetland protection areas (WPA) are policy trigger buffer areas that protect HES wetlands in the Great Barrier Reef catchments. The aim of the WPA buffer is to limit development within proximity of the HES wetland to provide for continual ecological protection. The WPA trigger area is also shown on **Figure 4-16**. The WPA area associated with the HES wetland extends onto the PTM Area, but remains outside of the PTM mining footprint. Further discussion on the HES wetland is provided below, in terms of the results of the recent GDE ground-truthing field study completed at PTM.

Local GDE Studies

A GDE field assessment at PTM was completed by 3D Environmental in August 2023 (3D Environmental, 2024) in accordance with the methods described in the GDE Toolbox (Richardson et al. 2011). The field survey focused on areas mapped as potential Aquatic and Terrestrial GDEs in the GDE Atlas (**Figure 4-16**), which are associated with woody vegetation occupying creek channels, floodplain vegetation and vegetation associated with older residual surfaces. In total, 10 representative sites were chosen for targeted GDE assessment, with soil augering completed at a subset of these and additional augering sampling completed at the Winchester South Project downstream (southeast) of PTM used to supplement these (**Figure 4-17**).



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	620.31445.00000
Date Drawn:	01-May-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Wetland of High Ecological Significance
- Wetland Trigger Area

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

GROUNDWATER DEPENDENT ECOSYSTEM MAPPING

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FIGURE 4-16

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_15_Groundwater Dependent Ecosystems Mapping

The methodology included testing using several methods for the purpose of using multiple lines of evidence to assess vegetation groundwater dependence including:

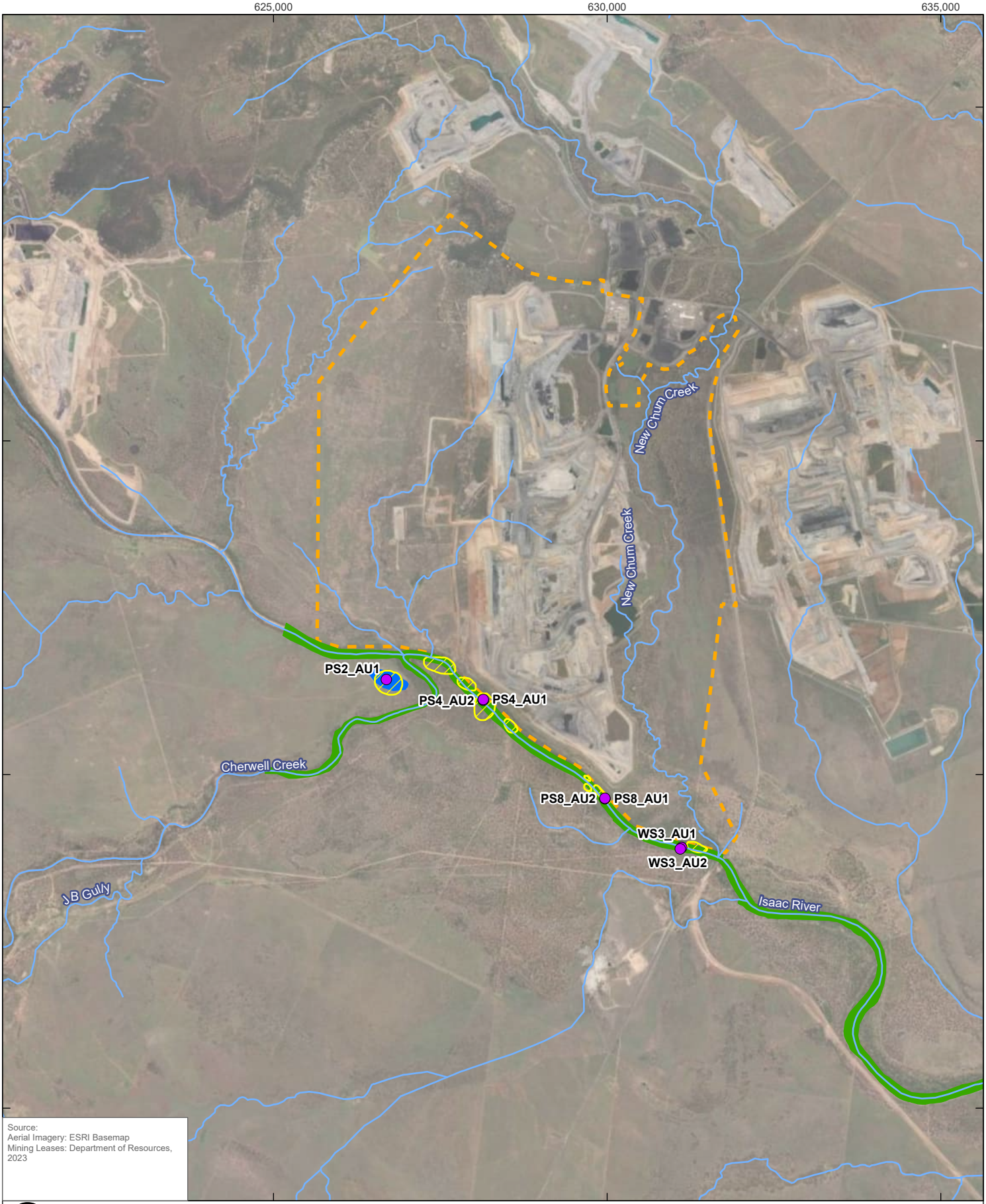
- Leaf Water Potential (LWP) - Provides indication as to whether trees are utilising saturated zones or soil moisture.
- Leaf Area Index (LIA) – Provides indication of a trees' response to reduced water availability and stress.
- Soil Moisture Potential (SMP) - Hand augering profiling to characterize SMP for areas where LWP indicates potential groundwater usage.
- Xylem Stable Isotope Sampling and Analyses and water sampling - Comparison of isotopic ratios of water contained in vegetation with those found in various sources of water to help define predominant source of water used.

Data interpretation followed a structured approach in which multiple lines of evidence were filtered to provide an assessment of groundwater dependence. The biophysical measurement of LWP formed the assessment, followed by the adjunct comparison with SMP, with stable isotope data used to provide supplementary evidence where ambiguity remained. As a final filter, the depth to groundwater table and groundwater salinity were used to determine potential for accessibility to groundwater and suitability as a source of moisture to support transpiration at each assessment locality.

The data from the assessment by 3D Environmental (2024) was summarised as follows:

1. Combined application of LWP and SMP measurements demonstrate the vast majority of riparian vegetation fringing the Isaac River is utilising soil moisture in the unsaturated portion of the soil profile to support transpiration at the time of assessment (i.e. not groundwater from below the water table). This is supported by analysis of the stable isotope composition of xylem, soils and waters which demonstrates twig xylem samples are generally isotopically enriched above other sources.
2. There is some evidence from stable isotopes that some components of fringing riparian vegetation (RE 11.3.25 – River Red Gum woodland) may be utilising moisture from the shallow river sand aquifer at some test sites (e.g. PS9), although this is likely to be restricted to trees on the lower riverbanks, and potential for groundwater utilisation decreases with distance from, and height above the river. That is, usage of groundwater from below the water table is restricted to some, but not all, River Red Gum vegetation located immediately on the current river channel.
3. The HES wetland southwest of PTM was similarly confirmed to be utilising moisture sourced from an unsaturated 3 m thick massive sequence interval of sand above the groundwater table and above weathered basement rock. Moisture sources were confirmed through reconciliation of data from three parameters which include SMP, LWP and stable isotope signatures of soil, xylem and water. Though no saturation was present at the time of survey, the sandy interval may become variably saturated during wet seasons through downward leakage of surface waters, with evidence from strong iron staining of sand grains suggesting a seasonally fluctuating water table, which may only be wet following significant surface pondage and associated leakage.

Based on the assessment, 3D Environmental (2024) inferred the spatial extent of Terrestrial (Type 1) and Wetland (Type 2) GDEs are confined close to the Isaac River as shown on **Figure 4-17**.



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	620.31445.00000
Date Drawn:	01-May-2024
Drawn by:	RB

LEGEND

- Watercourse
- Project Area
- Auger Hole
- Assessment Area

Known/Likely GDE Area

- Type 1
- Type 2

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

3D ENVIRONMENTAL (2024) LOCAL GDE ASSESSMENT AREAS AND KNOWN/LIKELY GDE AREAS

SLR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 4-17

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_F04_21_3D Environmental 2024 Local GDE Assessment Areas and known likely GDE Areas

As previously discussed, the hand augering by 3D Environmental intersected alluvial water directly within and immediately fringing the river bed channel but not away from it, with groundwater found between 1.5 and 1.7 m below the river bed. The results show that alluvial groundwater levels are closest to the ground surface within the river bed itself, but become rapidly deeper below ground surface level away from the incised channel on the topographically elevated river banks. This suggests that it is only the vegetation immediately fringing the river channel that might be able to access groundwater, as away from the channel itself the water table is too deep. Based on the results of the field survey it was concluded that the riparian vegetation immediately fringing the Isaac River and the major tributary of Cherwell Creek, plus floodplain wetland ecosystems including the HES wetland, represent the only GDEs identified during the assessment.

The riparian vegetation fringing the Isaac River is supported by the seasonally variable alluvial groundwater unit associated with fluvial sand deposits, which is seasonally recharged by surface flow events in the river. The groundwater system that supports the HES wetland vegetation on the floodplain south of the river is hosted in a thick interval of sand above the regional water table, is ephemeral in nature and is maintained by infiltration of ponded surface water (i.e. not connected to the regional groundwater system). Discharge of this groundwater is driven by evapotranspiration, and possible downwards leakage, with extended periods when deep rooted wetland vegetation relies solely on soil moisture.

The field assessment indicates that alluvial groundwater may dry drying during extended drought periods, accelerated by evapotranspiration. In this sense, the alluvial groundwater is likely to be seasonal with riparian trees demonstrating facultative dependence on the resource, with a shift to utilisation of soil moisture when the water is depleted. The interpretation that these GDEs demonstrate facultative dependence is consistent with previous GDE field studies in the vicinity of the PTM Area, including the nearby Isaac Downs Project (3D Environmental, 2019) and the Winchester South Project (SLR, 2020) which suggested that potential GDEs along the Isaac River are not solely reliant on groundwater for survival, with these vegetation communities capable of surviving on residual rainfall derived soil moisture present in unsaturated shallow soil layers.

An ecohydrological conceptual model produced by 3D Environmental (2024) showing the relationship between the alluvial water, deeper Permian groundwater and GDEs in the vicinity of the Isaac River is presented for as **Figure 4-18** (dry season), **Figure 4-19** (wet season), and **Figure 4-20** (baseflow); and for the HES wetland as **Figure 4-21** (dry season); and **Figure 4-22** (wet season).

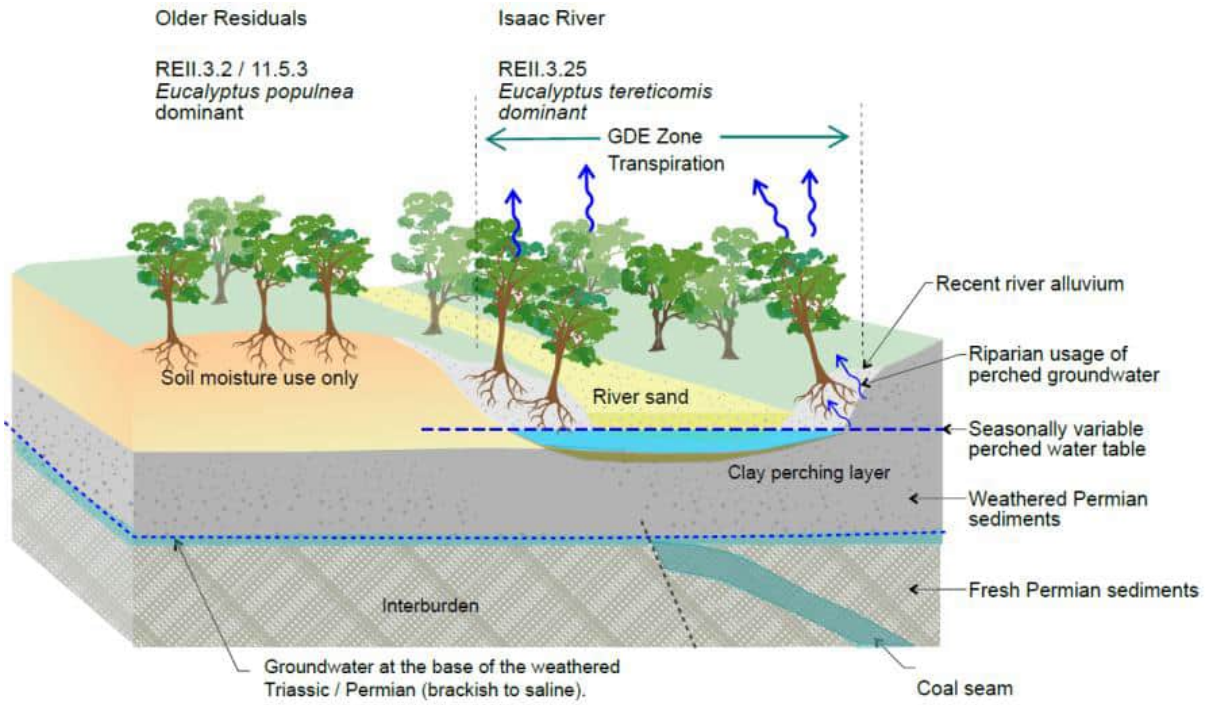


Figure 4-18 3D Environmental Ecohydrological Conceptual Model - Isaac River Dry Season

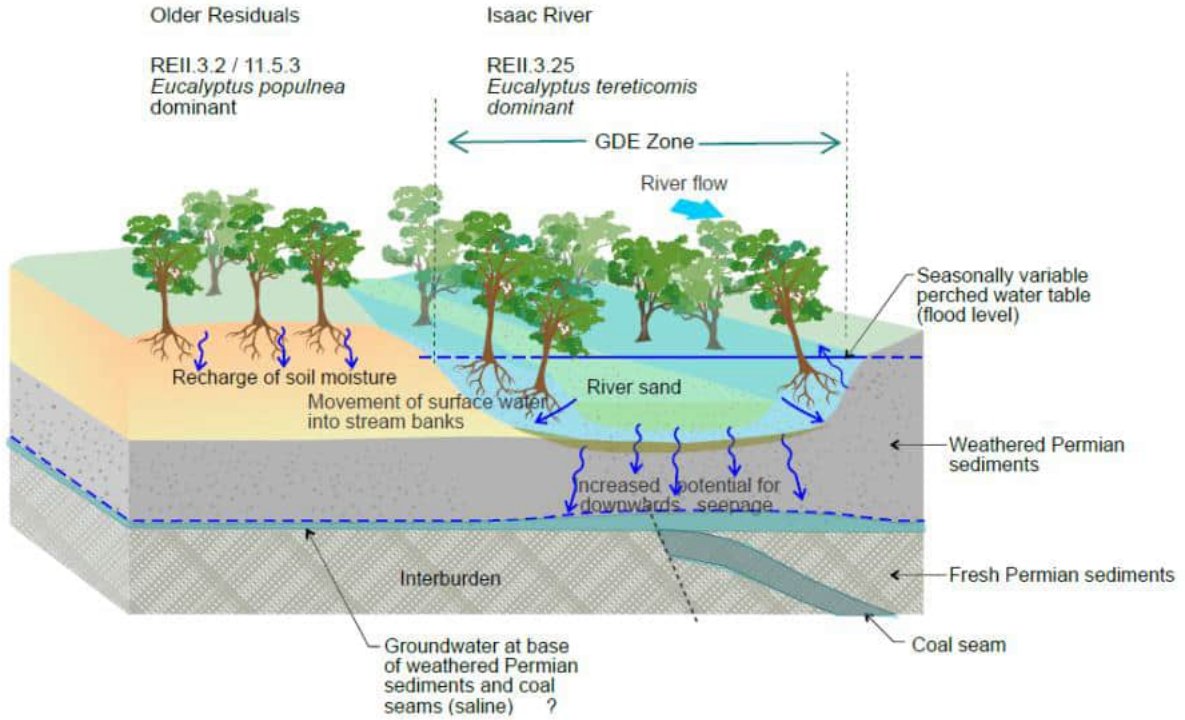


Figure 4-19 3D Environmental Ecohydrological Conceptual Model - Isaac River Wet Season

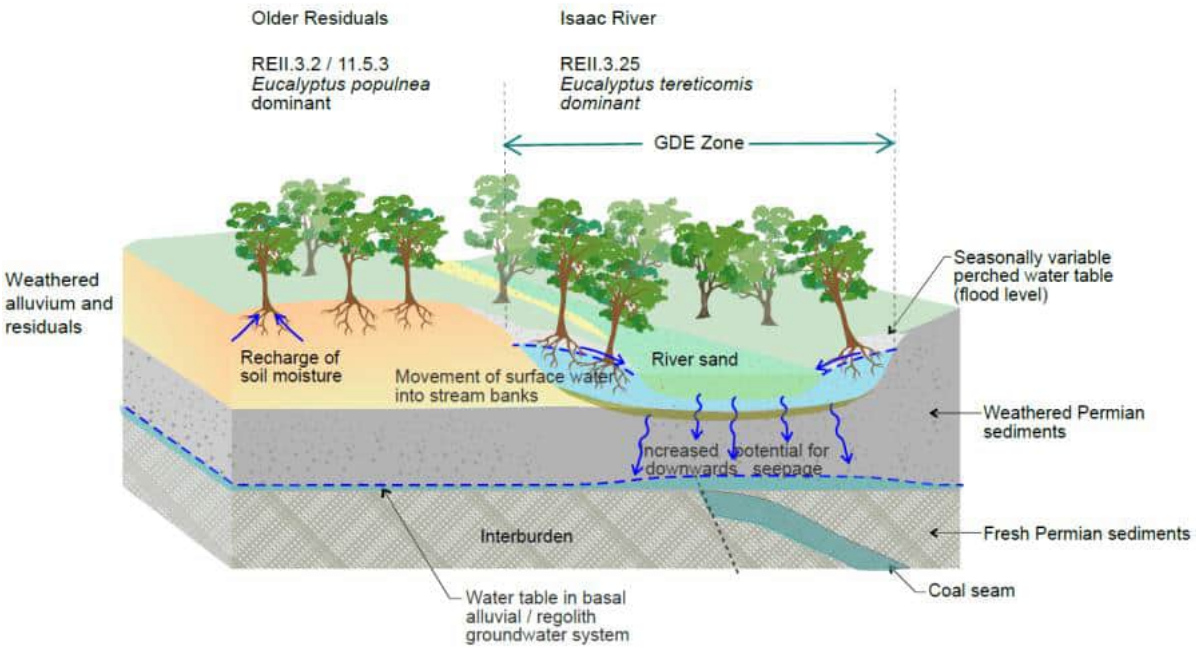


Figure 4-20 3D Environmental Ecohydrological Conceptual Model – Isaac River Baseflow Regime

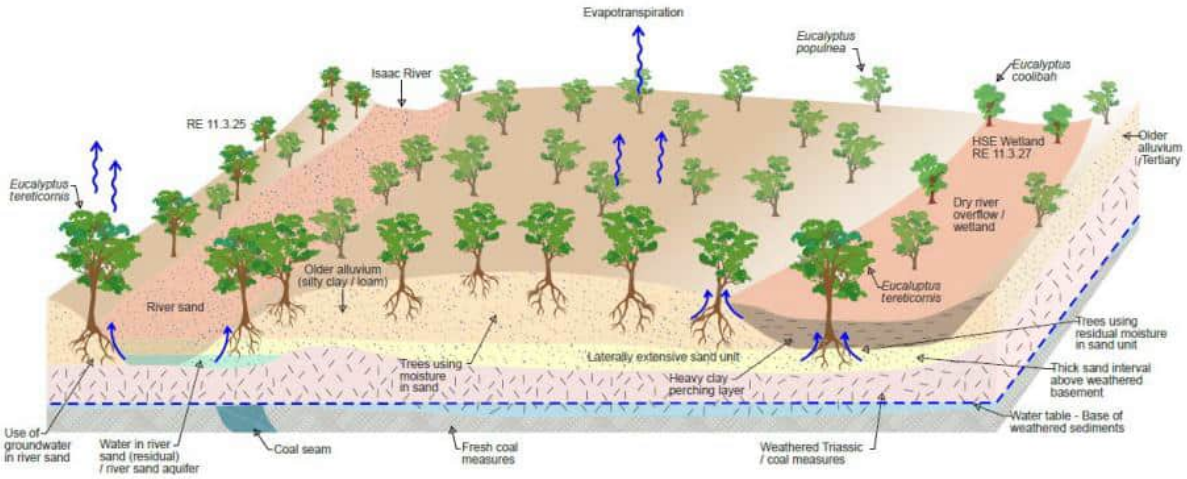


Figure 4-21 3D Environmental Ecohydrological Conceptual Model – HES Wetland Dry Season

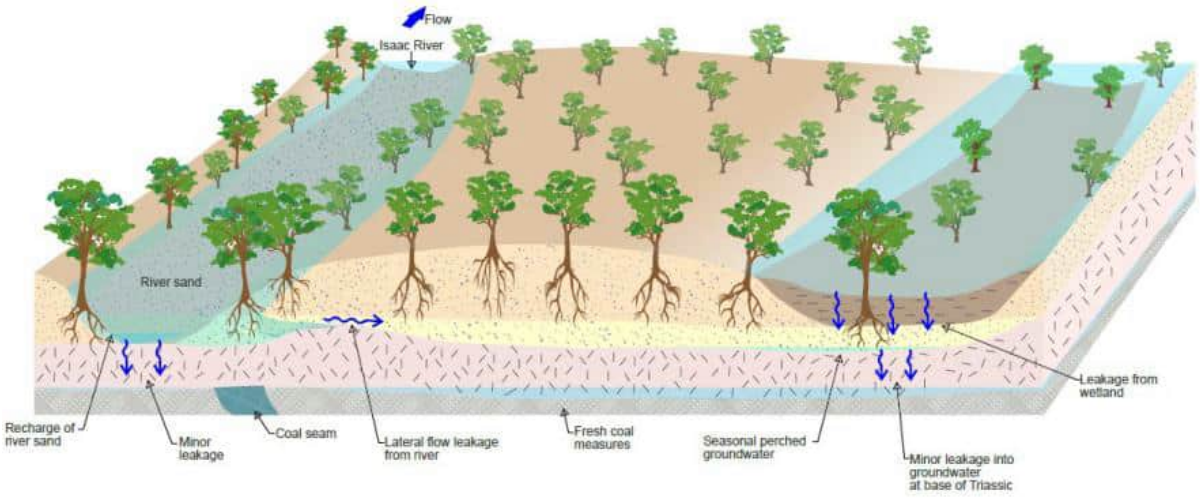


Figure 4-22 3D Environmental Ecohydrological Conceptual Model – HES Wetland Wet Season

4.5.2.2 GDE Local Studies Supporting Information

A GDE study was completed for the nearby Isaac Downs Project west (upstream) of the PTM Area that included hydro-ecological assessments using desktop and field based methods (3D Environmental, 2019). Similar to the 3D Environmental (2024) study discussed above, this study focussed on the potential GDEs mapped in the vicinity of the Isaac River (i.e. the Isaac River and associated floodplain environment that also is present adjacent PTM). The study results indicated:

- The terrestrial GDEs are often sustained by multiple sources of water, including direct rainfall, flooding, stored soil moisture and groundwater.
- Two areas were identified where terrestrial vegetation is likely interacting with shallow unconfined alluvial groundwater, both associated with riparian ecosystem analogous to RE 11.3.25.
- One of the identified GDE areas (denoted GDE Area 2 in the study) extended over much of the extent of the modern Isaac River stream channel and fringing vegetation, whilst the second GDE area (denoted GDE Area 2) was much more localised to a particular area of the river where the channel is broader.
- In the smaller GDE Area 2, the majority of trees were inferred to be permanently interacting with shallow groundwater in the alluvial aquifer. This was surmised to be due to the geomorphic characteristics of the river channel in this location, with a broad inner bench and flood overflow facilitating rapid recharge of the shallow aquifer. It was also found that there is also the likelihood that basement rock subcrop is elevated in this location relative to other areas on the river, providing a physical control on aquifer depth that facilitates a greater degree of interaction between the tree root zone and groundwater.
- In the larger GDE Area 1, vegetation on the riparian fringe was found to be variably interacting with groundwater dependent on position on the riverbank, with trees fringing the river channel generally demonstrating a greater degree of groundwater interaction than those higher up the bank. There is also likely to be a significant proportion of trees in GDE Area 2 that have no, or limited dependence on groundwater.

- In both GDE Areas, outside the modern Isaac River stream channel, moving up the inner bank onto higher river terraces, the dependence of vegetation on groundwater decreases significantly to the point that there is no interaction between trees and groundwater on the higher, older alluvial terraces.
- There is no suggestion that vegetation is utilising groundwater from deeper confined aquifers associated with coal seams.
- Providing volumetric changes to the alluvial aquifer are not rapid and otherwise normal hydrological function of the river system is maintained, the study found that mining related impacts to the identified GDEs are likely to be minor.

The results of the 3D Environmental (2019) study at the Isaac Downs Project are overall very similar to those found by 3D Environmental (2024) at PTM.

5.0 Conceptual Hydrogeological Model

A conceptual hydrogeological model (CHM) of the groundwater regime has been developed based on the review of the hydrogeological information for the PTM Area and surrounds as presented in the above report sections. Visual representation of the CHM is shown as **Figure 5-1**.

PTM is located within the northern part of the Bowen Basin. The geology of PTM comprises the stratified sequences of Permian aged Rangal Coal Measures, unconformably overlain by the Triassic Rewan Group, and by regolith where it occurs at subcrop, which is comprised of weathered Permian rock and unconsolidated to semi-consolidated Tertiary-aged sediment. Overlying the regolith in proximity to the Isaac River along the southern margin of PTM is Quaternary alluvium deposited by the River.

The key hydrostratigraphic units relevant to PTM include:

- Cainozoic Sediments –
    - Quaternary alluvium – unconfined aquifer where sparsely saturated (water-bearing strata of permeable rock, sand, or gravel) localised along the Isaac River;
    - Quaternary to Tertiary alluvium, colluvium and weathered units (collectively termed regolith) – unconfined and largely unsaturated unit bordering alluvium;
- Triassic Rewan Group – Considered a regional scale aquitard, however, some saturated more hydraulically conductive horizons exist within, particularly within the upper weathered zone.
- Permian Coal Measures - Coal seams of this unit form the primary regional aquifer. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden.

At PTM, the deeper parts of the unconsolidated Cainozoic alluvial sediments of the Isaac River, other Cainozoic sediments (e.g. Tertiary sediments), and weathered regolith, generally function as one interconnected hydrogeologic unit, though with significant heterogeneity given the lithological and stratigraphic distinctions within. Along the Isaac River, the alluvium comprises a highly heterogeneous distribution of silts to sands interspersed with lenses of clays and gravels. The hydraulic properties of the alluvium vary due to the variable lithologic composition; the hydraulic conductivity of the alluvium decreases away from the channel margin into the floodplain area due to the fining of sediments (i.e. a greater fraction of clay and silt).

Where present, groundwater within the alluvium is disconnected from the riverbed elevation. Spatially, the basal alluvium is locally variably saturated and drilling results close to PTM have indicated it is dry and/or comprised only of clay in several locations, with groundwater hosted in deeper coarser grained intersections of alluvium that are likely representative of incised paleochannels.

Immediately below and adjacent the Isaac River channel and banks at around 1.5 mBGL, alluvial groundwater is facultatively accessed by riparian terrestrial vegetation immediately fringing the current river channel. Away from the immediate proximity of the river channel, the alluvial groundwater system is too deep to be accessed by terrestrial vegetation.

Local groundwater elevations in the alluvium suggest groundwater flow towards the PTM mining area. Regionally, groundwater flow within the alluvium is a subdued reflection of topography, with groundwater flowing in a southeasterly direction consistent with the alignment of the Isaac River. Groundwater levels within the alluvium are also highest close to the Isaac River, indicating potential losing conditions from the Isaac River to the

underlying alluvium during flow periods. Recharge to the unconsolidated sediments is considered to be primarily from stream flow losses or flooding (losing streams), with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding.

Hydraulic connection between the Cainozoic unconsolidated sediments and the underlying formations is limited to areas where relatively high hydraulic conductivity units (e.g. coal seams) subcrop beneath the unconsolidated sediments, although the weathering horizon at the interface of the Permian and overlying Cainozoic units may reduce this connectivity. General downwards recharge to deeper units is limited by the low hydraulic conductivity (confining) coal measure interburden sequences. Water quality in the Cainozoic Sediments ranges from saline to highly saline and is indicated to be generally unsuitable to be used for drinking water or stock purposes, but may be suitable for irrigation purposes.

The Triassic aged Rewan Group, present across most of PTM, is considered a regional scale aquitard, though still contains some saturated horizons. Due to its typically fined grained nature, the Rewan Group generally exhibits a low vertical hydraulic conductivity, resulting in limited hydraulic connection between the unit and the underlying/overlying units, however local permeability testing indicates hydraulic conductivity values may be higher in the upper weathered zone of the unit. Despite acting as a regional aquitard, there are two active monitoring bores screened in the Rewan Group observing saturated horizons within the PTM Area. Though there is limited data available, groundwater flow direction would be expected to follow topographic gradients. Recharge is expected to occur predominantly via leakage from the overlying units. Recharge rates are likely very low due to the low hydraulic conductivity of the unit restricting infiltration. Discharge is expected occur via lateral flow, with the low hydraulic conductivity limiting any leakage to underlying units. Water quality in the Rewan Group ranges from moderately saline to highly saline and is indicated to be generally unsuitable to be used for drinking water, but may be suitable for stock, or irrigation purposes.

In the Permian aged coal measures strata, groundwater is encountered mainly in the coal seams, and occasionally in the sandstone/siltstone units. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences, with low hydraulic conductivity interburden generally confining the individual seams. The coal seams are dual porosity in nature with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats). Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at subcrop where the overlying strata permits. Regionally, groundwater within the Permian coal measures flows in a south-easterly direction with local modification of flow towards the active mining areas.

The Permian coal measures at PTM have undergone extensive deformation, including folding and faulting. Faults are common, with numerous main northwest-southeast trending faults (i.e. Isaac Thrust Fault and New Chum Fault), and minor southwest-northeast trending faults. These faults significantly compartmentalise the Permian groundwater system, particularly the major northwest-southeast trending faults. The compartmentalisation is likely to have contributed to the observed lack of significant response of groundwater levels to PTM mining outside of the mine footprint. Hydraulically, the Permian coal measures within the PTM Area is somewhat separated from units east and west of PTM due to faulting. Review of fault behaviour within the Study Area and from external studies has identified that faults can increase vertical hydraulic conductivity parallel to the fault trace and reduce it

perpendicular to the fault trace. However, any increases in vertical hydraulic conductivity is limited to small vertical horizons (<20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. Hydraulic testing of faults at sites near to PTM within the Study Area indicate that faulting zones tested are not pathways for preferential flow but rather act as hydraulic barriers.

Recharge to the Permian coal measures occurs where the unit subcrops. Due to the low hydraulic conductivity of the interburden material, groundwater largely flows horizontally, along the bedding plane of the coal seams. Groundwater discharge occurs predominantly via evaporation from pit faces in mining operations. Water quality in the Permian units ranges from moderately saline to highly saline and is indicated to be generally unsuitable to be used for drinking water, but may be suitable for stock, or irrigation purposes.

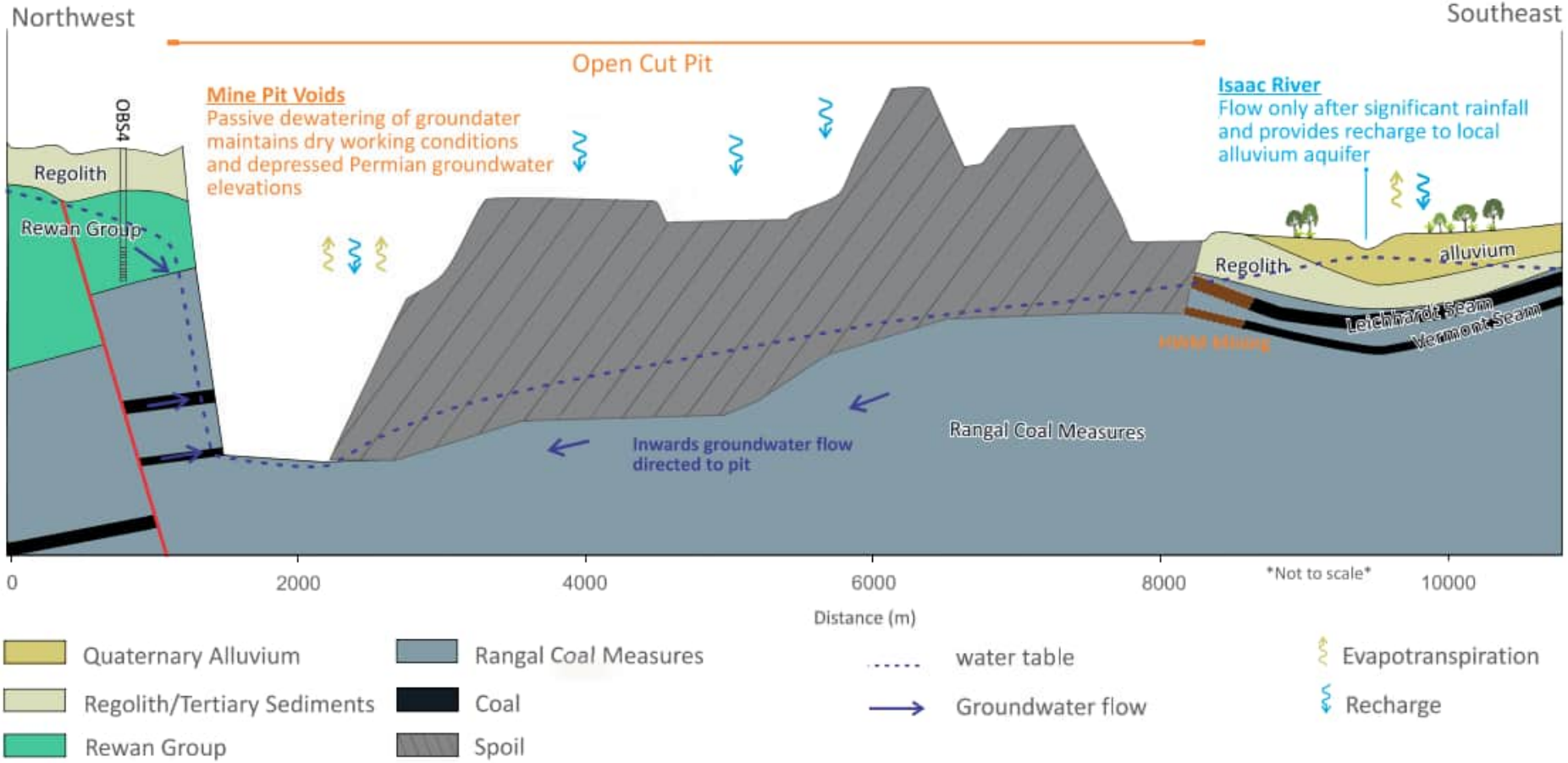


Figure 5-1 Conceptual Hydrogeological Model of PTM Groundwater System – (End of Mining)

6.0 Groundwater Modelling

6.1 Model Details

The existing PTM numerical groundwater model was adopted for the PRCP's hydrogeological assessment. This section provides a summary of the design and development of the PTM numerical groundwater model. Details of the PTM numerical groundwater model are included within SLR (2023b), whilst SLR (2022a) provides the details of the most recent model update of the model as adopted for this hydrogeological assessment.

The existing PTM numerical groundwater model was deemed appropriate for the purposes of the PRCP for the following reasons:

- Adoption of the MODFLOW-USG code in the existing model allows for sufficient refinement of the model grid around the PTM operations such that the limitations of a regional model in terms of the grid design are mitigated.
- The groundwater incorporates the PTM geologic model with groundwater model layer representation consistent with the geologic model.
- The model is robustly calibrated to PTM specific monitoring data as well as an extensive regional dataset including that collected at neighbouring mines.
- The model incorporates regional influences that may interact with the groundwater system (and model predictions) post-closure at PTM, including operations at the neighbouring Daunia Mine and Millennium Mine that are considered likely to interact with the PTM void given their proximity.
- The model was recently accepted by DESI as part of the PTM HWM Project EA Amendment application / approval (SLR, 2023a and 2023b).
- The model adopted for the PRCP is the latest update to the existing regional numerical model that has been subject to multiple independent peer reviews, as well as State and Commonwealth regulator reviews, and has found widespread acceptance as a result of those reviews. In particular, the independent peer reviewer of the prior SLR (2021b) Caval Ridge Mine version of the model found that "the documented groundwater assessment is best practice" and that the "groundwater modelling has been conducted to a very high standard" (HydroAlgorithmics, 2021).

6.1.1 Model Objectives

Numerical modelling was undertaken in support of this hydrogeology assessment for the PRCP to evaluate the potential impacts of the final landform (refer **Section 1.2**) on the groundwater regime. The objectives of the predictive modelling were to:

- Assess groundwater inflow to the final landform's residual void;
- Simulate the level and rate of recovery of the residual void lake, and the level and rate of mining-related groundwater drawdown recovery in the groundwater system surrounding the residual void; and
- Identify areas of potential risk, such as private supply bores (**Section 4.5.1**) or GDEs (**Section 4.5.2**), where groundwater impact mitigation/control measures may be necessary post-closure.

6.1.2 Model Design

The most recently updated version of the regional numerical groundwater model was developed primarily to support the Saraji East Mining Lease Project approvals process, building upon the version of the model previously developed specifically for PTM. The model is regional in nature, designed primarily to predict regional scale mining impacts in a cumulative impact framework. That is, mines such as PTM are represented within the regional cumulative hydrogeological impact framework in which they sit.

The numerical model was developed using a Geographic Information System (GIS) in conjunction with MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the USGS. MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard.

The numerical groundwater model builds on the regional scale Olive Downs Project model (the foundational model) (HydroSimulations, 2018). The foundational model was subsequently updated for the Moorvale South Project in 2019 (SLR, 2019), Winchester South Project in 2020 (SLR, 2020), Caval Ridge Mine (CVM) Horse Pit Extension (HPE) Project in 2021 (SLR, 2021a), Lake Vermont North (LVN) Extension Project (SLR, 2021b), Millennium Mine (MIL) Mavis Extension (SLR, 2021c), the Daunia Mine (DNM) Water License Review later in 2021 (SLR, 2021d), and then the PTM HWM Project in 2022 (SLR, 2023b). Most recently, the model was updated for the Peak Downs Mine Continued Operations Project and the Saraji East Mining Lease Project (SLR, 2022a).

At the time of the model revision developed for the PTM HWM Project (SLR, 2023b), a range of model updates were deemed required to ensure the previous iteration of the regional Bowen Basin model was fit for purpose for use at PTM. The updates to the model design that were undertaken included:

- Model extent and grid – revise grid refinement around PTM.
- Model layers – update layers to capture faulting within PTM area and match the PTM geological model.
- Boundary Conditions – update model boundary conditions with revised grid and regional flows.
- Stresses – Maintain inputs, but with updates from more recent and site-specific data.

These updates resulted in a model that was deemed suitable for the representation of all historic and future mining at PTM, as well as the post-mining period.

Model layering is based on a simplified regional scale representation of the central Bowen Basin hydrogeological framework. The model layer structure is presented in **Table 6-1**.

Table 6-1 Model Layering

Model Layer	Geologic Formation	Hydrogeologic Unit	Present at PTM
1	Alluvium, colluvium, Tertiary basalt	Alluvium, surface cover	Yes
2	Tertiary sediments, Tertiary basalt	Tertiary sediments, weathered Permian, Tertiary basalt	Yes
3	Rewan Group	Triassic	Yes
4	Rangal Coal Measures	Leichhardt overburden	Yes
5		Leichhardt seam	Yes
6		Interburden	Yes
7		Vermont seam	Yes
8		Vermont underburden	Yes
9	Fort Cooper Coal Measures	Fort Cooper overburden	Yes
10		Fort Cooper seams (combined)	Yes
11		Fort Cooper underburden	Yes
12	Moranbah Coal Measures	Q Seam	Yes
13		Interburden	Yes
14		P Seam	Yes
15		Interburden	Yes
16		H Seam	Yes
17		Interburden	Yes
18		D Seam	Yes
19		Interburden	Yes

6.1.3 Model Calibration

A detailed description of the calibration procedure for the most recent version of the model as adopted for this report is provided in SLR (2022a). The numerical model includes a steady state and a transient calibration (2008 to 2021). In all, calibration used 3,499 target heads for 282 bores, including 11 observation sites at PTM. Both the steady-state and transient calibrations capture historical mining at PTM, Saraji, Peak Downs, Caval Ridge, Lake Vermont, Daunia, Millennium, Isaac Plains, Olive Downs and Grosvenor mines. Mining was represented in the model using the MODFLOW drain package, with the drain cells set to the base of the target coal seam for each pit, and within the target coal seam for underground mines. Calibration of the model was carried out with the objective being to replicate the groundwater levels measured in the in the PTM, Saraji, Caval Ridge, Lake Vermont, Winchester South Project, Olive Downs, Moranbah South Project, Moorvale South Project, Millennium, and Daunia monitoring networks, as well as some registered bores, in accordance with Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Given the regional scale model design, equal weighting was applied to all bores/data from each site so as not to bias model calibration to any one area/mine and potentially decrease model reliability elsewhere, but provide the most robust regional scale calibration possible given the regional cumulative hydrogeological impact framework. This approach also means

that any data uncertainty associated with a single calibration point in any one model layer will not bias the calibration results, as all data for each layer from across the entire regional model domain is treated equally. Similarly, the calibration approach means that the influence on calibration performance of any perceived lack of local calibration points for a layer at any particular mine site, or a relatively short monitoring record at anyone monitoring site, is somewhat mitigated by the regional scale approach to calibration where calibration is aiming to achieve the best fit to all available data across any one model layer. The number of model calibration points and associated target head measurements for each layer is provided in **Table 6-2**.

Table 6-2 Model Calibration Targets (SLR, 2022a)

Model Layer	Geologic Formation	Hydrogeologic Unit	Calibration Target Locations	Number of Target Head Measurements
1	Alluvium, colluvium, Tertiary basalt	Alluvium, surface cover	18	212
2	Tertiary sediments, Tertiary basalt	Tertiary sediments, weathered Permian, Tertiary basalt	93	910
3	Rewan Group	Triassic	15	153
4	Rangal Coal Measures	Leichhardt overburden	10	251
5		Leichhardt seam	28	358
6		Interburden	6	123
7		Vermont seam	23	259
8		Vermont underburden	5	175
9	Fort Cooper Coal Measures	Fort Cooper overburden	23	338
10		Fort Cooper seams (combined)	10	90
11		Fort Cooper underburden	4	29
12	Moranbah Coal Measures	Q Seam	3	117
13		Interburden	2	39
14		P Seam	6	99
15		Interburden	5	66
16		H Seam	14	85
17		Interburden	3	7
18		D Seam	14	138
19		Interburden	0	0
		Totals	**282**	**3449**

Calibration for the model achieved a 10.4 m root mean square (RMS) error, equating to a 6.9% scaled root mean square (SRMS) error, which is within the recommended range (i.e. 10%) in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). Observations from the PTM monitoring bores achieved an RMS error of 6.4 m, reflecting slightly better calibration performance at PTM bores than across the remainder of the model domain. Calibrated hydraulic parameters were shown to be all within the range of available field data (SLR, 2022a). The model has been previously deemed to reliably simulate historic

groundwater system response to PTM mining, and therefore is considered reliable for the purpose of predicting future potential impacts at PTM (SLR, 2023c).

6.1.4 Model Performance and Limitations

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), the Murray Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2001) and the released IESC Explanatory Note for Uncertainty Analysis (IESC, 2018). These are mostly generic guides and do not include specific guidelines on special applications, such as underground coal mine modelling.

The 2012 Australian Groundwater Modelling Guidelines has replaced the model complexity classification of the previous MDBC guideline by a "model confidence level" (Class 1, Class 2 or Class 3 in order of increasing confidence) typically depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design and construction.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

It is generally expected that a model confidence level of Class 2 is required for mining environmental impact assessment; the 2012 Australian Groundwater Modelling Guidelines state that a Class 2 model may be used for assessing impacts associated with mine dewatering (Barnett et al. 2012).

Table 6-3 summarises the subjective qualitative criteria allowing model classification, per Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines. The classification of the PTM model as presented in **Table 6-3** has been assessed subjectively by a Principal level groundwater modeller and reviewed by a Technical Director level hydrogeologist/modeller.

The assessment shown in **Table 6-3** indicates that, overall, the PTM groundwater model can be classified as primarily Class 3 using the 2012 Australian Groundwater Modelling Guidelines classification system (effectively “high confidence”), with some aspects meeting the lower Class 2 criteria. This is considered an appropriate level for this PRCP context. The classification of the previous iteration of the model as at least Class 2 has been validated by an independent expert hydrogeologist/modeller (HydroAlgorithmics, 2021), with that independent reviewer noting that “all models are in fact mixtures of Class 1, Class 2 and Class 3”.

Table 6-3 Groundwater Model Classification Table[1,2]

Class	Model Characteristics					
	Data		Calibration		Prediction	
1		Few or poorly distributed data points		Not possible		Predictive timeframe >> calibration timeframe
		Unavailable or sparse data in areas of greatest interest		Unacceptable levels of error		Temporal discretisation is different to calibration
	✓	No metered groundwater extraction data		Inadequate distribution of data		Transient prediction but steady state calibration
		Remote climate data		Targets incompatible with model purpose		Unacceptable validation
		Little or no useful data on land-use, soils, or river flows and stage elevations				
2		Some data but may not be adequate throughout domain	✓	Reasonable calibration statistics with errors in parts of the model	✓	Predictive timeframe > calibration timeframe
		Some metered groundwater extraction data		Long-term trends not replicated in all parts of domain		Long stress periods compared to calibration
	✓	Streamflow and stage measurements are available at some points		Transient calibration not extending to present day		New stresses not in calibration
		Reliable irrigation application data available in part	✓	Weak seasonal replication		Poor validation
				No use of calibration targets compatible with model purpose		
			✓	Validation not undertaken		
3	✓	Spatial and temporal distribution of data adequate	✓	Scaled RMS error or other calibration statistics are acceptable		Predictive timeframe ~ calibration timeframe
		Clearly defined aquifer geometry	✓	Long-term trends adequately replicated where important	✓	Temporal discretisation in predictive model consistent with transient calibration
		Reliable metered groundwater extraction data		Seasonal fluctuations adequately replicated	✓	Similar stresses to those in calibration
	✓	Rainfall and evaporation data is available	✓	Transient calibration is current		Steady state prediction consistent with steady state calibration
	✓	Aquifer testing data to define key parameters	✓	Model is calibrated to heads and fluxes		Model validation suggests calibration is appropriate
	✓	Good quality and adequate spatial coverage of DEM	✓	Key modelling outcomes dataset used in calibration		Steady-state predictions when the model is calibrated in steady-state
		Streamflow and stage measurements are available at many points				
		Reliable land-use and soil-mapping data available				
		Reliable irrigation application data available				

1. Refer Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines (Barnett et al. 2012)
2. Grey highlighted cells = model has been subjectively assessed to meet the classification criteria for that Class

6.2 PRCP Final Landform Model

Post-mining groundwater impacts at PTM were investigated for the purposes of the PRCP's hydrogeology assessment with a numerical groundwater recovery model for the final landform (i.e. one residual void; refer **Section 1.2**).

6.2.1 Model Setup

The PRCP's proposed final landform was replicated in the recovery model, including areas of spoil emplacement within mined out pits and the proposed residual void. The distribution of modelled spoil emplacement is shown on **Figure 6-1**.

The recovery model commenced from the end of mining at PTM (end of the year 2035) and was run for 2309 years over 82 model stress periods. The model stress period setup is shown in **Table 6-4**.

Table 6-4 Recovery Model Stress Periods

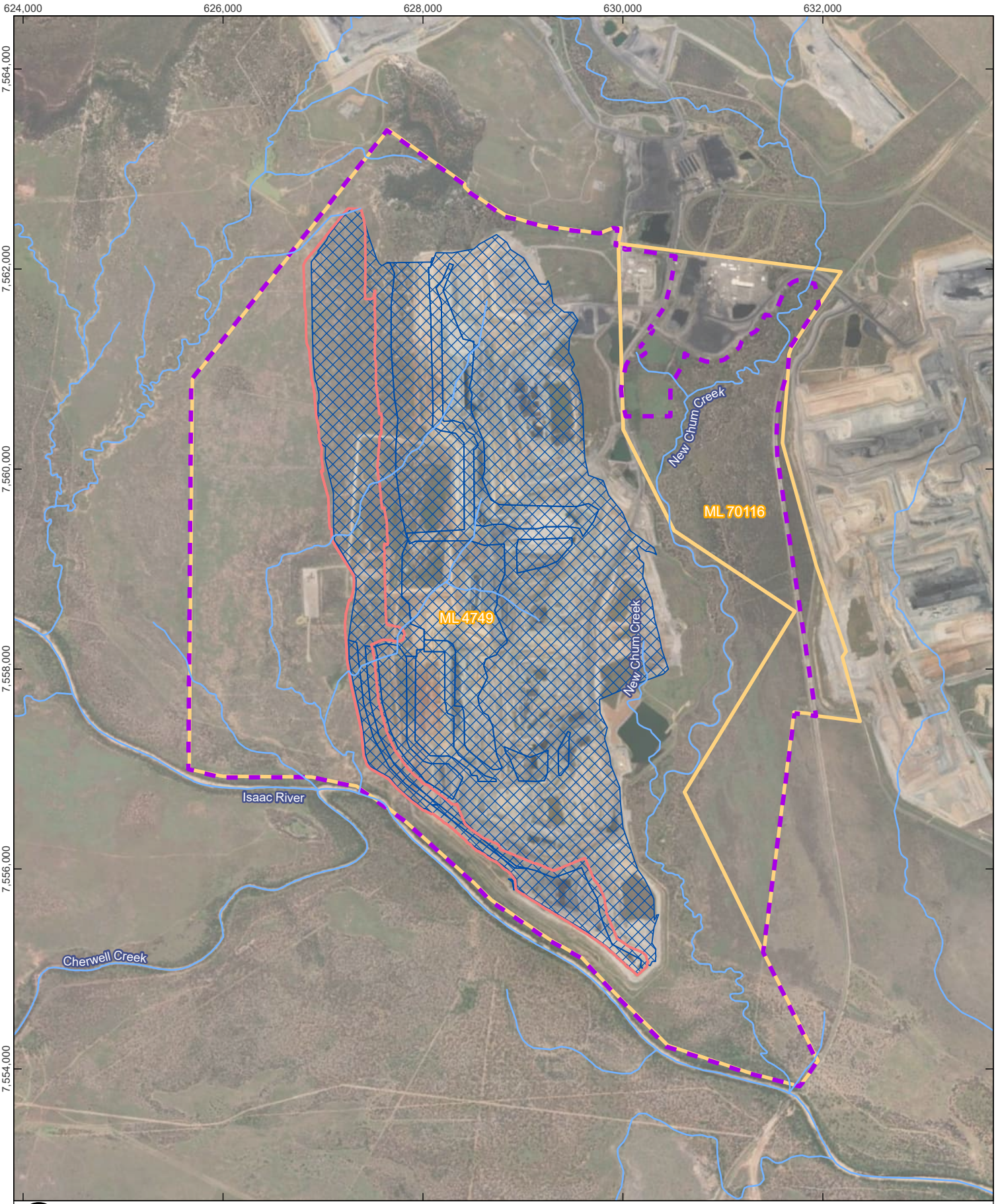
Stress Period	Stress Period Duration (Years)	Starting Year (Post-Mining)	Ending Year (Post-Mining)
1 – 20	1.0	1	20
21 – 28	5.0	21	60
29 – 48	1.0	61	80
49 – 58	2.0	81	100
59 – 63	5.0	101	125
64 – 77	10.0	126	265
78 – 81	50.0	266	465
82	1843.0	466	2309

The final recovery model adopted for reporting in this hydrogeology assessment used end of PTM mining predicted groundwater levels from the predictive model as the starting heads, and removed all drain cells simulating the proposed mining areas at PTM to allow groundwater levels to equilibrate. The starting heads for each relevant hydrostratigraphic unit are provided in **Appendix A**.

Climate-related boundary conditions (i.e. recharge and evapotranspiration [ET]) in the recovery model were set constant for the duration of the recovery model, at their values consistent with the predictive model (SLR, 2022a). Recharge and ET were not applied to the final void in the groundwater model, since the WSP (2024) water balance model was used iteratively with the groundwater model (see **Section 6.2.2**) accounts for these boundary conditions.

The properties of the residual void cells were converted to values representative of void values consistent with the methodology adopted in the predictive model (SLR, 2022a). That is, the void cells were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of 5.0×10^{-6} m^{-1}), to simulate free water movement within the residual void.

The simulations of Millennium Mine and Daunia Mine in the groundwater model, located immediately north and east of the PTM Area respectively, have the potential to influence the model results at PTM. The simulation of these mines in the PTM PRCP model utilises the proposed final landforms for those sites in accordance with their respective PRCP hydrogeology assessments (SLR, 2023d and 2023e).



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	AS

LEGEND

- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Modelled Spoil Extent

POITREL MINE PRCP
HYDROGEOLOGY ASSESSMENT

SIMULATED SPOIL EMPLACEMENT

SLR

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FIGURE 7-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_01_Simulated Spoil Emplacement

6.2.2 Integration with Residual Void Water Balance Model

Figure 6-2 presents a conceptual diagram of the post-mining modelling setup adopted for this hydrogeological assessment. As shown in **Figure 6-2**, the residual void will accumulate water over time due to direct rainfall, surface water runoff and groundwater inflow from both spoil and natural rock as groundwater levels recover. Whilst the numerical groundwater model can reliably account for the groundwater inflow component, the surface components of direct rainfall, surface water runoff, as well as evaporative loss from the void lake, are considered to be better accounted for within a surface water balance model. This is due to the inherently more refined nature of simulating those surface components within a water balance model, as compared to a numerical groundwater model. This surface water modelling is discussed below.

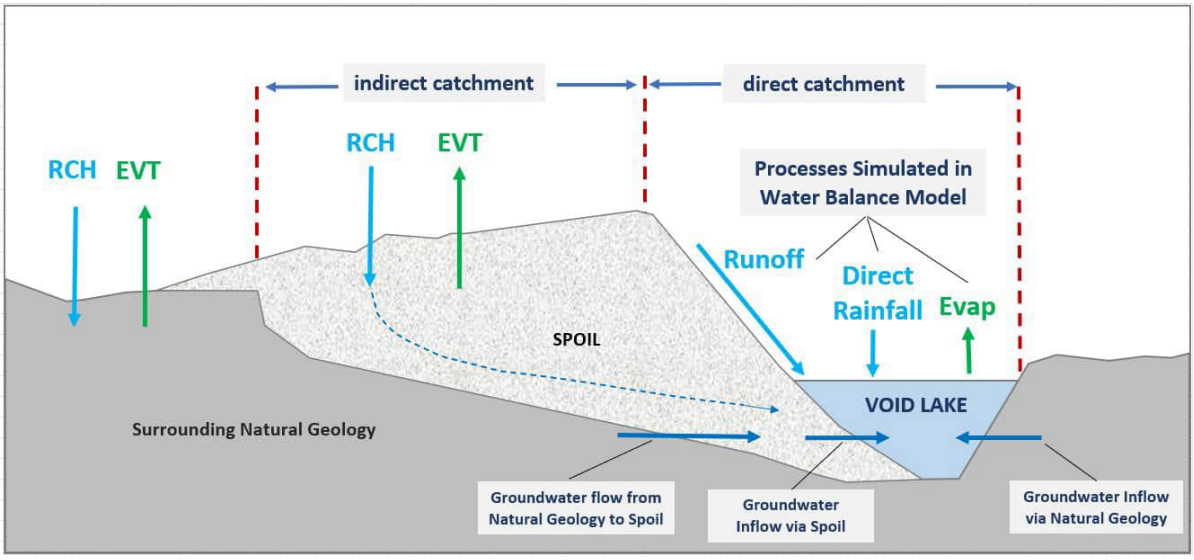


Figure 6-2 Residual Void Recovery Model Conceptual Diagram

The groundwater model was therefore used to predict the following fluxes to the residual void:

- Groundwater inflow to the pit shell from the surrounding geology, including inflow from the natural geology to the spoil backfill and inflow from the natural geology directly to the residual void; and
- Groundwater inflow originating from the indirect catchment (i.e. areas of spoil backfill that receive rainfall recharge that then flows through the spoil into the residual void).

Void water levels were not predicted by the groundwater model, but were estimated by the balance between groundwater inflow and the direct rainfall and rainfall runoff from the surrounding catchment against the evaporation loss from the lake surface through iterative surface water balance modelling (WSP, 2024). The iterative modelling approach was undertaken in a stepwise manner as follows:

1. The residual void lake levels with time were initially predicted by the WSP (2024) water balance model, incorporating surface water fluxes and processes and initial analytical estimates of groundwater inflows.
2. To refine the prediction of residual void groundwater inflows to the residual void, the daily residual void water elevations derived from the WSP (2024) water balance modelling (Step 1) were then replicated within the numerical groundwater model for

the final landform using the time variant constant head boundary (CHD) condition, adopting a simplified average of the WSP (2024) daily results over the relevant groundwater model stress period length.

3. Revised predictions of the residual void lake levels with time were then made by the WSP (2024) water balance model, incorporating the numerical groundwater model predicted groundwater inflows (Step 2), and the surface water fluxes and processes.
4. To further refine the prediction of residual void groundwater inflows to the residual void, the revised daily residual void water elevations derived from the WSP (2024) water balance modelling (Step 3) were then again replicated within the numerical groundwater model for the final landform using the time variant constant head boundary (CHD) condition.
5. Since the refined groundwater model predictions for fluxes to the residual void from were then in agreement with what was used as input to the water balance modelling, it was considered by WSP (2024) and SLR that further iterations between the two models were not required and therefore the Step 4 groundwater model results were adopted for reporting in this hydrogeology assessment.

6.2.3 Residual Void Lake Recovery

Figure 6-3 provides a graphical representation of the final simulated recovery of water levels in the residual void, based on the iterative groundwater and surface water balance modelling. It should be noted that, as predicted groundwater inflow to the void is only approximately 3% of the total volumetric inflow to the void (see **Section 6.2.4**), within the water balance model the surface water fluxes are the dominant driver for the estimated void water levels and associated trends, rather than the predicted groundwater inflow volumes.

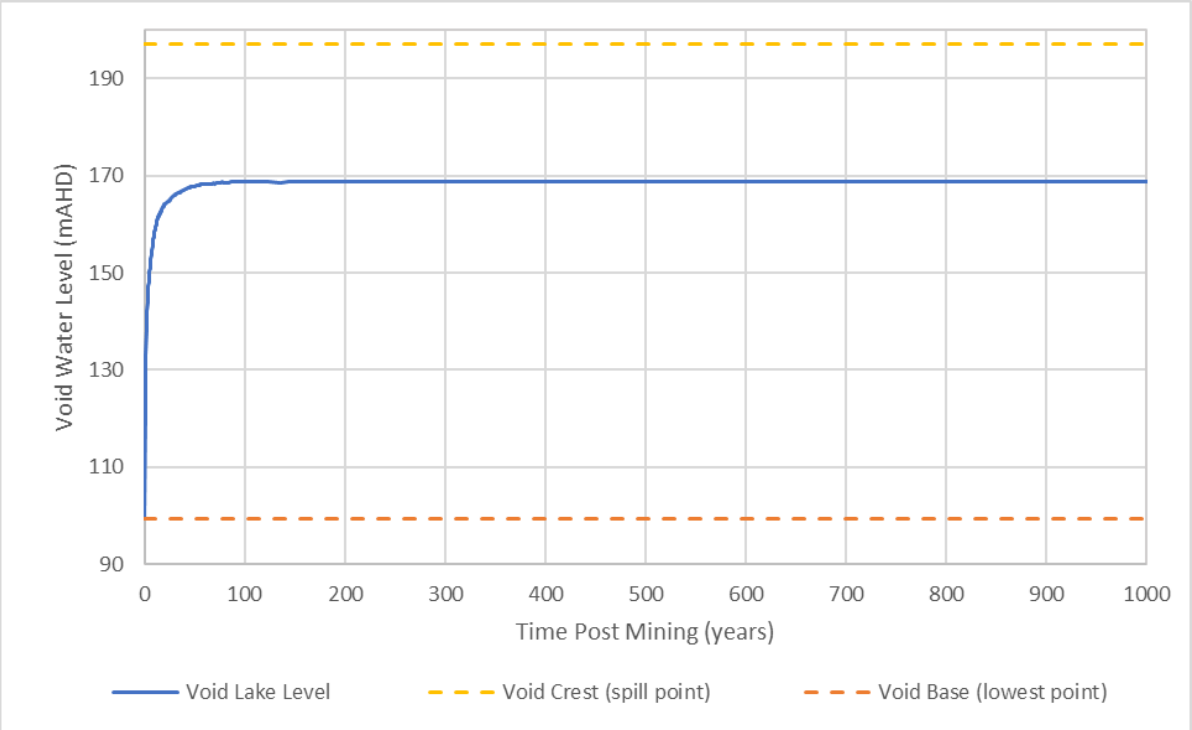


Figure 6-3 Simulated Void Water Level Recovery over Time – Ramp 10/20/30/40/50 Residual Void (based on WSP, 2024)

Figure 6-3 shows that the residual void water level recovery is a process that takes decades with the recovery rate declining as the lakes reach equilibrium conditions. The majority of recovery in the void is achieved within the first 50 years and equilibrium water level conditions are reached after approximately 84 years in the groundwater model. The predicted equilibrated water levels and the freeboard (i.e. the difference in elevation between the long-term water levels in the residual void and the landform crest elevation) in the residual void is shown in **Table 6-5**. Predicted void lake level remains significantly below the surface 'spill' level for the residual void.

Table 6-5 Equilibrated Water Levels in the Ramp 10/20/30/40/50 Residual Void (based on WSP, 2024)

Initial water level (mAHD)	Approximate time to equilibrium (years)	Equilibrium water level (mAHD)	Freeboard (m)
99	84	169	28

The difference in elevation between the long-term water levels in the residual void and the lowest point of the base of the shallow geologic formations (Surface cover incl alluvium; model Layer 1, and Tertiary sediments and weathered regolith; model Layer 2) adjacent the void is as shown in **Table 6-6**. Predicted residual void lake levels remain below the base of the shallow geologic formations for the residual void. That is, there is no potential for a flux of water to leave the residual void and enter the shallow geologic formations.

Table 6-6 Predicted Difference between Residual Void Water Levels and Shallow Formations

Model Layer / Formation	Lowest Elevation of base of Model Layer adjacent Void (mAHD)	Difference between void lake level and lowest elevation of base of Model Layer adjacent Void (m)[1]	
		Start of Post-Mining	Post-Mining Equilibrium
Layer 1 (Alluvium)	170.0	70.8	1
Layer 2 (Regolith)	182.0	82.8	13

1. A positive number means the base of Model Layer is that many metres higher than the void lake level

6.2.4 Residual Void Groundwater Inflow

The final predicted groundwater inflows to the residual void from the groundwater model is shown on **Figure 6-4**, with inflows partitioned between that which flows into the residual void through spoil, and that which flows into the residual void through surrounding natural geological formations.

In approximately the first 50 years post-mining, groundwater levels are predicted to remain suppressed, particularly within the spoil around each residual void that is yet to saturate to a significant degree. During this time, groundwater fluxes to the void are largely controlled by the difference between the predicted spoil groundwater levels and the predicted WSP (2024) residual void lake levels that rise and fall periodically (refer **Figure 6-3**) according to:

- the day-on-day climatic simulation within the WSP (2024) water balance model; and
- how the daily timestep water balance results are translated to the groundwater model's more simplified stress period setup.

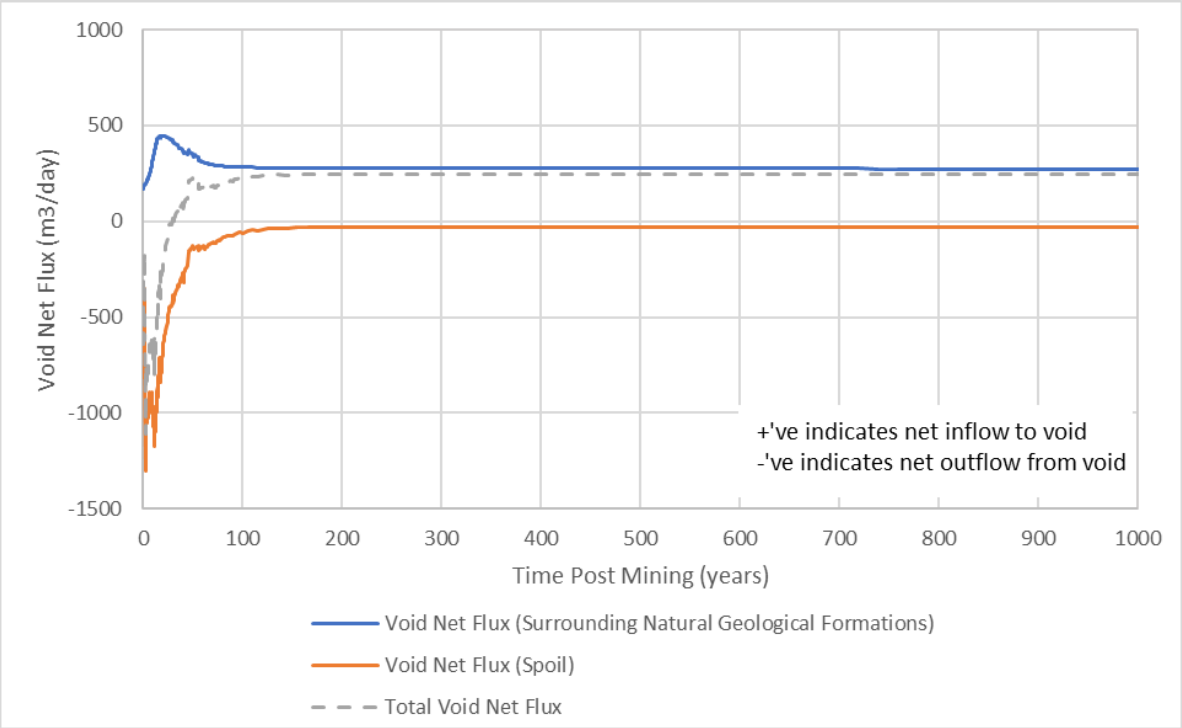


Figure 6-4 Predicted Void Groundwater Inflows – Ramp 10/20/30/40/50 Residual Void

Accordingly, there are periods of variable groundwater outflow from the void to the spoil and inflow to the void from the natural geological formations predicted by the groundwater model. Over these time periods, rainfall derived surface water captured in the residual void (per the WSP water balance model) is predicted to move into the spoil, as the groundwater levels in the surrounding in-pit spoil backfill (and natural geological formations) slowly recover from mining activities. All predicted outflows from the residual void over this time occur to the spoil, that is, there is no predicted outflow from the void to the natural geological formations. It is noted that any form of further backfilling of the residual void to above the groundwater level as a means to attempt to limit this early post-closure void water discharge will likely result in poorer environmental outcomes, as water in the backfilled void will have a hydraulic head gradient toward the surrounding groundwater system. This will facilitate discharge outwards to the surrounding environment, in the absence of the hydraulic control (sink) caused by a relatively deep void lake that is maintained by evaporation in the long term (SLR, 2022b).

Predicted equilibrium groundwater fluxes to the residual void are presented in **Table 6-7**. The net equilibrium groundwater inflows to the residual void shown in **Table 6-7** represent approximately 3% of the total volumetric inflow to the residual void's water balance (WSP, 2024), that is, groundwater volumetric contribution to the residual void is very small in comparison to surface water (rainfall and runoff) contribution.

Table 6-7 Equilibrium Groundwater Inflow to the Ramp 10/20/30/40/50 Residual Void

Equilibrium Net Flux from Spoil to Residual Void (m^3/day)[1]	Equilibrium Net Flux from Natural Geological Formations (m^3/day)[2]	Equilibrium Net Flux – Total (m^3/day)
-28.2	273.6	245.4

1. Directly net flux from spoil into the residual void lake.
2. Directly net flux from natural geological formations into the residual void lakes.

6.2.5 Predicted Groundwater Levels

Groundwater level predictions and associated discussion are presented in this section.

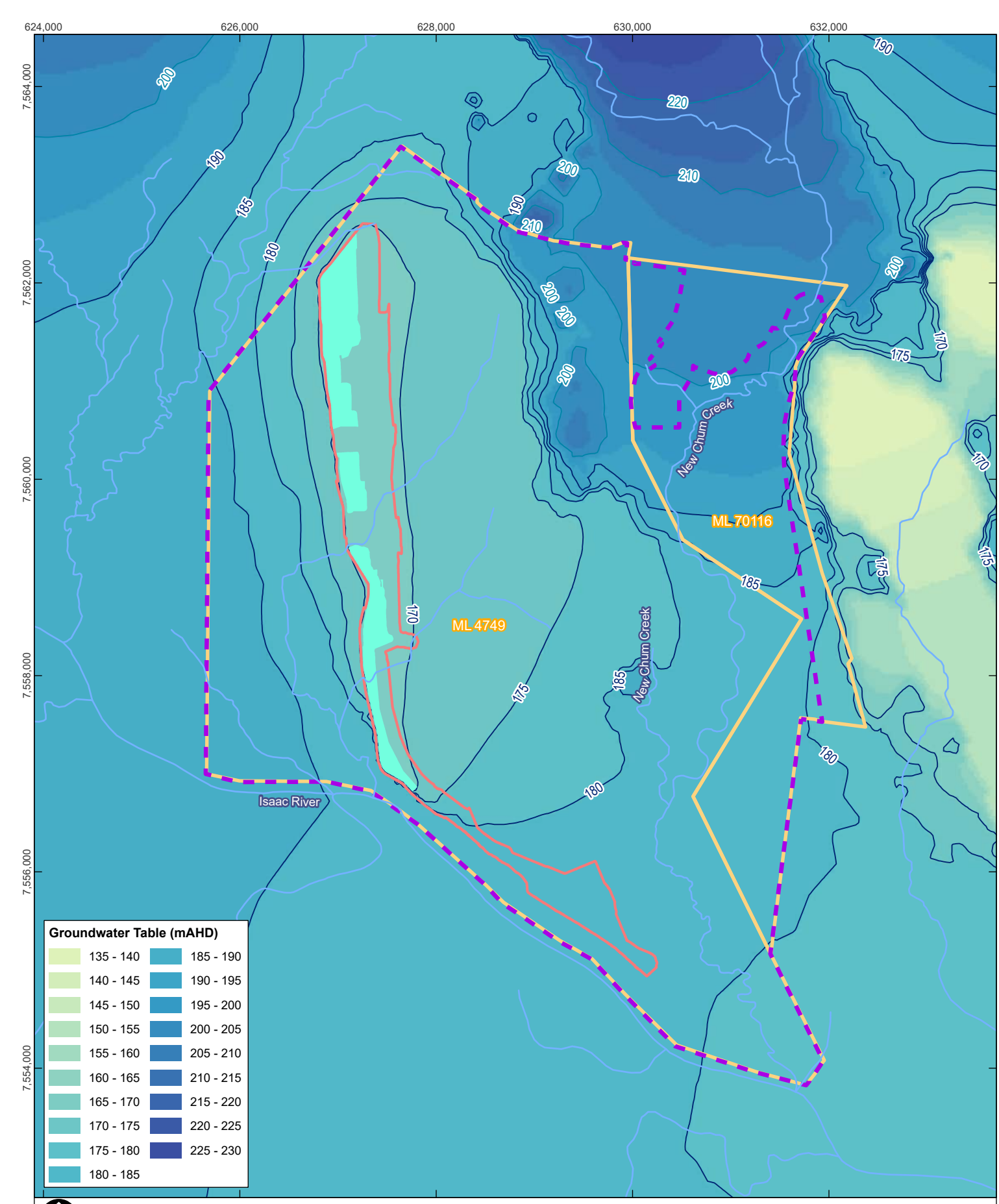
Groundwater Levels – General

The predicted equilibrium water table elevation adjacent to the residual void is shown on **Figure 6-5**. Predicted groundwater levels for the Alluvium, Regolith, Leichhardt and Vermont Seams (model layers 1, 2, 5, and 7, respectively) outside of the residual void are shown on **Figure 6-6** through to **Figure 6-9**, again at equilibrium.

Groundwater levels surrounding the final void are controlled by the predicted residual void lake levels, which in turn are controlled by the rate of evaporation from the void lakes balancing mostly surface inflows and some groundwater inflows to the lakes (WSP, 2024), including a component of groundwater net flux from spoil and the natural geological formations into the residual void (refer **Table 6-7**). The conceptual relationship between these components is displayed in **Figure 6-2**. That is, predicted groundwater levels are a function of predicted lake levels, which as discussed in **Section 6.2.3** are dominantly controlled by surface water fluxes and maintained by evaporation.

The water table is predicted to remain depressed in the immediate vicinity of the residual void in the long term, driven by the ongoing groundwater discharge to the residual void lake and governed by the lake elevation itself. That is, long term inwards groundwater flow gradients are maintained post-mining for the water table. There is a sharp gradient from the natural geological formations, whereas it is relatively flat from the spoil. This is in part due to a residual head difference of over 10 m between groundwater in the natural geological formations and the residual void lake, compared to less than 5 m head difference between the spoil emplacement area and the residual void lake, whilst also in part being due to the lower hydraulic conductivities of the natural geology as compared to the spoil.

The Alluvium is predicted to remain ‘dry’ in the long term within most of the PTM Area consistent with current conditions, with some saturation present in the south of the PTM Area. The Regolith is predicted to remain ‘dry’ in the long term across most of the PTM Area also consistent with current conditions, with some saturation present in the west, south, and east of the PTM Area. Predicted groundwater levels for the Leichhardt and Vermont Seams indicate that groundwater levels are predicted to remain depressed in the long term, driven by the ongoing groundwater discharge inwards towards the residual void lake and governed by the lake elevation.



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	AS

LEGEND

- Groundwater Elevation (5mAHD)
- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake

POITREL MINE PRCP
HYDROGEOLOGY ASSESSMENT

PREDICTED WATER TABLE ELEVATION – POST-MINING EQUILIBRIUM

SLR

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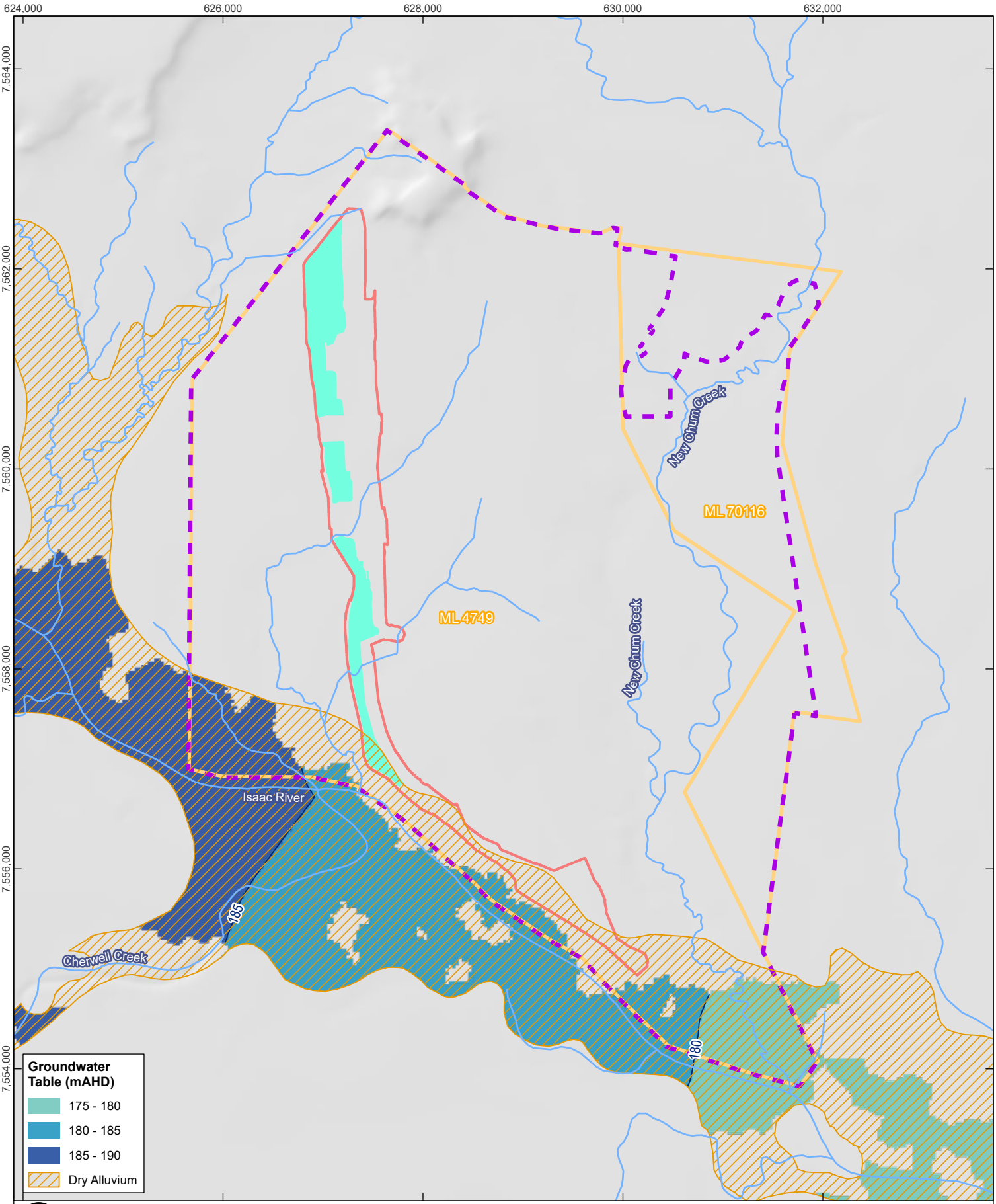
FIGURE 7-5

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_05_Predicted Water Table Elevation – Post-Mining Equilibrium



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (5mAHD)
- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake
- Alluvium Extent

POITREL MINE PRCP
HYDROGEOLOGY ASSESSMENT

PREDICTED GROUNDWATER LEVELS WITHIN ALLUVIUM (LAYER 1) – POST-MINING EQUILIBRIUM

SLR

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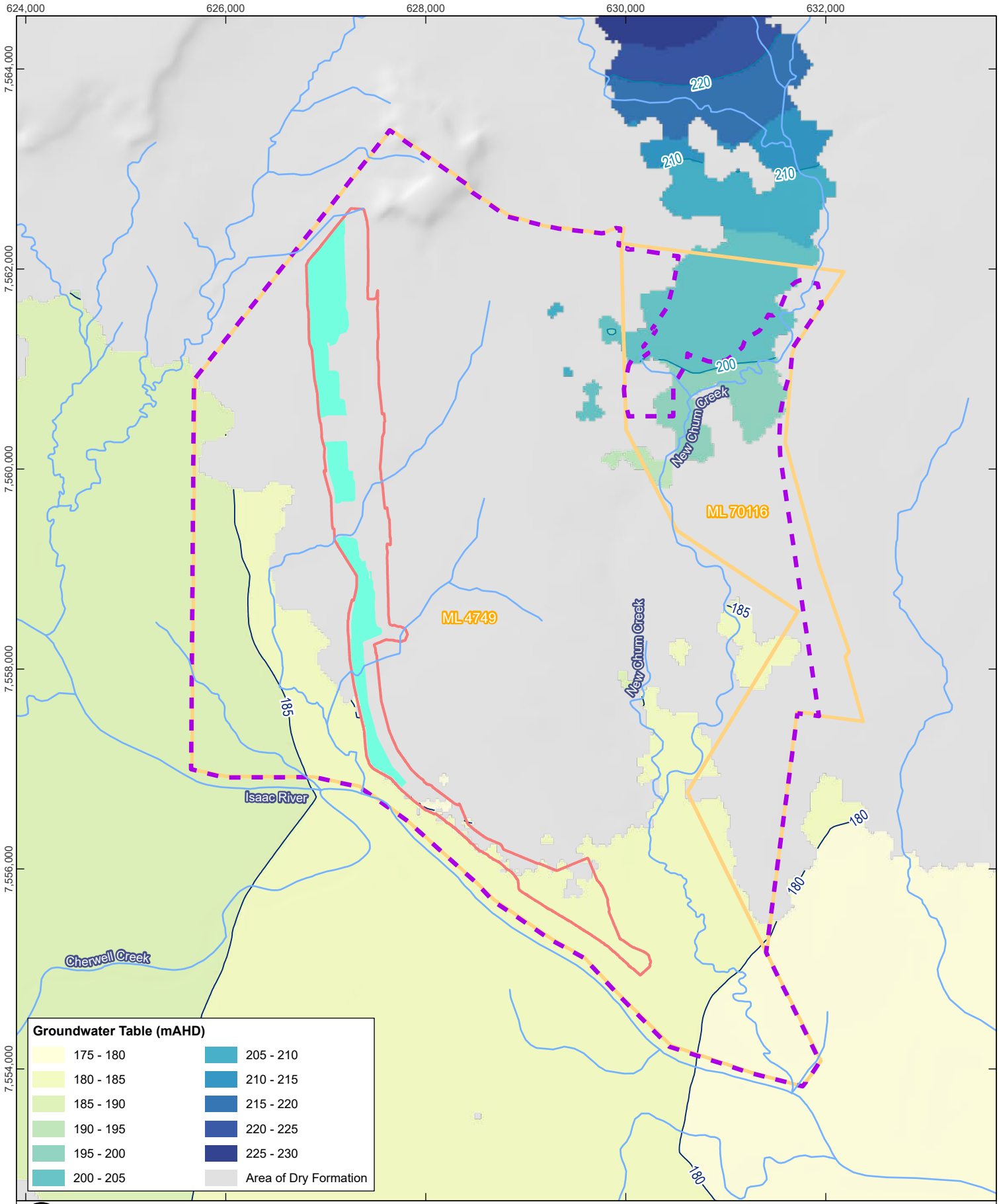
FIGURE 7-6

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_06 Predicted Groundwater Levels Within Alluvium (Layer 1) – PME



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (5mAHD)
- Groundwater Elevation (10mAHD)
- Watercourse
- Project Area
- Mining Lease
- Void Extent
- Void Lake

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED GROUNDWATER LEVELS WITHIN REGOLITH (LAYER 2) – POST-MINING EQUILIBRIUM

SLR

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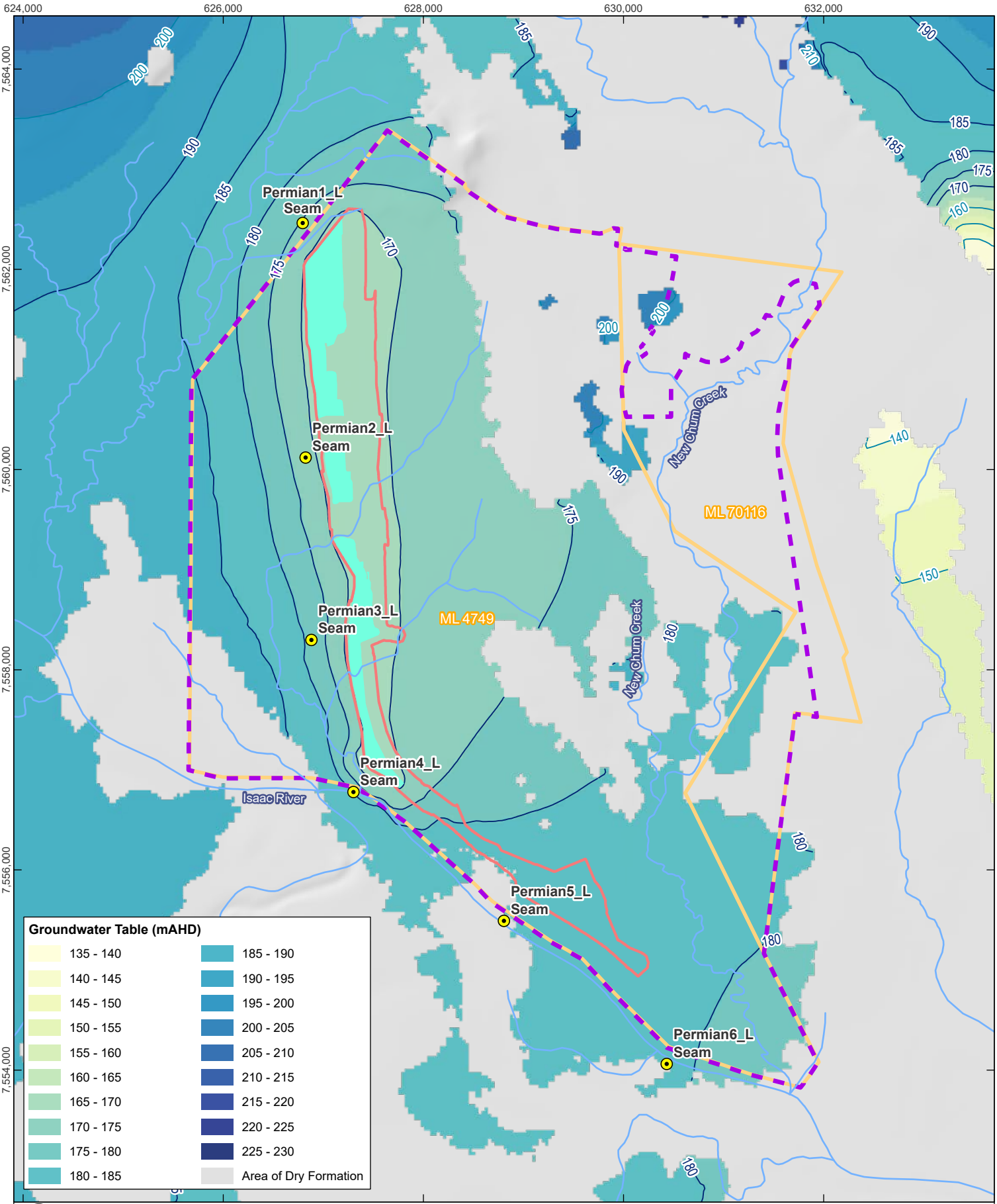
FIGURE 7-7

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_07 Predicted Groundwater Levels Within Regolith (Layer 2) – PME



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Hydrograph Location
- Groundwater Elevation (5mAHD)
- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED GROUNDWATER LEVELS WITHIN LEICHHARDT SEAM (LAYER 5) – POST-MINING EQUILIBRIUM

SLR

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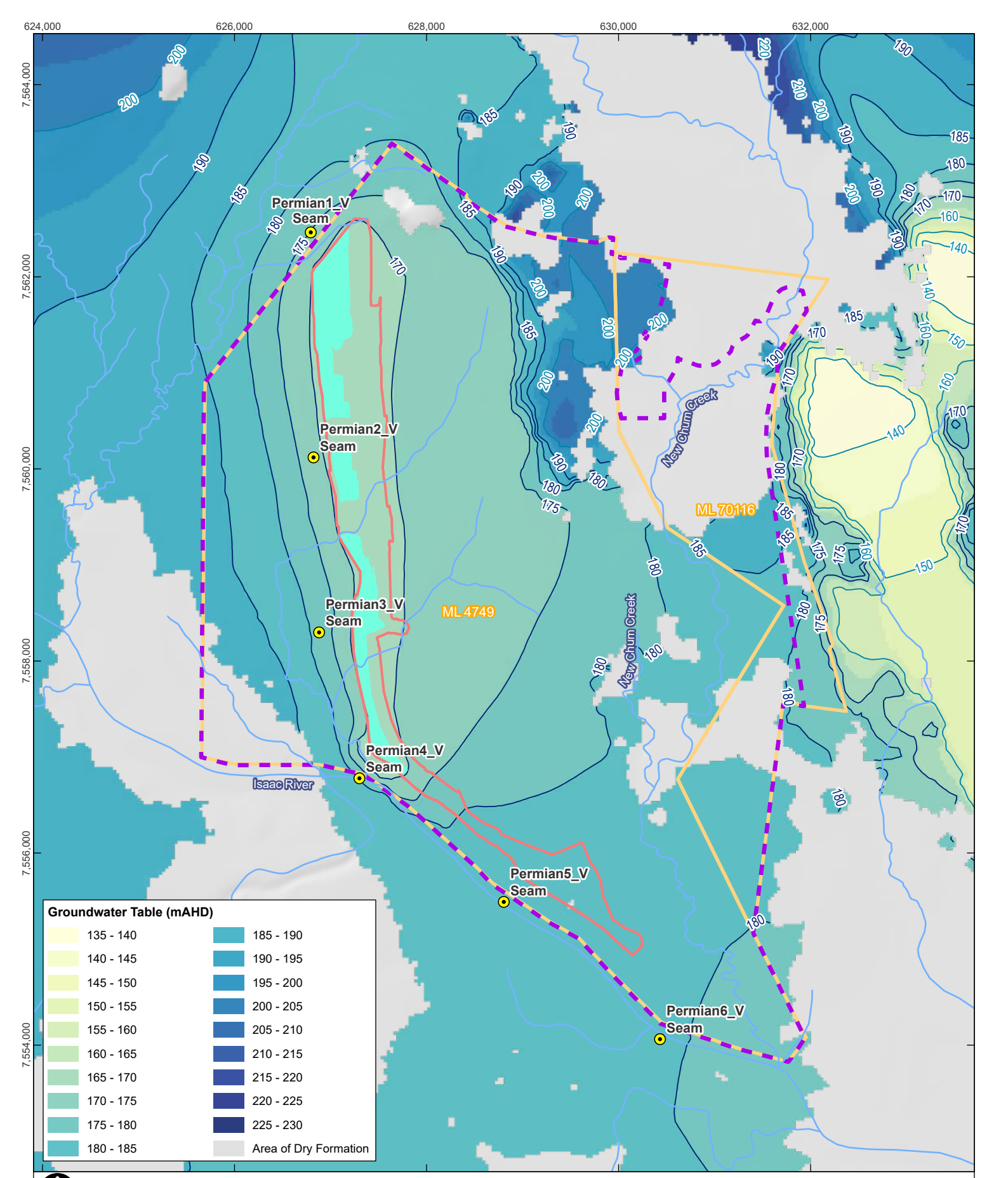
FIGURE 7-8

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_08 Predicted Groundwater Levels Within Leichhardt Seam (Layer 5) – PME



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Hydrograph Location
- Groundwater Elevation (5mAHD)
- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

PREDICTED GROUNDWATER LEVELS WITHIN VERMONT SEAM (LAYER 7) – POST-MINING EQUILIBRIUM

SLR

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FIGURE 7-9

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_09 Predicted Groundwater Levels Within Vermont Seam (Layer 7) – PME

Predictive hydrographs showing the change in groundwater levels over time for the Leichhardt and Vermont Seams of the Permian Coal Measures just outside (west) of the residual void are shown as **Figure 6-10** through **Figure 6-12**, with the hydrograph locations shown on **Figure 6-6** through to **Figure 6-9**. Given the relatively significant north-south to northwest-southeast strike length of the residual void, six sets of predictive hydrographs have been generated including, as shown on the figures.

The hydrographs demonstrate that the vast majority of groundwater level drawdown in the Permian Coal Measures occurs during mining operations, with post-closure groundwater levels in the deeper coal seams recovering from their lowest point that occurred during mining. Furthermore, the hydrographs demonstrate very little effect on groundwater levels from the residual void inflow flux variability in the early post-closure period as shown and discussed in **Section 6.2.4**.

The hydrographs also show that:

- For the area to the west of the northern end of the residual void:
    - At the northern end of the residual void (hydrograph site Permian1), lake levels are predicted to recover to within approximately 6 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
    - At the northern end of the residual void (hydrograph site Permian2), lake levels are predicted to recover to within approximately 2 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
- For the area to the west of the central part of the residual void:
    - At the centre of the residual void (hydrograph site Permian3), lake levels are predicted to recover to within approximately 11 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
    - At the centre of the residual void (hydrograph site Permian4), lake levels are predicted to recover to within approximately 11 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
- For the area to the west of the southern end of the residual void:
    - At the southern end of the residual void (hydrograph site Permian5), lake levels are predicted to recover to within approximately 13 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.
    - At the southern end of the residual void (hydrograph site Permian6), lake levels are predicted to recover to within approximately 11 m of the predicted Leichhardt Seam and Vermont Seam groundwater elevation just outside the void.

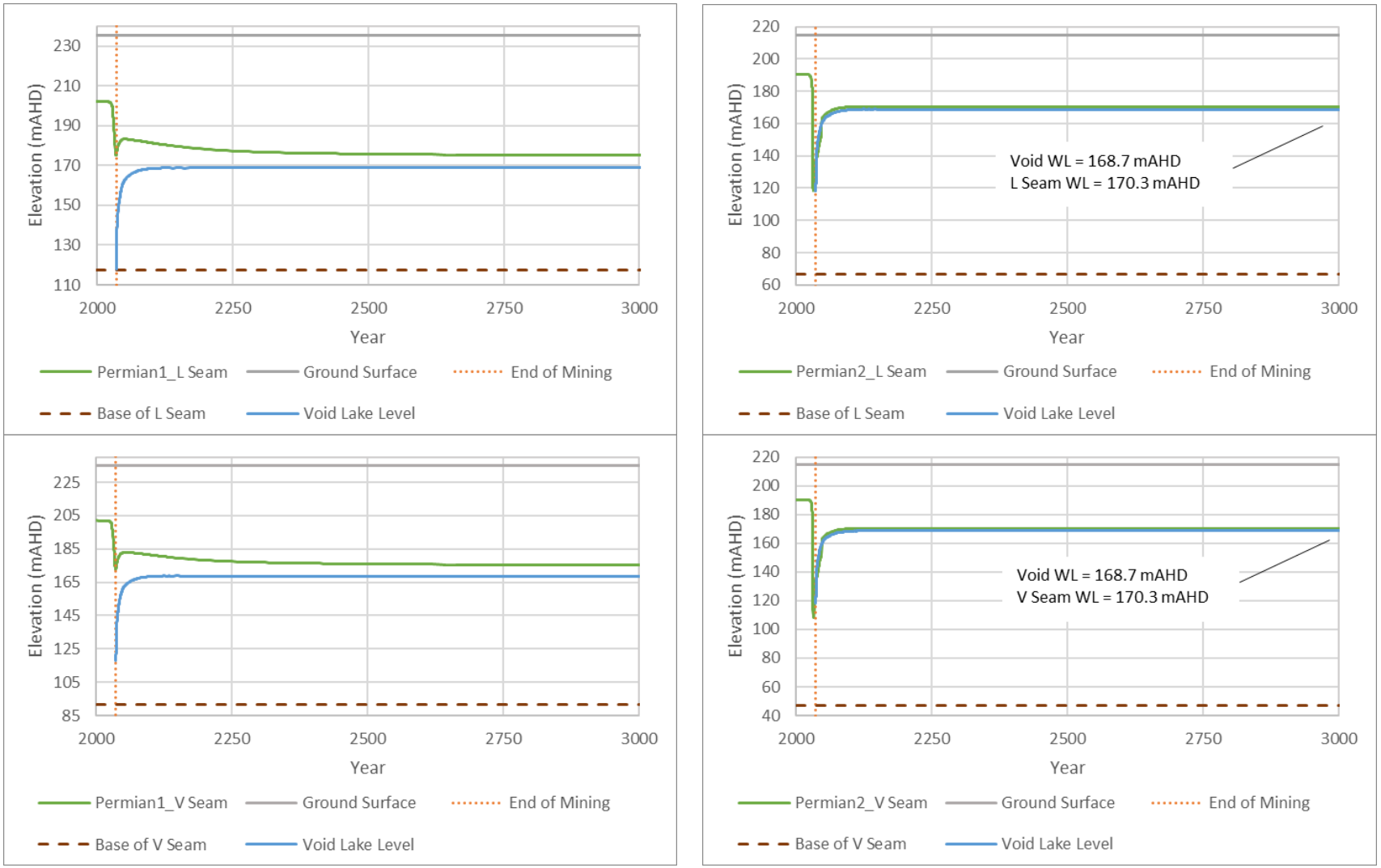


Figure 6-10 Permian Coal Measures Predictive Hydrographs Adjacent the Residual Void (north)

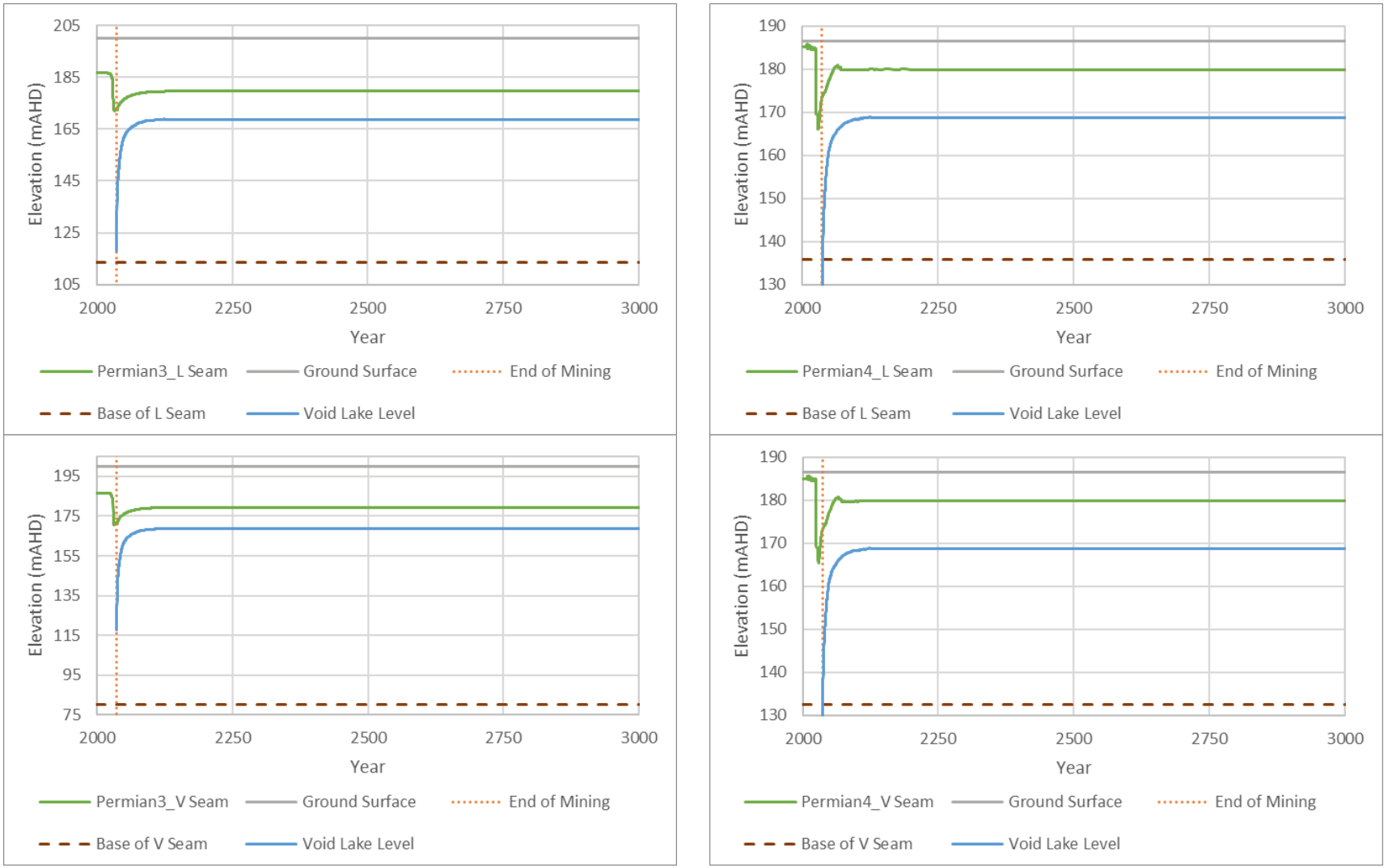


Figure 6-11 Permian Coal Measures Predictive Hydrographs Adjacent the Residual Void (centre)

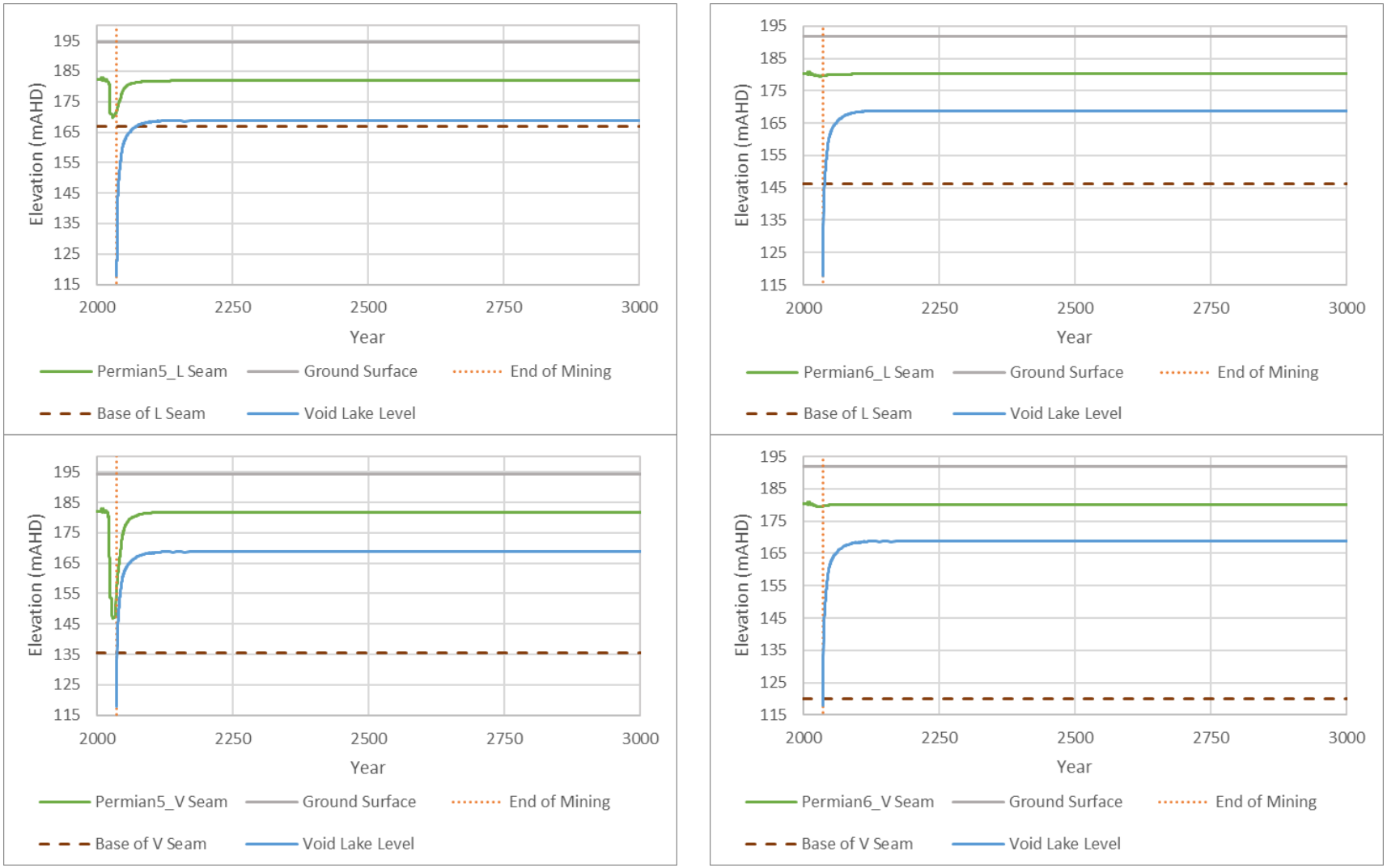


Figure 6-12 Permian Coal Measures Predictive Hydrographs Adjacent the Residual Void (south)

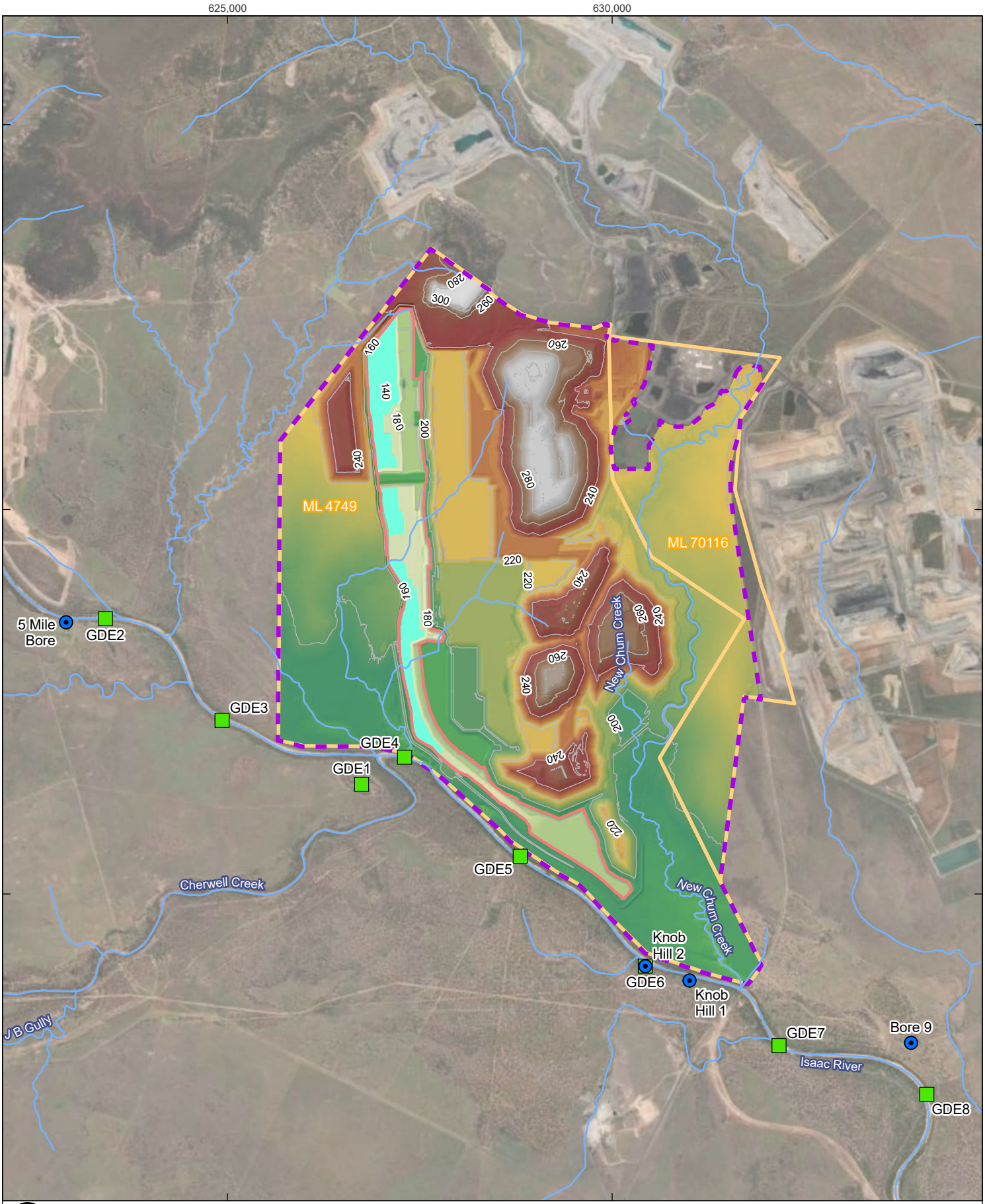
The hydrograph results for the Leichhardt and Vermont Seams suggest that, although model predictions indicate inwards flow gradients residual void prevailing in the long term, the differences in predicted void lake levels and the predicted groundwater levels in those seams immediately adjacent to the void are relatively small in some cases, particularly in the case of the Permian1 and Permian2 hydrographs (at the northern end of the residual void). It should be noted that there is a distinct lack of groundwater environmental receptors identified in the Leichhardt and Vermont Seams (**Section 4.5**) and therefore there is little environmental risk posed by any void outflow to those seams. Additionally, net flux over the post-mining simulation remains inwards for the void, i.e. any outwards flux is recaptured by the void in the long term post-mining.

Increasing the head gradient toward the residual void lakes from the surrounding groundwater system could be achieved by reducing predicted void lake levels via deepening the residual void and/or limiting surface water inputs to the void, noting that surface water inputs represent approximately 97% of the total volumetric inflow to the residual void (**Section 6.2.4**) and therefore groundwater inflow has a relatively insignificant effect on void lake formation. Further backfilling of the residual void would increase the void lake level elevation and therefore be likely to increase the potential for outflow to the groundwater system, and therefore result in poorer environmental outcomes. This is particularly the case in the event that beneficial evaporative control of groundwater gradients is lost, rather than offer a means to reduce the potential for groundwater impacts (SLR, 2022b; refer **Section 6.2.4**).

Groundwater Level Impacts on Potential Receptors

Predictive hydrographs have been derived from the groundwater model to understand the nature of likely groundwater level change in the interpreted source aquifer for identified potential natural and anthropogenic groundwater receptors in the vicinity of the PTM Area (refer **Section 4.5**). The aim of the hydrographs is to assess the potential for additional impacts to these potential receptors in the period post-mining, i.e. identify additional potential impacts beyond those that have occurred during already approved mining operations that may be attributable to the PRCP's proposed final landform. **Figure 6-13** provides the hydrograph locations.

Predictive hydrographs for the water table at the potential GDE sites identified adjacent to the PTM Area (refer **Section 4.5.2**) are provided as **Figure 6-14**. The hydrographs indicate that several of the sites have the predicted depth to groundwater of >5 m at some locations (sites GDE1, GDE2, GDE5 and GDE6). Of the other potential GDE sites, GDE3 and GDE4 on the southwest of the PTM area, and GDE7 and GDE8 on the southeast of the PTM Area, have relatively shallow predicted water table depths. The hydrographs also indicate that much of the water table drawdown in the vicinity of the potential GDEs is predicted to occur prior to the end of mining (i.e. associated with approved PTM mining operations), with any additional drawdown occurring over the post-mining period continuing the drawdown trends that commence prior to the end of mining. The shape of the hydrographs suggests that the additional drawdown impacts that occur in the post-mining period are residual impacts from approved previous active mining activities (i.e. a time lag from active mining), rather than new impacts caused by the PRCP's landform design; i.e. suggesting that the final landform is not contributing significantly to additional impacts at the potential GDE locations.



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:65,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

Hydrograph Location
- Bore
- GDE
- Topographic Contour (20mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake

Final Landform Elevation (mAHD)
320
99

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

POTENTIAL RECEPTOR PREDICTIVE HYDROGRAPH LOCATIONS

SLR

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FIGURE 7-13

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_13_Potential Receptor Predictive Hydrograph Locations

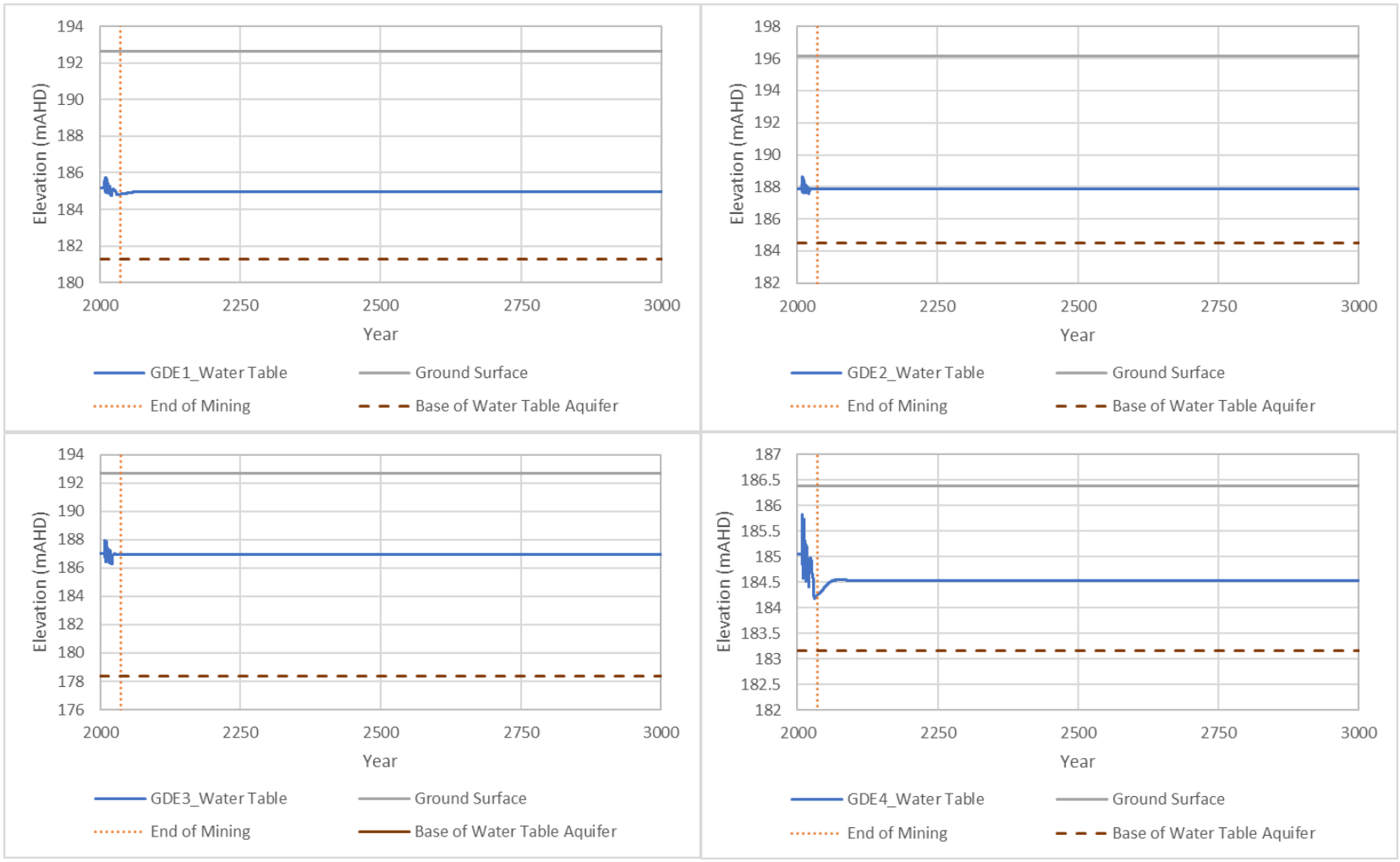


Figure 6-14 Water Table Hydrographs at Potential GDEs

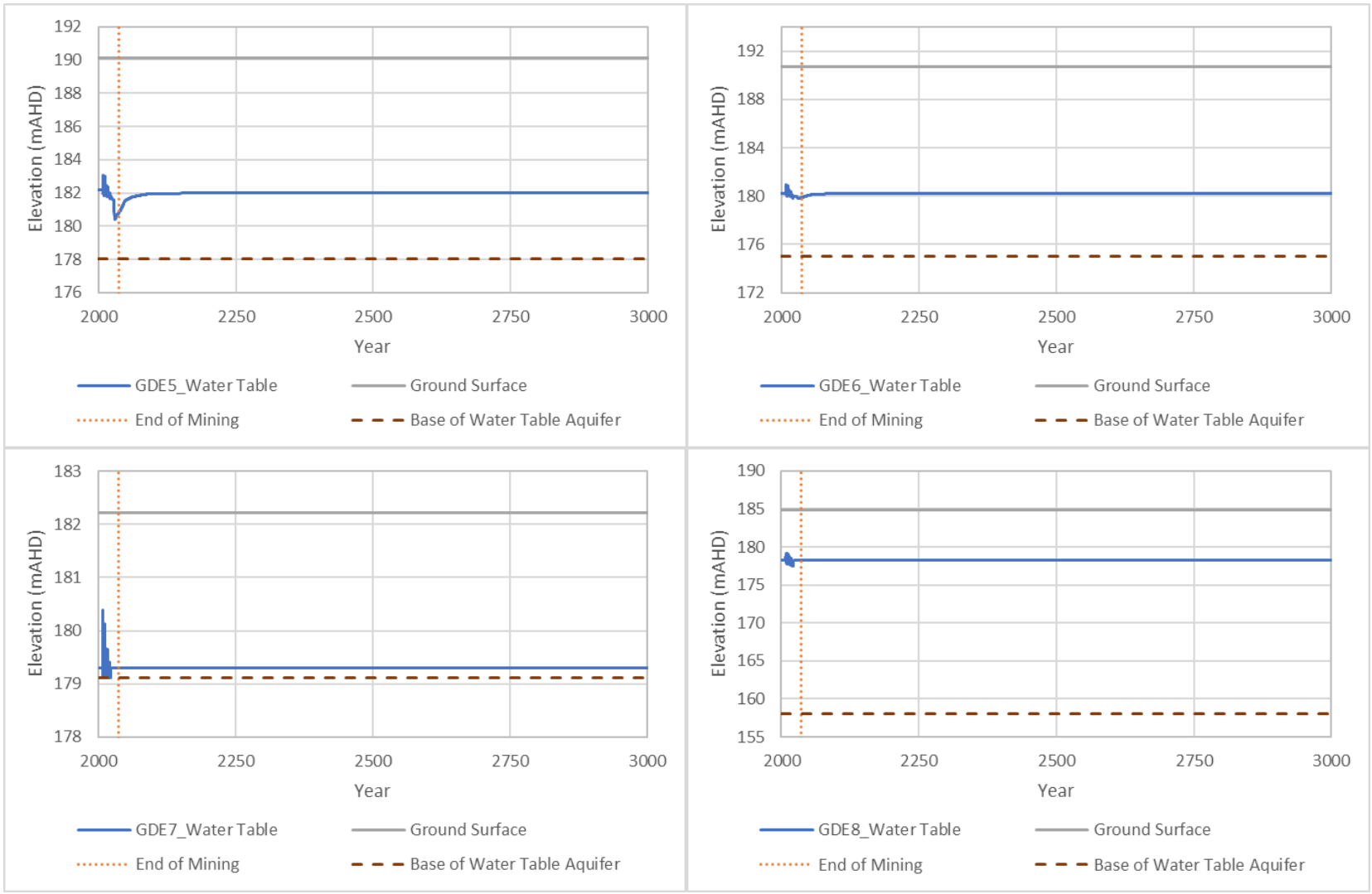


Figure 7-14 Water Table Hydrographs at Potential GDEs (cont.)

Predictive hydrographs for the four identified third-party water supply bores with sufficient information to attribute a source aquifer (refer **Section 4.5.1**) are provided as **Figure 6-15**. Predicted drawdown at these bores occurs prior to the end of PTM mining, with only recovery of groundwater levels predicted in the post-mining period, i.e. there are no drawdown impacts attributable to the PTM final landform. The maximum drawdowns at these bores are not greater than the relevant 'bore trigger thresholds' identified in Chapter 3 of the *Water Act 2000*, i.e. the threshold at which drawdown impacts may need to be further investigated for the purposes of determining any requirement to 'make good' a bore impairment.

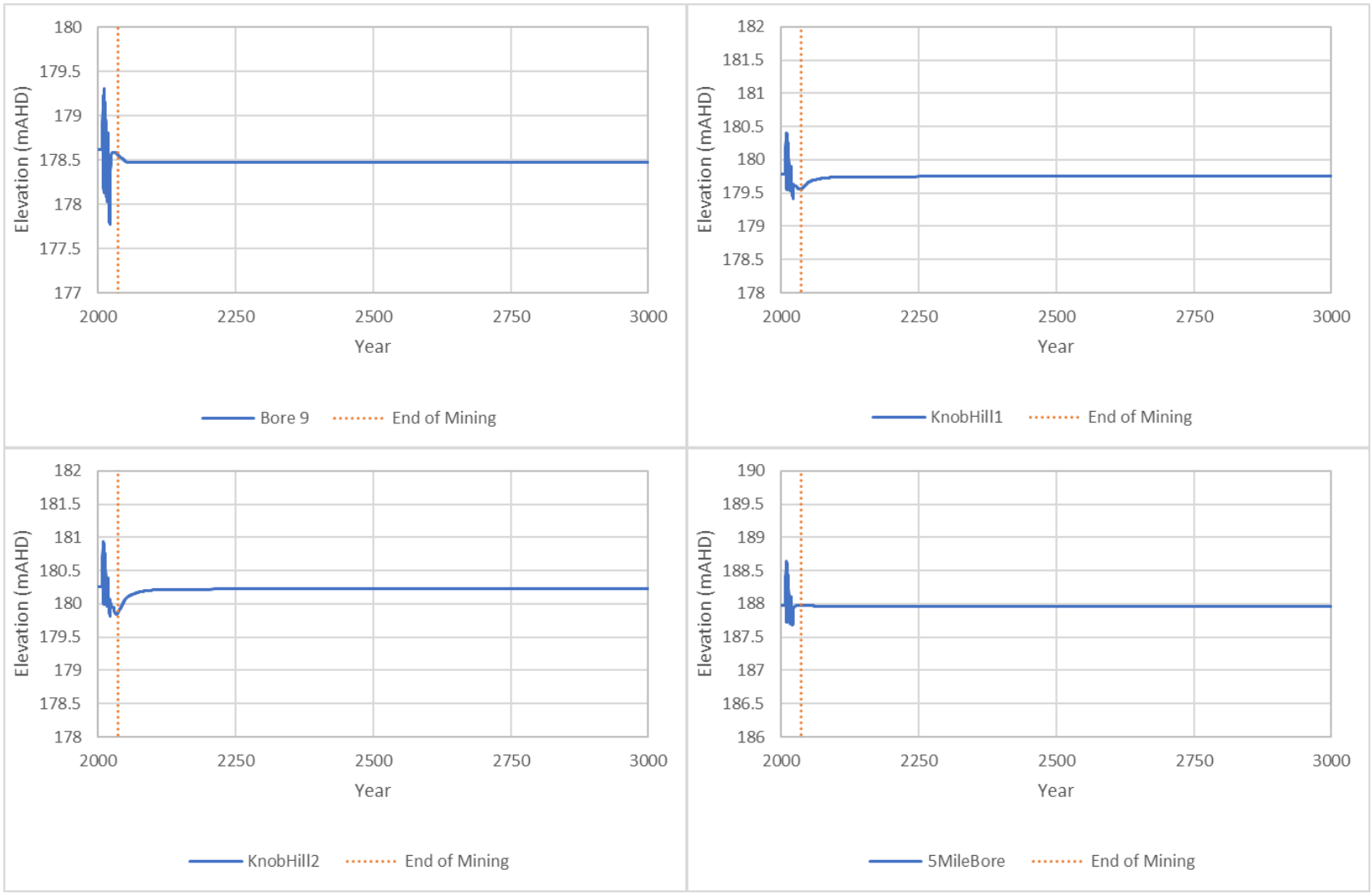


Figure 6-15 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer

6.2.6 Flow Path Simulation

An analysis of the water movement within the final landform was undertaken to simulate and assess the movement and fate of water particles through the groundwater system post-mining. A number of particles were placed on the final landform and within the residual void in the recovery groundwater model and the mod-PATH3DU code (S.S. Papadopulos & Associates, Inc., 2018) was used to simulate particle pathways along the groundwater flow field during recovery (i.e., 2309 years). To run the mod-PATH3DU code the transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flow path lines.

Figure 6-16 shows the initial location of particles on the final landform. The particles were placed at the surface of the model and released at the start of the post-mining simulation, with the movement of the particles then recorded during the post-mining simulation. It should be noted that the mod-PATH3DU code automatically moves the particle from the model surface to the shallowest saturated layer at the commencement of the simulation; as shown on **Figure 6-16** for many of the particles, this represents the Leichhardt seam as the shallow layers (Layers 1 and 2) are unsaturated across much of the PTM Area at the commencement of the post-mining simulation. Locations where the model predicts saturation in the shallow groundwater system (i.e. Layer 2) at the end of mining and therefore where particles did commence in shallow groundwater include the southern side of the PTM Area (refer **Figure 6-16**).

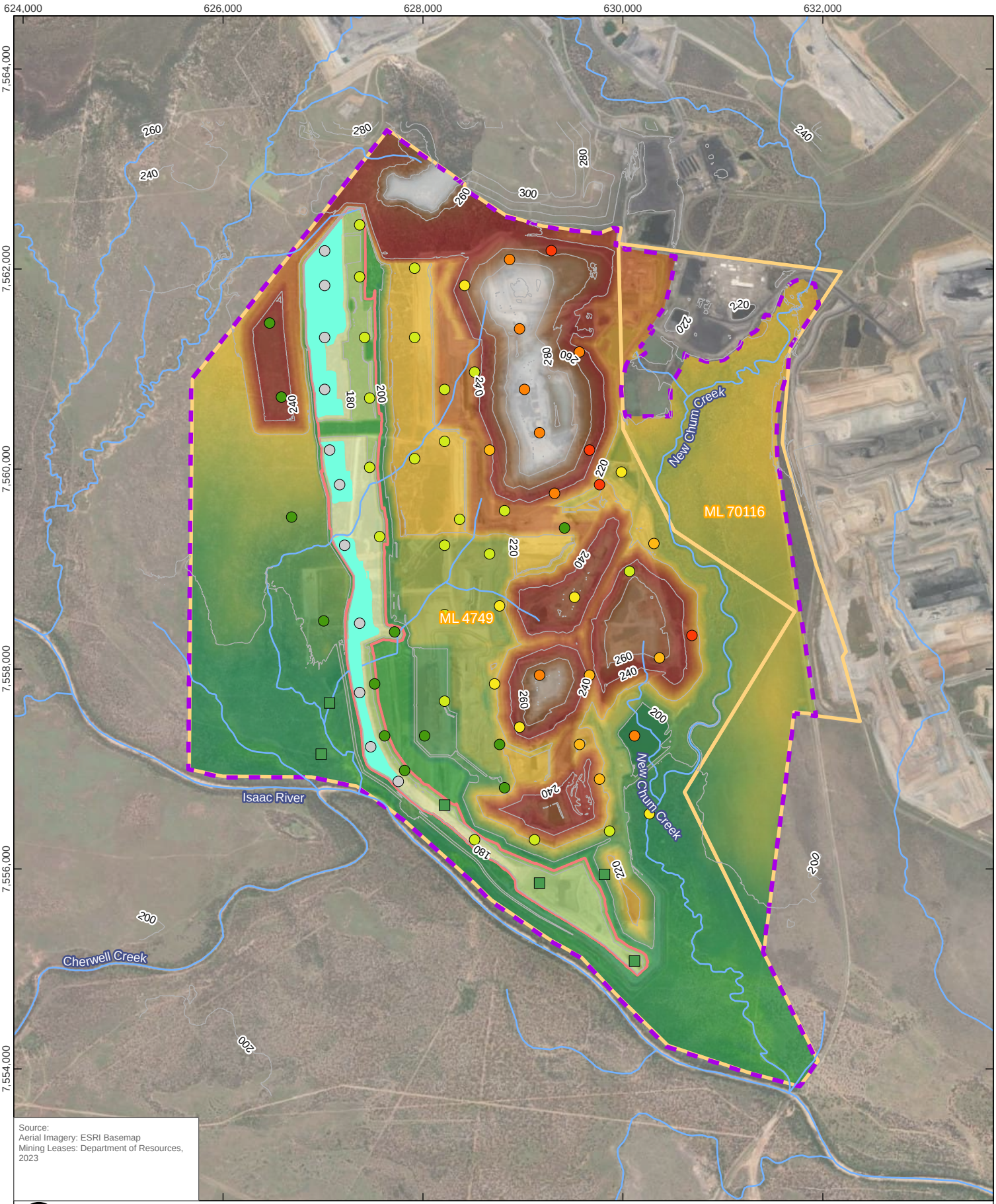
Figure 6-17 shows the predicted movement of water particles in the 2309-year recovery simulation of the final landform. The colours along the predicted particle flow paths provide the model layer the particle was simulated to be moving through, with the green to red scale classification representing particles moving from shallow to deep model layers.

The colour changes along the paths on **Figure 6-17** indicate that particles situated within the shallower saturated layers at the beginning of the post-mining simulation generally move progressively toward deeper layers representing the Leichhardt and Vermont Seams (or backfilled spoil where the coal measures have been mined out) over the post-mining period. The flow path analysis indicates the particles generally move toward the void lake, with many of the particles captured in the void. No particles are shown to move significantly away from the PTM Area to the broader receiving environment.

All of the particles starting in the void lake don't move to the outside of the void lake. Particles with starting locations within the Mine Infrastructure Area (MIA) are also shown to be captured by the void.

Overall, the particle movement simulation indicates that groundwater on PTM, including that flowing through spoil of the final landform and that beneath the MIA, would remain within the final landform (e.g. backfilled spoil and void) in the long-term with no groundwater predicted to flow to the receiving environment, i.e. the void would remain as a groundwater sink and groundwater would not flow from the residual void off-site.

Given that the particle pathlines are simulated from the start of recovery, they generally follow predicted head gradients. However, the particle directions at times appear to be contrary to the head contours/gradients shown on **Figure 6-17**. It should be noted that the contours shown on **Figure 6-17** only represents the final head pattern when the aquifer has reached an equilibrium and hence does not necessarily show the transient head changes occurring during the 2309 years recovery simulation, given the recovery simulation commences from the first year post-mining. For example, head gradients will change over the 2309 years of recovery simulation as void lake levels stabilise and the groundwater system recovers partially from mining.



Source:
Aerial Imagery: ESRI Basemap
Mining Leases: Department of Resources, 2023

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	02-May-2024
Drawn by:	AS

LEGEND

- Topographic Contour (20mAHD)
- Watercourse
- Mining Lease
- Project Area
- Void Extent
- Void Lake

Final Landform Elevation (mAHD)

320 — 99

Starting Location and Layer of Particle Simulation

2, 3, 4, 5, 6, 7, 8, Void Lake

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

STARTING LOCATION OF PARTICLES

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FIGURE 7-16

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_F07_16_Starting Locations of Particles

7.0 Conceptual Hydrogeological Model – Post Mining

A visual representation of the post mining CHM is provided as **Figure 7-1** based on the existing CHM discussed in **Section 5** and the post-mining groundwater modelling presented in **Section 6**. There is no evidence from a groundwater perspective that the final landform is unsuitable for the proposed PMLUs and NUMAs, given the hydrogeological assessment objectives outlined in **Section 1.3** and the following key features:

- Residual void lake formation, with lake levels stabilising significantly below the pre-mining groundwater elevations and any shallow post-Permian, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium, Tertiary units, and weathered regolith).
- Residual groundwater drawdown within the Rangal Coal Measures as caused by the approved PTM mining operation, with ongoing evaporative discharge from the residual void lake, resulting in continued inwards hydraulic flow gradients in the coal measures to the residual void and no outflow in the long term.
- The residual void continues to capture any seepage from spoil emplacements.
- Little to no impact on surficial aquifers, including alluvial aquifers, caused by the PRCP's final landform.
- No impact on environmental receptors caused by the PRCP's final landform.
- No impact on anthropogenic receptors caused by the PRCP's final landform.

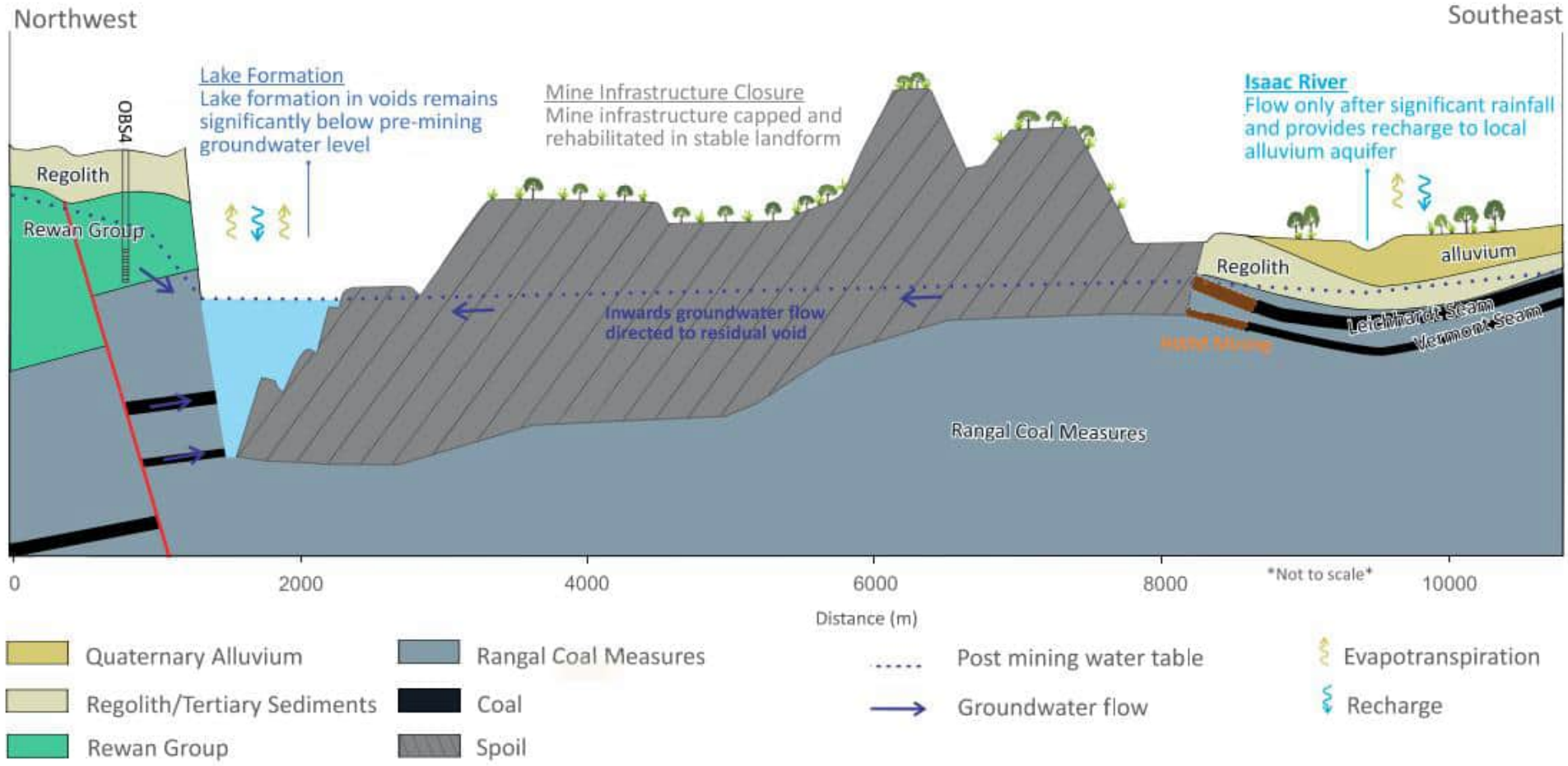

Figure 7-1 Conceptual Hydrogeological Model of PTM Groundwater System – (Post Mining)

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Appendix A Recovery Model Starting Heads

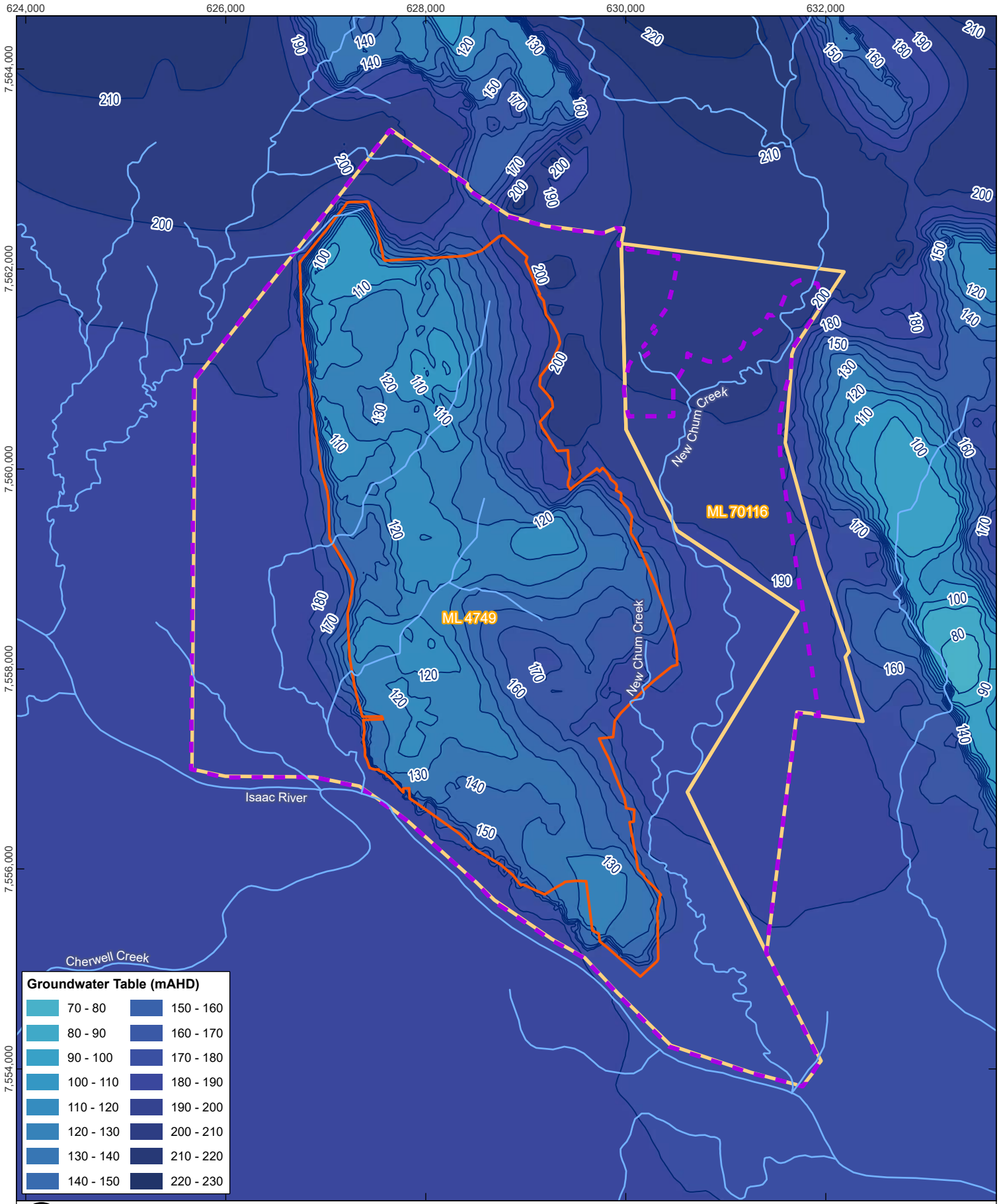
Poitrel Mine

PRCP Hydrogeology Assessment

Stanmore Resources

SLR Project No.: 620.31445.00000

3 May 2024



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Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Maximum Pit Extent

POITREL MINE PRCP
HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – WATER TABLE

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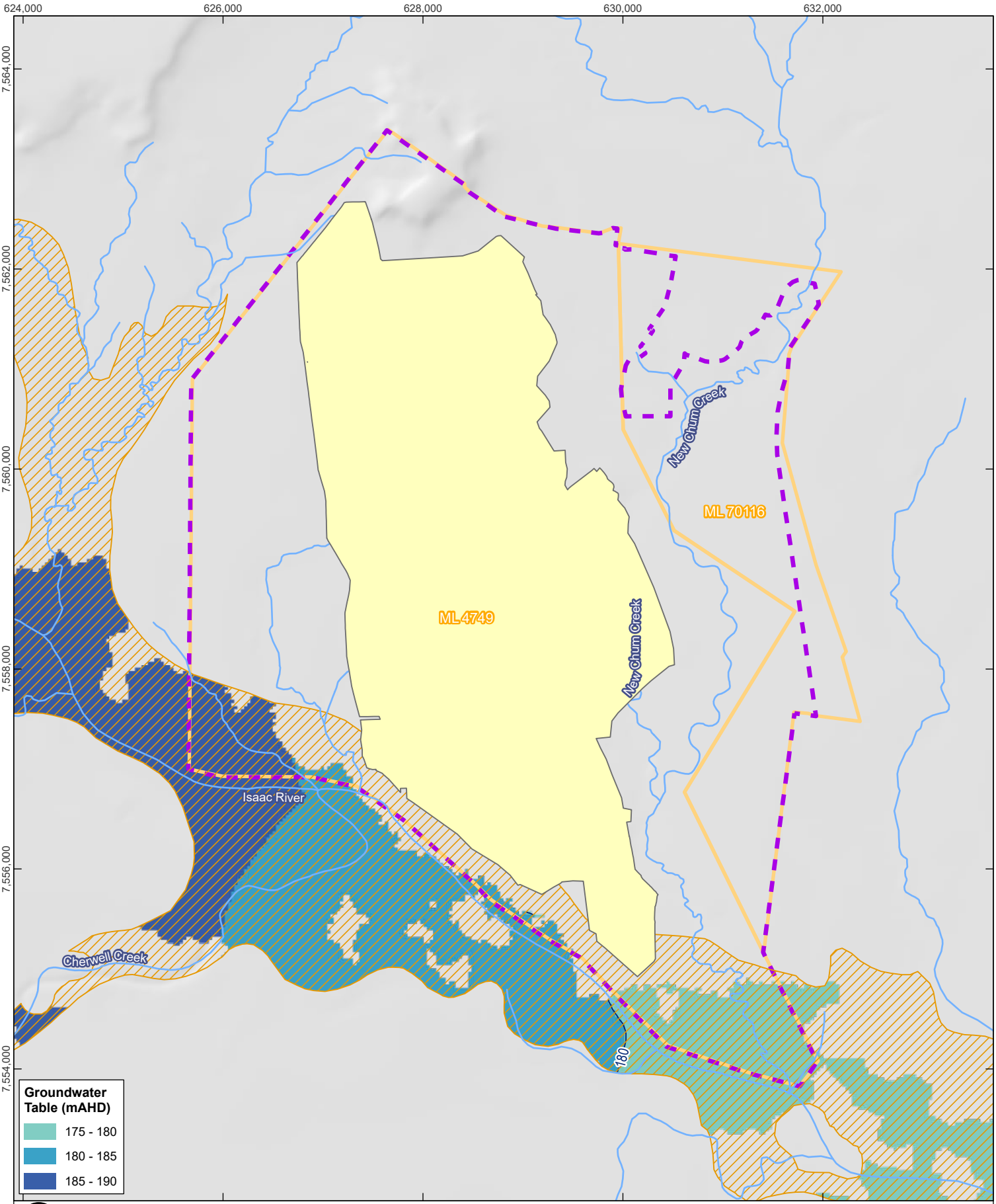
FIGURE A-1

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_FA_01 End of Mining Groundwater Levels - Water Table



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Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Alluvium Extent
- Maximum Pit Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – ALLUVIUM (LAYER 1)

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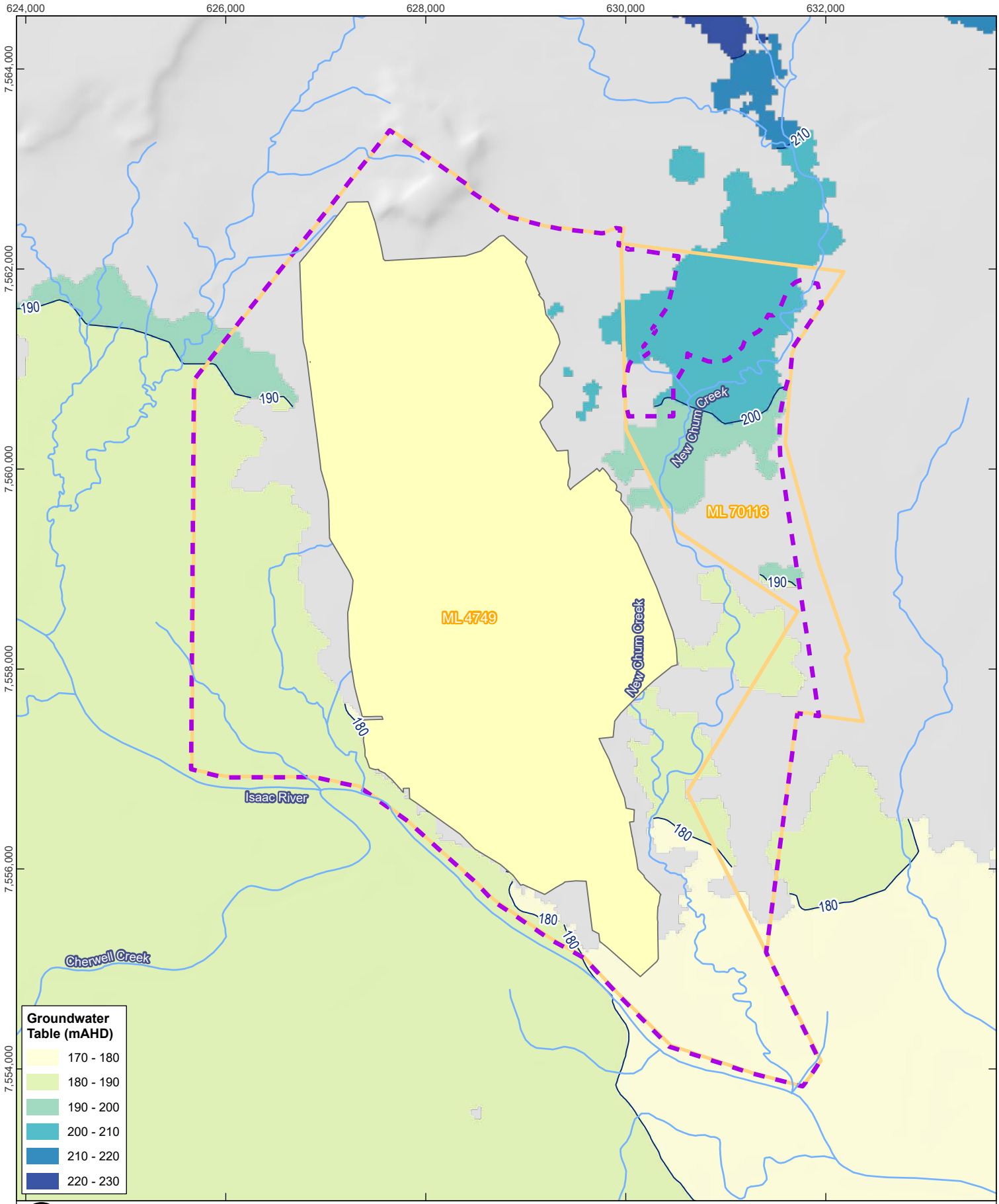
FIGURE A-2

Path: H:\Projects-SLR\620-BNE\620-BNE\620.31445.00000 Poitrel PRCP Groundwater\03 SLR Data\01 CADGIS\GIS\ArcPro\Poitrel_PRCP_Groundwater\Poitrel_PRCP_Groundwater.aprx\62031445_MOD_FA_02 End of Mining Groundwater Levels – Alluvium (Layer 1)



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Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (10mAHD)
- Watercourse
- Project Area
- Mining Lease
- Maximum Pit Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – REGOLITH (LAYER 2)

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FIGURE A-3

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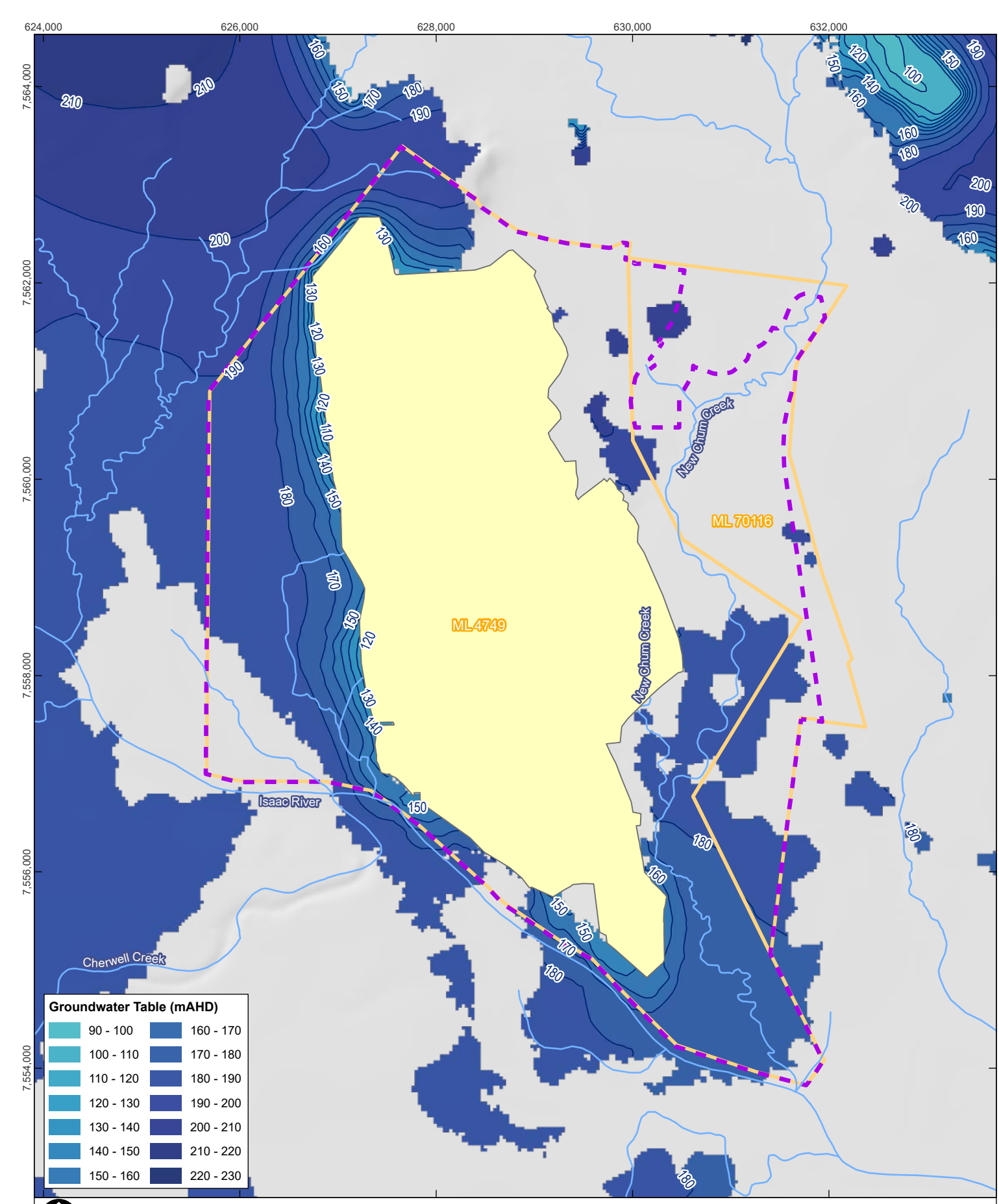

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Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

LEGEND

- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Maximum Pit Extent

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – LEICHHARDT SEAM (LAYER 5)

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FIGURE A-4

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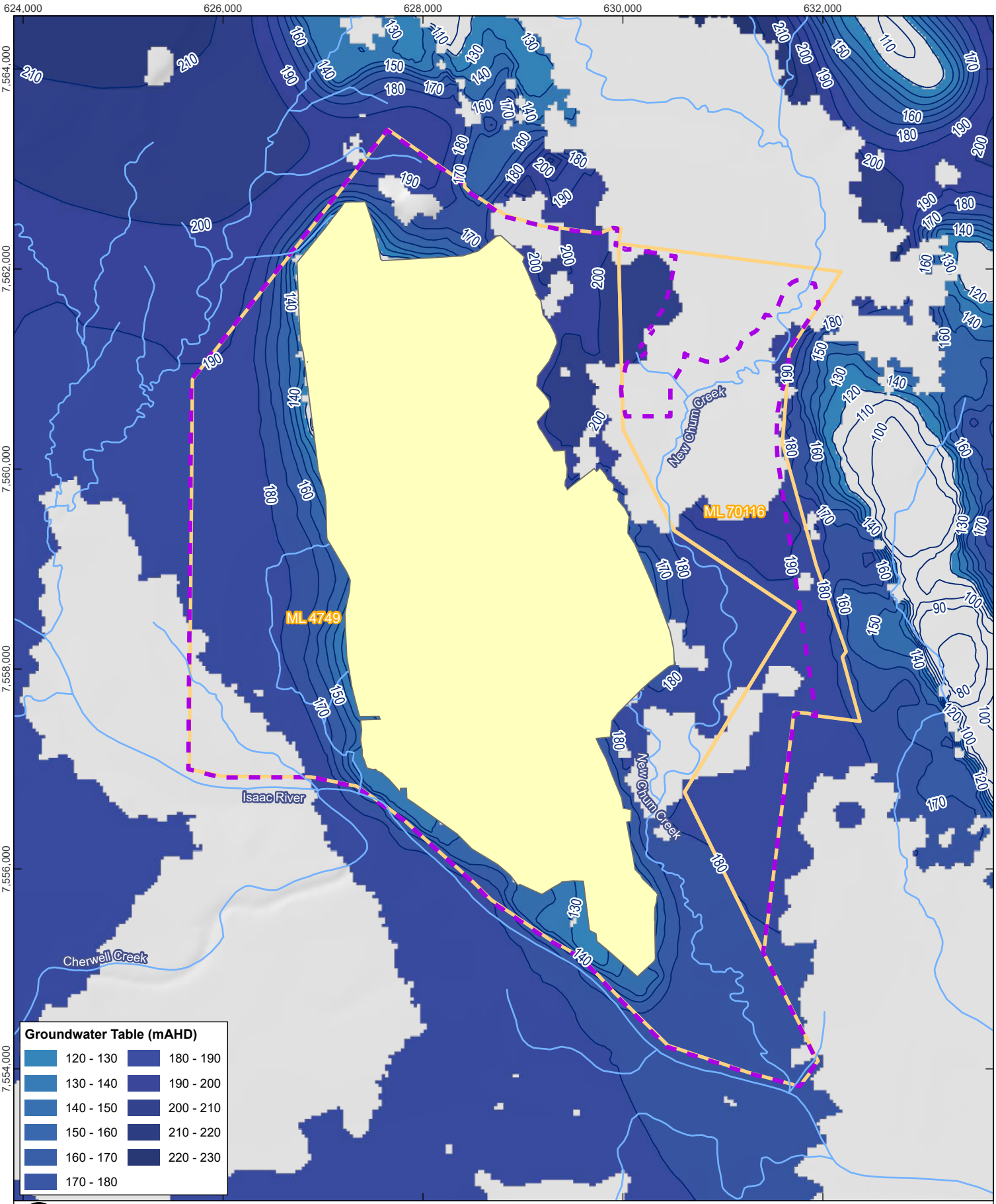

LEGEND

- Groundwater Elevation (10mAHD)
- Watercourse
- Mining Lease
- Project Area
- Maximum Pit Extent

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:50,000 at A4
Project Number:	620.31445.00000
Date Drawn:	22-Apr-2024
Drawn by:	RB

POITREL MINE PRCP HYDROGEOLOGY ASSESSMENT

END OF MINING GROUNDWATER LEVELS – VERMONT SEAM (LAYER 7)

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FIGURE A-5

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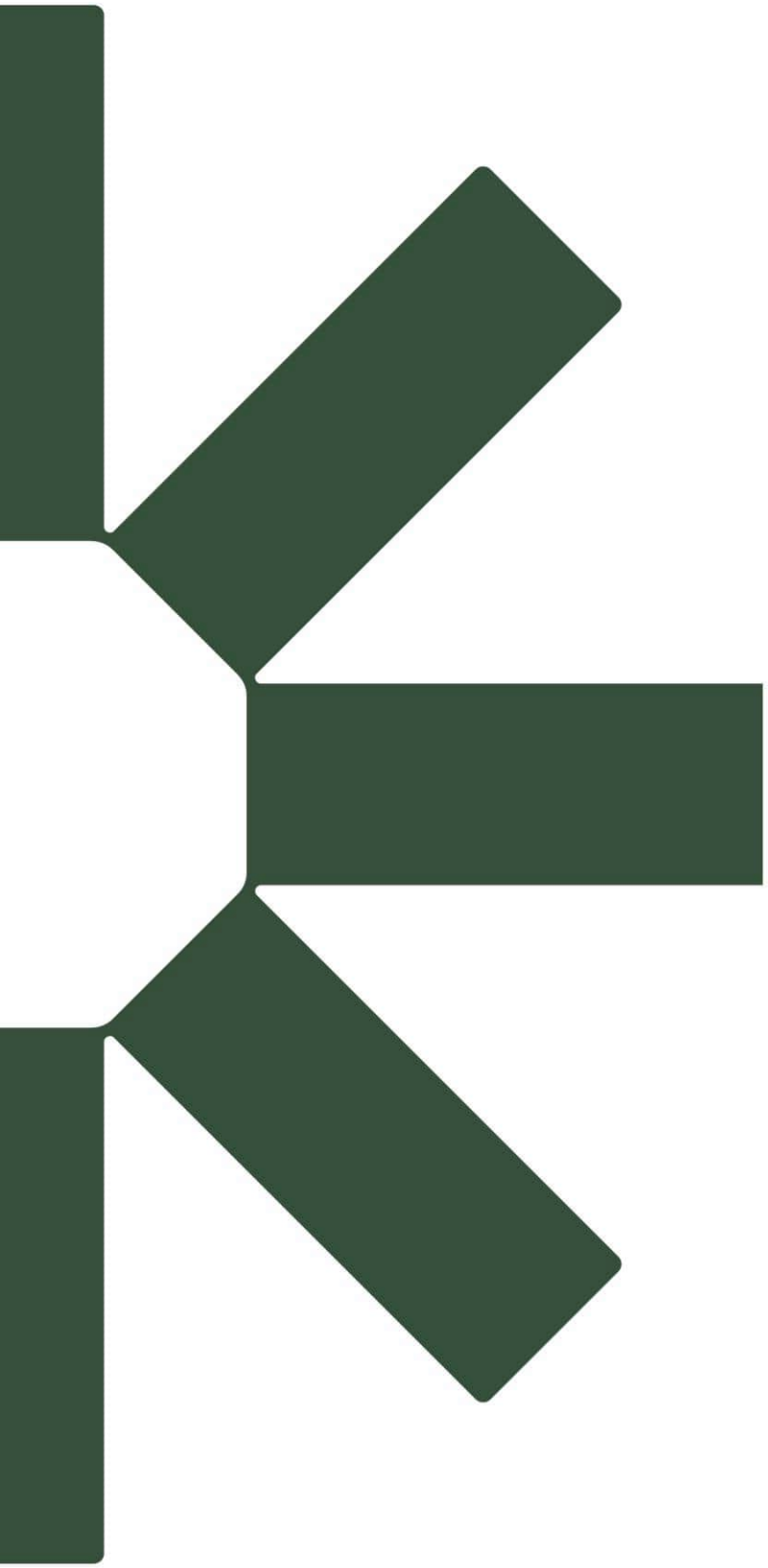

Making Sustainability Happen

Appendix 4 Material Characterisation Study (8 June 2022)

Landloch

POITREL MINE (PTM) – MATERIAL CHARACTERISATION STUDY

June 2022

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The landscape is not uniform. Because of this non-uniformity, no monitoring, testing or sampling technique can produce completely precise results for any site. Any conclusions based on the monitoring and/or testing presented in this report can therefore only serve as a 'best' indication of the environmental condition of the site at the time of preparing this document. It should be noted that site conditions can change with time.

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1 INTRODUCTION

BHP Billiton Mitsubishi Alliance (BMA) has engaged Landloch to provide a material characterisation study of stockpiled materials at the Poitrel Mine (PTM). Specifically, the study will evaluate the quality of materials for their use as growth media in rehabilitation.

To ensure rehabilitation success, the materials planned to be placed near the surface of the landforms need to be assessed for their suitability to support the vegetation required to meet the target post-mining land use(s).

This report evaluates the quality of materials for use as growth media for rehabilitation of the mine and identifies any gaps in the available information or resources.

1.1 Project Description

PTM is an open cut coal mine in the Bowen Basin, located approximately 20 km east of Moranbah, and is situated in the Isaac Regional Council Local Government Area. PTM was previously a BHP Billiton Mitsui Coal joint venture and is currently owned and operated by Stanmore Resources.

The general arrangement of the Mine is provided in Figure A1 (Appendix A).

1.2 Scope of Work

The scope of work involves the following tasks:

i. Review previous soils and land assessments undertaken at the Mine.
ii. Review readily available published soil and land data within the region.
iii. Conduct data gap analysis to determine information required to:
    - Develop an inventory of materials available for rehabilitation; and
    - Assess the suitability of materials as plant growth media.
iv. Collate existing and recent soil laboratory data.
v. Sample and analyse topsoil stockpiles.
vi. Interpret data, characterise materials, and prepare this report.

2 DESKTOP REVIEW

The current project area covers mining leases *ML4749* and *ML70116,* operating under the EA *EPML00963013*. The mining areas consist of one void, comprising of five pits (R10, R20, R30, R40, and R50). As of FY2022, a total of 3892 ha will have been disturbed through mining activities.

2.1 Climate

The Mine is situated in Queensland's sub-tropical climatic zone, which is characterised by high summer temperatures, warm dry winters, and distinct wet and dry seasons.

Average monthly maximum temperatures tend to range from 24°C to 27°C in winter, and from 33°C to 36°C in summer. Summer temperatures can exceed 40°C for short periods (Bureau of Meteorology (BoM), 2022)

Average monthly minimum temperatures range from 8°C to 10°C in winter and from 20°C to 22°C in summer (BoM, 2022).

Rainfall is concentrated in the summer with approximately 75% of annual rainfall occurring between November and March. The median annual rainfall for the area, recorded at Moranbah airport, is 520 mm.

2.2 Topography

The pre-mining topography of the study area is dominated by gently undulating grazing lands with low relief. The project area straddles a low ridge line which runs roughly north-south and forms the catchment divide between New Chum Creek on the east and an unnamed creek to the west. The surrounding land is characterised by poorly defined ephemeral drainage lines that flow only immediately after rain, draining into New Chum Creek.

2.3 Geology and Soils

2.3.1 Overburden geology

PTM has three separate rock units: Permian Rocks, Tertiary Sediments and Post-Tertiary Sediments. The deposit occurs in the Late Permian Rangal Coal Measures in a drag syncline within the Burton Range fault system (BHP Billiton, 2005).

A number of geological units occur across the project area including the following:

- Quaternary-aged channel and flood plain alluvium; gravel, sand, silt and clay, located around Isaac River in the southern portion of the site, along with a tributary of Isaac River in the western corner of the site;
- Quaternary-aged sand plains along the southern boundary of the site;
- Quaternary-aged colluvium and/or residual deposits; boulder, gravel, sand, located in the central portion along with the north-eastern and south-eastern corners of the site;
- Triassic-aged Rewan Group consisting of lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone located in the centre and northern portions of the site;
- Permian-aged Blackwater Group consisting of sandstone, siltstone, shale, mudstone, coal, tuff, conglomerate located in the eastern portion of the site; and
- Cretaceous-aged intrusive volcanics located on the southern boundary of the site.

The coal deposit occurs in a basin like structure with seams dipping gently to the west. Two major coal seams have been identified, the Leichhardt and Vermont Seams.

The geology units for the project area are mapped in Appendix A.

2.3.2 Regional soils

Soil mapping of the region identifies two broad soil groups across the project area (State of Queensland (Department of Resources), 2021) These include:

- Ro9 – Sodosols; and
- MM7 – Friable earths.

Relevant details of these soil types are provided in Table 1.

Table 1. Summary details of regional soils in the Study Area.

Soil Landscape Code	Description	Associated Australian Soil Classification (ASC)
Ro9	Sodosols. Dominant soils are hard alkaline duplex brown soils.	Sodosol
MM7	Chief soils are neutral dark and yellow friable earths with friable brown soils.	Vertosol, Dermosol

2.3.3 Recoverable soils

Pre-mining soil and land suitability assessment of the region, that includes the study area, was completed by CSIRO (Story, Galloway, Gunn, & Fitzpatrick, 1967) and agricultural management units were described by Bourne and Tuck (1993). Both surveys produced land and soils information at a scale of 1:500 000.

A more detailed soil survey was conducted as part of the EIS (BHP Billiton, 2005), which included approximately 203 survey sites at a scale of 1:25 000 across the Study Area. Across all surveys, a total of 13 soil mapping units (SMU) were identified, including 3 variants.

A summary of all SMUs, including associated Australian Soils Classification (ASC) and Agricultural Management Units (AMU) is provided in Table 2.

Table 2. Summary details of the SMUs developed in the previous soil assessments for the mine site (BHP Billiton, 2005)

SMU		Soil Concept	Description	ASC	AMU (Bourne and Tuck, 1993)
A1		Alluvial – deep Isaac sands	Alluvial soils adjacent to the Isaac River which are either uniform deep coarse sands or duplex with coarse loamy sands extending past 50 cm. River red gum and Moreton Bay ash.	Arenic Rudosol	Isaac
A2		Alluvial – Sandy hard duplex	Hard setting sandy loam duplex soils alongside New Chum Creek often with bleached A2 over hard, coarse structured, medium yellow clay, often heavily mottled. Poplar box mixed woodlands with associated brigalow and blackbutt.	Brown Sodosol	Lascelles
A3		Alluvial – Uniform Brigalow clay	Deep, generally alkaline with carbonate nodules, possibly bleached A2 horizon, uniform medium sandy clay which is non-cracking. Brigalow, blackbutt and Bauhinia.	Brown Dermosol	Rolleston
B1		Red/Brown deeper uniform clay undulating plains	Undulating plains up to 3% gradient of mostly cleared brigalow, blackbutt and Bauhinia. A firm to hard-setting sandy surface, often gravely, overlies stiff medium sandy clays which are neutral and red to brown coloured. Weathered parent material or gravels generally predominate by 80 cm depth.	Red Dermosol	Glengallan
B2		Gravelly clay on ridgelines	Relic ridgelines and scree slopes associated with residual mesas. Uniform non-cracking clay and thin duplex with hard-setting sandy clay surface with strong gravel layer starting from 10-15 cm depth, underlying light clay is pale to red coloured. Mostly cleared of original brigalow, blackbutt with minor poplar box.	Petroferric Red Chromosol	Glengallan / Highlands
B3		Uniform Brigalow	Generally non-cracking uniform grey/brown clay but includes areas of normal gilgai (up to 40 cm deep) which may crack. Also	Brown Dermosol	Rolleston

SMU		Soil Concept	Description	ASC	AMU (Bourne and Tuck, 1993)
		grey/brown clays	includes isolated areas of B4 (melonholes) in lower slope positions.		
B3v		Melonholed brigalow clay lowlands	Approximately 50% or more of land surface is melonholed (40-100 cm deep) with deep grey cracking clay.	Brown Dermosol	Lonesome
B4		Friable brigalow scrub soil	Deep well-structured black cracking clay with granular surface mulch.	Black Vertosol	Picardy
B4v		Variant to B4	Fine granular non-cracking red/brown brigalow scrub soil.	Brown Dermosol	-
B5		Linear gilgai brigalow	Dark cracking clay in association with red non-cracking clay in linear gilgai complex.	Crusty Black Vertosol	Rolleston
E1		Sandy duplex plains with poplar box	Undulating plains of poplar box and blackbutt with very uniform duplex soils with 30-40 cm sandy clay loam over hard yellow/brown clays, often with a bleached A2.	Brown Sodosol	Lascelles
E2		Residuals (mesas)	Mixture of outcropping rock, skeletal and shallow, gravelly duplex soils with a range of vegetation. Includes mesa tops and rugged margins.	Sodosol	Highlands
E3		Texture contrast soil	Duplex soils with thin sandy loam A horizon.	Brown Chromosol	Lascelles

2.4 Waste Materials

The waste materials consist of coal rejects, tailings and overburden/interburden materials (spoil). The overburden generally consists of moderately weak to strong sandstone, siltstone and claystone, with carbonaceous siltstones.

Tailings are not characterised in this report as they are not currently considered as a rehabilitation resource.

2.4.1 Coal Rejects

Initial analysis of interburden material, representative of coal rejects for PTM, was completed as part of the Environmental Impact Statement (EIS) (BHP Billiton, 2005). Over the life of the mine subsequent analysis of reject samples for acid/base and salinity characteristics has been conducted by BMA. The materials were found to have the following properties:

- Variable sulphur content, but low acid generating capacity;
- Strongly alkaline; and
- Low to moderate salinity.

These characteristics indicated that the rejects are not ideal as a growth medium on their own but have potential to be blended or ameliorated.

Further studies and testing may identify some reject material that is beneficial for rehabilitation use due to its high organic carbon and coarse physical structure, or strategies may be developed for mixing reject material with spoil to deliver a more suitable growth medium.

2.4.2 Spoil materials

Characterisation of the overburden was undertaken as part of the EIS (BHP Billiton, 2005) and throughout the life of the mine subsequent analysis of spoil materials has been conducted by BMA. Generally, spoil materials at PTM were found to be:

- Non-acid forming, with acid neutralising capacity;
- Strongly alkaline;
- Sodic and dispersive; and
- Generally low salinity.

These characteristics indicate that most spoil material is suitable as growth medium with varying degrees of amelioration. Fresh Permian wastes are likely to be better suited to rehabilitated batter slopes and to provide a higher quality growth medium.

2.5 Topsoil Stockpiles

Stockpile materials and locations information was provided by BHP. Approximate total volume of available stockpiled material is 2 793 354 m^3. Locations of topsoil stockpiles on PTM are presented in Figure 1.

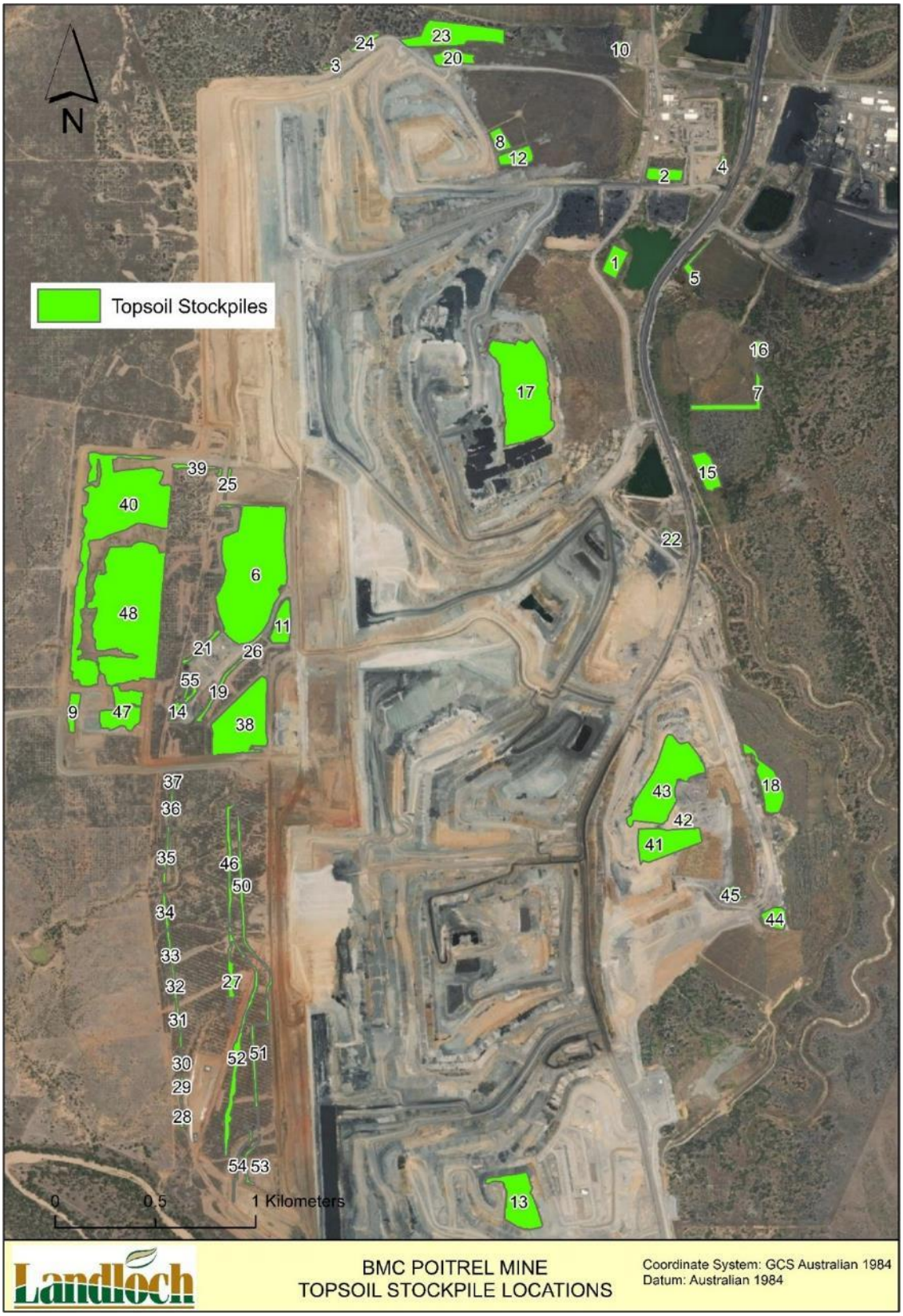

Figure 1. Stockpiled topsoil materials across the Poitrel Mine.

2.6 Post Mining Land Uses (PMLU)

Post-mining land uses for the Mining Lease are divided into four main categories:

1. Cattle grazing;
2. Woodland habitat;
3. Water storage; and
4. Watercourse.

Final landform and post-mining land use details for each PMLU are summarised in Table 3 and mapped in Appendix A.

Table 3. Summary of landform details provided by BHP for relevant PMLUs.

Landform	Post Mining Land Use Details
Undisturbed area	• Cattle grazing • Woodland habitat • Watercourse • Water storage
Disturbed area (outside of spoil and pit area) – low gradient	• Cattle grazing • Woodland habitat • Watercourse • Water storage
Spoil area (15% gradient)	• Woodland habitat Note: areas based on draft landform and assumption of 15% gradient.
Low wall area (>25% gradients)	• Woodland habitat Note: areas based on draft landform and assumption of >25% gradient.
NUMA	• As outlined in EA

2.7 Revegetation Methodology

The revegetation methods for all types of disturbed land at PTM will normally consist of the following:

- Re-spreading stockpiled or freshly stripped topsoil;
- Contour ripping;
- Seeding with an appropriate seed mix; and
- Applying appropriate fertiliser for plant establishment if required.

As a guide, soils used in rehabilitation should be applied at no less than 25 cm depth. This provides sufficient depth for re-ripping if follow-up maintenance should be required (BHP Mitsui Coal Pty Ltd, 2010).

Where available, competent materials will be placed on steeper slopes to aid stability. A seed mix containing grass, native shrub and tree species will be used to establish a sustainable vegetation cover in a one-pass operation.

Revegetation activities will occur prior to the commencement of the wet season (October – December) to maximise rainfall (BHP Billiton, 2005).

The material characterisation and landform design studies aim to identify and improve where possible:

- Growth media placement depth and soil profile depths relevant to post mining land uses;
- Soil and alternate growth media preparation details; and
- Expected soil and alternate growth media amelioration activities.

3 METHODOLOGY

3.1 Materials

The following materials were targeted for consideration as potential growth media in the landform design process:

- Topsoil materials; and
- Spoil.

Topsoil materials were sampled in a field program completed as part of this work, and spoil data from previous projects were considered as potential growth media in this assessment.

All materials were characterised in terms of basic chemical and physical fertility properties.

Any materials with the potential to be placed at the surface for use as topsoil/primary growth media were subjected to additional fertility assessments.

3.2 Topsoil

3.2.1 Field Program – topsoil stockpile sampling

The field program was undertaken on 8 – 10 February 2022.

Site conditions were wet at the time of inspection, with ponded water observed across the Study Area. For the preceding months, the Bureau of Meteorology recorded Moranbah's rainfall as 150 mm in November 2021, 84 mm in December 2021, and 97 mm in January 2022.

3.2.2 Sampling Plan and Intensity

The sampling plan is provided in Table 4 and the stockpiles sampled are presented in Appendix A.

Table 4. Topsoil stockpile sampling program.

Stockpile ID	Sample Sites	Stockpile ID	Sample Sites
1	1	27	1
2	1	38	1

Stockpile ID	Sample Sites	Stockpile ID	Sample Sites
6	2	40	2
11	1	41	1
12	1	43	2
13	1	47	1
17	2	48	2
20	1	52	1
Total			**21**

The sample density for soil cover material is considered to be at a *'moderate (detailed)'* intensity of 1:25 000, based on the *Guidelines for Surveying Soil and Land Resources* (McKenzie, Grundy, Webster, & Ringrose-Voase, 2008). This assumes soil will be placed at an average depth of 0.2 m at rehabilitation.

Using these criteria, Table 5 shows the sampling intensity on a *stockpile volume* basis; and based on *soil reinstatement* at rehabilitation to an average depth of 0.2 m.

Table 5. Sampling intensity for topsoil stockpiles.

Material	Volume (m^3)	Reinstatement Coverage (ha)	Total Samples	Sampling Density (volume m^3)	Sampling Density (area ha)	Survey Scale
Topsoil	2 793 354	1 396	84	1/33 000	1/16.5	1:25 000

3.2.3 Sample Collection

Samples and descriptions of materials were taken from test pits. Depth of excavation was to the base of the topsoil stockpile, or to the limit of excavation (~3–5 m).

Samples were collected from the stockpiles at depth intervals of 0.5–1 m (e.g. 0.5–1.0 m, 1.5–2.0 m, and 2.5–3.0 m etc.).

Sampling included composite and discrete samples. Each composite sample was composed of materials from three discrete samples. Laboratory analyses were as follows:

- Laboratory analysis of composite samples was a 'detailed' suite, to characterise the soil nutrients and physio-chemical parameters of the stockpile.
- Laboratory analysis of discrete samples was a 'basic' suite of pH and salinity. This analysis indicates the variability within the stockpile and exposes the potential for extreme values to be masked in composite samples.

Brief details about the collected materials were recorded in the field.

3.2.4 Laboratory Analysis

Laboratory analysis was undertaken by East West EnviroAg, a laboratory with National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) accreditation.

Laboratory analysis involved two different laboratory suites as described below and in Table 6.

1. The 'basic suite' screened for salinity and extremes of pH. This was conducted on all discrete samples from topsoil stockpiles. Data were used to provide an indication of the heterogeneity of materials within the stockpile. All samples were analysed with the *basic suite*.
2. The 'topsoil suite' extends the *basic suites* to include dispersion, sodicity, exchangeable cations, macro and micronutrients. It was conducted on topsoil materials, as well as samples of any other materials intended to be used as primary growth media.

Table 6. Laboratory analytical suites.

Analyses	Suite	
	Topsoil	Basic
pH and electrical conductivity.	✓	✓
Exchangeable cations (with calculations of effective cation exchange capacity and exchangeable sodium percentage) and chloride.	✓	
Total nitrogen and phosphorous; available phosphorous, potassium, and sulphur; trace nutrients (Cu, Zn, Mn, Fe, B), chloride, organic carbon and phosphorus buffer index (PBI), field texture.	✓	
Dispersion potential.	✓	
Totals	**21**	**63**

3.3 Spoil

Geochemical and physical characterisation data for the spoil materials were collated from multiple assessments conducted throughout the project. These included:

- Poitrel Mine – Final Void @ Landform Management Plan, June 2015 (BHP Mitsui Coal Pty Ltd, 2010);
- Soil and waste erodibility and landform design: Daunia Mine (Landloch Pty Ltd, 2017);
- Poitrel Coal Mine Project – Environmental Impact Statement (BHP Billiton, 2005); and
- BHP ALL SITES Coal Tailing and Rejects All Sites Earth Systems laboratory data spreadsheet (BHP, 2022).

Wastes at PTM were found to be very similar to the neighbouring Daunia Mine. Therefore, many physical properties are associated with the erodibility testing Landloch completed in 2017 (Landloch Pty Ltd, 2017).

4 FINDINGS

The two categories of materials characterised as part of this assessment include -

- Topsoil stockpiles; and
- Spoil materials.

Details of these materials are provided below. Site location details are provided in Appendix A and in Table B1. Stockpile description records and laboratory results are provided in Appendix B.

4.1 Topsoil Stockpiles

A total of 84 samples were collected from 21 locations within topsoil stockpiles. A total of 21 samples were analysed using the *topsoil suite* and another 63 samples were analysed using the *basic suite*.

The sample locations are provided in Figure A1 (Appendix A) and laboratory data are presented in Tables B3 and B4 (Appendix B).

Stockpiled topsoil materials were named and categorised into two groups:

- Red/Brown Clays; and
- Red/Grey Loams.

4.1.1 Red/Brown Clays

Red/brown clays are the dominant topsoil material stockpiled at PTM. The generalised topsoil materials are dark brown, brown, or reddish brown with texture of clay loam to medium clay. Gravel content is generally less than 10%, although sometimes gravel content of up to 20% is present. All red/brown clays were non-sodic and generally stable.

Erodibility studies conducted on a similar clay topsoil from Daunia mine (Landloch Pty Ltd, 2017) indicate these soils are comparable to the most stable clay topsoils available for rehabilitation in the region. They are suitable as a topsoil for all rehabilitation areas, providing basic erosion control practices are established and chemical fertility is managed to ensure both initially vigorous vegetation growth and maintenance of suitable levels of surface cover in the longer term.

A summary of key chemical and physical properties is presented in Table 7.

Figures 2 to 5 are representative of red/brown clay topsoils at the Mine.

Figure 2. Excavated soil at stockpile 11.

Figure 3. Soil sampling pit at stockpile 12.

Figure 4. Soil material at stockpile 27.

Figure 5. Variable soil at stockpile 43.

4.1.2 Red/Grey Loams

Red/grey loams form a minor portion of stockpile topsoil material at PTM. Less than 15% of samples collected are characterised as loams. The generalised topsoil materials are pale red, pale grey, or grey with texture of sandy loam to sandy clay loam. Gravel content is 10-20%. All red/grey loams were non-sodic but susceptible to slaking and dispersion, thereby increasing the risk of erosion.

A summary of key chemical and physical properties is presented in Table 7.

Figures 6 and 7 are representative of red/grey loam topsoils at the mine.

Figure 6. Excavated soil at stockpile 48.

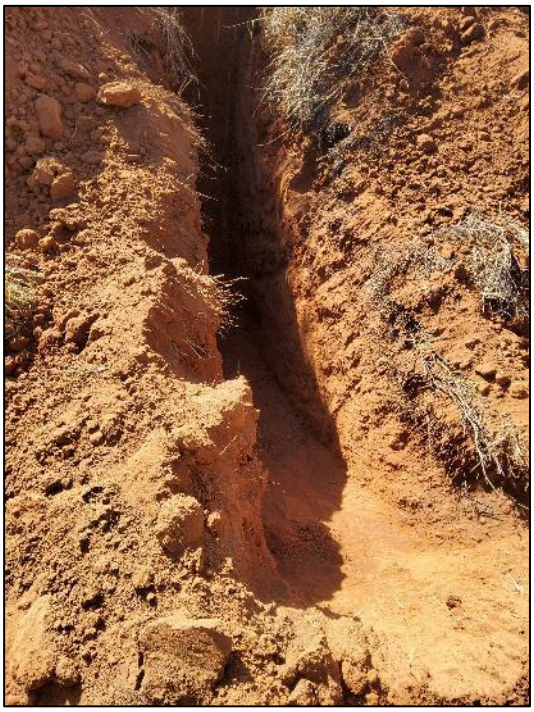

Figure 7. Soil sampling pit at stockpile 48.

Table 7. Summary of key chemical and physical properties for topsoils at PTM.

Analysis	Red/Brown Clay	Red/Grey Loam
Chemical Properties		
$pH_{1:5}$ (H_2O)	Neutral to strongly alkaline (7.1 – 8.5)	Neutral to strongly alkaline (6.9 – 8.5)
$EC_{1:5}$ (dS/m)	Low to moderate (0.9 – 0.28)	Low (0.12 – 0.14)
ESP (%)	Non-sodic (1.2 – 4.9)	Non-sodic (2.8 – 3.5)
Total N (mg/kg)	Low the moderate (270 – 1384)	Low (396 – 471)
Available P (mg/kg)	Low (4 – 16)	Low (4 – 14)
Available K (mg/kg)	Low the moderate (76 – 364)	Low the moderate (124 – 222)
Organic Carbon (%)	Low to moderate (0.57 – 1.82)	Low (0.29 – 0.83)
CEC (meg/100g)	Low to moderate (5.5 – 24.6)	Low (5.8 – 8)
Ca/Mg (ratio)	Low Ca to balanced (2.7 – 8)	Low Ca to balanced (3 – 5.2)
Physical Properties		

Analysis	Red/Brown Clay	Red/Grey Loam
Clay content (%)	>30	<30
Rock content (%)	<20	10 – 20
Dispersion (EAT)	Slightly dispersive to stable (3b – 7)	Slightly dispersive to slaking (3b – 5)
Permeability*	Low	Moderate
Erodibility*	Low to Moderate	Moderate
Associated regional soil	MM7	Ro9
Associated SMU	A3, B1, B3, B3v, B4, B4v and B5 (B2 where gravel content is >10%)	A2, E1 and E3 (E2 where gravel content is >20%)

Note: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed.
* Based on measured erodibility parameters (Landloch Pty Ltd, 2017).

4.2 Spoil Materials

From the previous assessments detailed in section 3.3, broad spoil characteristics were found to be similar across all studies and identify two spoil management groups:

- Permian spoil (overburden); and
- Weathered sediments and clay spoil (interburden).

Both spoil management groups have identical properties to spoils characterised at the nearby Daunia Mine. Therefore, it is assumed erodibility properties of PTM spoils can be inferred from the testing conducted by Landloch in 2017 on Daunia Mine spoils (Landloch Pty Ltd, 2017).

4.2.1 Permian spoil (overburden)

Generally, Permian spoil is a rocky material consisting primarily of sandstone, siltstone, and claystone with clay content below 25%, resulting in low water holding capacity. It is generally grey or pale brown in colour. Permian spoil at the Mine, however, can vary depending on the strata location and degree of carbonaceous inclusions present. The materials are sodic and dispersive. A summary of key chemical and physical properties is presented in Table 8.

Of the two spoil materials, fresh Permian is considered the most suitable option as a growth medium. Fresh or recently stripped Permian sandstone that has not be exposed to extended periods of weathering should be used in the upper growth media profile to greatly increase batter slope resistance to erosion while vegetation establishes. Slake durability data indicated that only 25% of Permian samples have a slake durability higher than 70% (Landloch Pty Ltd, 2017). If this material could be isolated, it may be useful to rock armour and stabilise steeper areas. Additional studies and testing for rock properties such as hardness (consolidation and cementation), mineralogy

(susceptibility to weathering of the component minerals) and permeability would be useful to locate additional competent material.

4.2.2 Weathered sediments and clay spoil (interburden)

The weathered sediments and clay spoil is a highly weathered material containing portions of fragile rock and a clay content of >35%, resulting in moderate to high water holding capacity. It is typically pale orange to brown in colour. The materials are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Key chemical and physical properties are summarised in Table 8.

Placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended due its high erodibility. Consideration could only be given to use as a secondary growth medium on flat or very low gradient areas if the intended material has no chemical limitations to vegetation growth.

Table 8. Summary of key chemical and physical properties for spoils at PTM.

Analysis	Spoil Material	
	Permian (overburden)	Weathered Sediments and Clay (interburden)
Chemical Properties		
$pH_{1:5}$ (H_2O)*	Moderate to strongly alkaline (8 – 9.5)	Neutral to strongly alkaline (7 – 9)
$EC_{1:5}$ (uS/cm)*	Low to moderate (180 – 820)	Moderate to high (510 – 1200)
ANC (H_2SO_4/t)*	High (20 – 30)	High (20 – 50)
PAF	No	No
CEC (meq/100g)*	Moderate to high (14 – 32)	Moderate to high (14 – 36)
ESP (%)*	Non-sodic to strongly sodic (5 – 27)	Sodic to strongly sodic (6 – 24)
Metals	Comparable to background levels	Comparable to background levels
Physical Properties**		
Clay content (%)	<25	>35
Rock content (%)	>30	<20
Slake durability (%)	Moderate (50 – 75)	Low (<50)
Permeability	Very high	Low to moderate
EAT*	Dispersive (Class 2)	Dispersive (Class 2)
Dispersion risk	Moderate	Moderate

* Chemical properties are based on average values for all spoil samples analysed.
** Taken from erodibility testing results for similar spoil at Daunia mine (Landloch Pty Ltd, 2017).

5 GROWTH MEDIA SUITABILITY AND AMELIORATION

The materials encountered have been classified according to their ability to support plant growth, as either *primary* or *secondary* growth media.

5.1 Primary Growth Media

Primary growth media infers the materials have the ability to be used as a topsoil or topsoil surrogate, such as an alternative growth media.

It is the upper-most layer of soil/material placed over the rehabilitated area. It can be applied at various thicknesses depending on the post-mining land use and consists of surface soil (topsoil) materials recovered prior to mining, or an alternative growth medium developed to a standard suitable to support sustainable plant growth.

Compared to subsoil and overburden materials, it is typically higher in organic matter and both macro- and micronutrients, and has low to negligible limitations to plant growth. Its primary purposes are to provide nutrients and a stable surface for vegetation establishment.

If adequate topsoil is not available, an alternative may be derived from high quality spoil with amendments. If this is required, analysis of macronutrients is to be conducted to determine the fertility stores needed to sustain healthy vegetation growth and identify any additional amelioration requirements for the spoil materials if used as primary growth media.

Target growth media properties are provided in Table 9. The aim is to provide rehabilitationparameters for a primary growth medium, post amelioration. Criteria values are based on representative soil parameters provided in the QLD Department of Primary Industries (DPI) *Land Management Manual – Understanding and Managing Soils in the Central Highlands* (Bourne & Tuck, 1993) and acceptable soil chemistry ranges from Bruce and Rayment (1982). The soils referenced have not been disturbed by mining, having formed naturally over time. It is not recommended that these thresholds are utilised as performance criteria, but rather as a target for amendments only. These thresholds do not guarantee successful rehabilitation and must be used in context.

Although these properties have been derived from relevant literature, they are still based on substrates formed from natural processes over time. The target properties are to be considered as a guide for amelioration of materials for which some properties might fall outside of these ranges.

Table 9. Summary details of representative soil units developed by QLD DPI in the Land Management Manual for the Central Highlands (Bourne & Tuck, 1993) and acceptable target properties for alternate growth media.

Analysis	Units	Representative Management Units			Target growth media properties*
		Rolleston (Grey and brown clay)	Picardy (Red and brown clay)	Glengallan (Solodic and solodized solonetz)	
Surface pH	-	8	7.5 – 8.5	>6.5	6 – 9
Salinity ($EC_{1:5}$)	dS/m	0.15 – 0.9	<0.45	<0.45	<0.75
Sodicity (ESP)	%	<6 (increasing with depth)	6 (increasing with depth)	6 (strongly sodic below 0.2 m)	<6
Total N	mg/kg	500 – 2500	1,500 – 2,500	<1,500	>1,000
Available P	mg/kg	5 – 40	5 – 100	5 – 40	>10
Available K	mg/kg	200 – 500	200 – 1000	200 – 500	>200

* Target alternate growth media criteria are provided as a post remediation target. Initial soil analysis values may be outside of the displayed ranges.

5.2 Secondary Growth Media

Secondary growth media infers the ability of materials to be used as a substrate or substrate surrogate.

It may consist of waste/spoil material that is capped with the primary growth medium or may be an intermediate layer placed on the waste/spoil material, and then capped with a primary growth medium.

The main purpose of the secondary growth medium is to increase the soil water storage capacity of the soil profile and/or to meet the soil depth criterion for certain vegetative post-mining land uses and target vegetation communities.

In some circumstances, secondary growth media may be able to be sufficiently improved by the addition of amendments (e.g. gypsum, lime, organic matter) to convert them to a primary growth medium.

5.3 Suitability Classification

A four-class suitability system is applied in the evaluation of materials as growth media. These classes are defined as follows:

Class A – Good Quality

- Negligible limitations to plant growth.
- Good quality material for intended purpose.

- *Nil* to *low* levels of amendment will be required.

Class B – Fair Quality

- Minor limitations to plant growth.
- Reasonable quality material for intended purpose.
- *Low* to *moderate* levels of amendment may will be required.

Class C – Marginal Quality

- Moderate limitations to plant growth.
- *Moderate* to *high* levels of amendment may be required to improve material quality to support plant growth.

Class D – Not Suitable

- Severe limitations to plant growth.
- It will generally be uneconomic or unviable to amend these materials to the degree needed to support plant growth.

Suitability of materials as primary or secondary growth media is presented with recommendations in Table 10.

5.4 Fertiliser and Ameliorants

Fertiliser and amendment rates for soil materials are dependent on the intended post-mine land use (PMLU) for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus based amendments would be recommended for these areas. As a guide amelioration application should aim to provide:

- Phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40 mg/kg;
- An appreciable source of starter nitrogen;
- Adequate macro and micronutrients; and
- Reduced potential for dispersion.

5.4.1 Gypsum

Gypsum has been recommended for sodic/dispersive materials or where calcium is low. It should be applied during soil preparation stages, in a manner that allows for as thorough mixing as is practicable of the surface materials. Gypsum should be applied prior to seeding and fertilising.

The depth to which sodicity is ameliorated should be dependent upon erosion risk/gradient. For slopes with gradients

- less than approximately 35 %, incorporate gypsum into the upper 0.3 m of sodic materials.
- greater than approximately 35 %, incorporate gypsum into the upper 0.5 m of sodic materials.

Considering the annual rainfall depth at the Mine is approximately 520 mm, it is expected that as a 'rule of thumb' gypsum will dissolve at a rate of 0.5 – 1 t/ha/y. Hence, there is benefit in applying gypsum at recovery of materials, or as soon as is practicable in the rehabilitation program.

5.4.2 Fertiliser

A balanced NPK fertiliser such as Crop King (CK) 55 (N: ~13.5%, P: ~15 %, K: 12.5%) and slow-release nitrogen source such as coated urea (N: ~46%) or organic compost is recommended to provide a balanced source of nutrients to plants during rehabilitation. Any composted material should comply with the Australian Standard for Composting (AS4454-2012).

Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. Spreaders are typically suitable for slopes with gradients less than 35%, and pneumatic or hydraulic applications will be required for steeper slopes.

Accurate application rates should be determined by a suitably qualified person prior to use in rehabilitation.

Table 10. Fertiliser and ameliorant treatment rates for materials and growth media suitability classification.

Material	Limitations	Amendments	Growth Media Suitability (Classes)	
			Primary (1)	Secondary (2)
Red/brown clay topsoil	• Sometimes strongly alkaline. • Often low N, P, K, and TOC.	• Fertiliser and/or compost rates are to be determined by a suitably qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Red/grey loam topsoil	• Sometimes strongly alkaline. • Often low N, P, K, and TOC.	• Fertiliser and/or compost rates are to be determined by a suitably qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Permian spoil (overburden)	• Strongly alkaline. • Sodic to strongly sodic and dispersive. • Rock content up to 50%.	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. • If to be used as a primary growth media then further assessment is required.	1B/C	2B
Weathered sediments and clay spoil (interburden)	• Often strongly alkaline. • Can have elevated salinity. • Often sodic to strongly sodic and dispersive. • Slake durability <50%. • Low permeability.	• Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. • Bury all saline material to a depth greater than 2 m below the surface.	1D	2C

Notes:

Class A – Good Quality: Negligible limitations to plant growth.

Class B – Fair Quality: Minor limitations to plant growth.

Class C – Marginal Quality: Moderate limitations to plant growth.

Class D – Not Suitable: Severe limitations to plant growth.

6 SUMMARY AND RECOMMENDATIONS

This material characterisation summary describes and characterises the materials identified on-site for use in rehabilitation, as per the topsoil stockpile assessment, previous soils and spoils assessments and other PTM project-related documents.

6.1 Topsoil Quality and Stockpiles

Generally, the topsoil material is considered to be of adequate quality for use as primary growth medium. Due to the high degree of heterogeneity in topsoil material, the summarised laboratory data should be considered representative of the topsoil materials as a whole, and not representative of individual stockpiles. As such, the sampling program is considered adequate to describe these materials into broad management groups. Therefore, any stockpile not included in this assessment should be sampled and characterised prior to use in rehabilitation.

The main limitations of topsoil materials for use in rehabilitation is low fertility. Generally, chemical fertility of the available topsoils is quite low. A balanced NPK fertiliser or compost should be applied during rehabilitation to provide a starter source of nutrients for initial vegetation growth. Additional applications may be required to maintain adequate fertility levels.

Amelioration products and application rates should be assessed by a suitably qualified professional prior to use for rehabilitation and to complement the desired PMLU.

6.2 Spoil Materials

Generally, Permian spoil materials at the mine are suitable to be used as secondary growth media with varying degrees of amelioration. Permian spoil that has been freshly stripped and has not been exposed to extended weathering is considered the most beneficial for use in the upper soil profile as it offers the highest stability and resistance to erosion. Where possible, placing weathered sediments and clay spoil in the upper soil profile should be avoided.

The laboratory analysis and erodibility testing of spoil materials identified limitations for their use as *primary growth media*. The main limitation of all spoil materials is the tendency to rapidly weather when exposed, making them susceptible to erosion on steep areas. However, weathered Permian material may provide suitable growth media for establishment of woodland vegetation on lower slopes. This material has only minor chemical limitations and is unlikely to significantly reduce growth of most plant species used in rehabilitation. Testing did not consider macro or micro nutrient fertility of the Permian spoil, nor its potential use as a *primary growth medium*. It is recommended that analysis of macronutrients be conducted to determine the fertility stores needed to sustain healthy vegetation growth and identify any additional amelioration requirements for the spoil materials if used as a primary growth medium.

Data suggest that relatively competent rock with a slake durability higher than 70% is present on site. If this material can be isolated, it could be used as a rock armour to greatly increase batter slope resistance to erosion and to stabilise steeper areas in the short-term until vegetation establishes.

6.3 Growth Media for PMLU

Physical and chemical properties of the soil and spoil material available on site meet the requirements to establish the PMLU for rehabilitated areas of cattle grazing or woodland habitat. It is recommended that the growth media is assessed by an appropriately qualified person prior to rehabilitation, to identify the required ameliorants and fertilisers.

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APPENDIX A: MAPS AND FIGURES

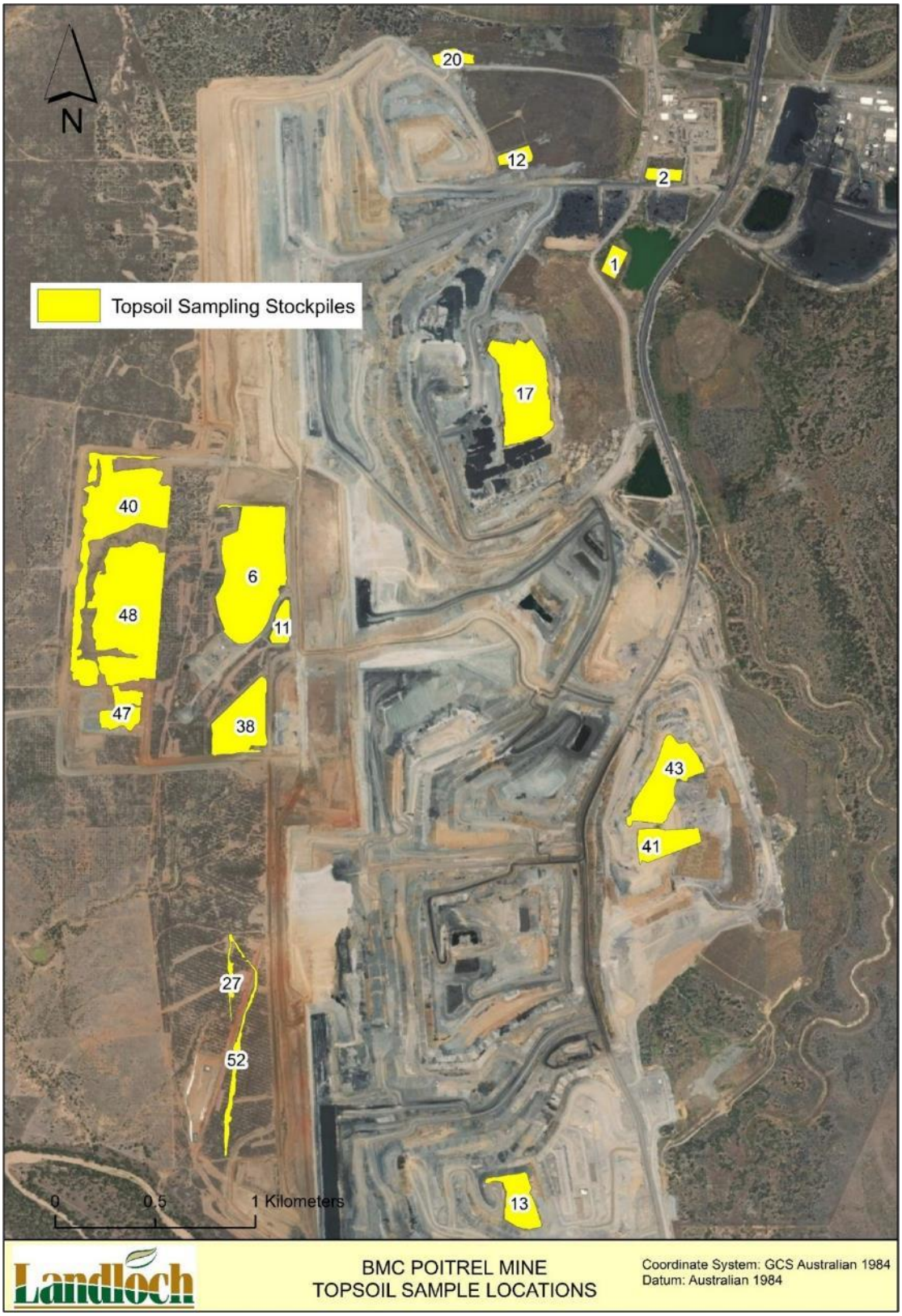

Figure A1. Topsoil stockpile materials sampling locations at PTM.

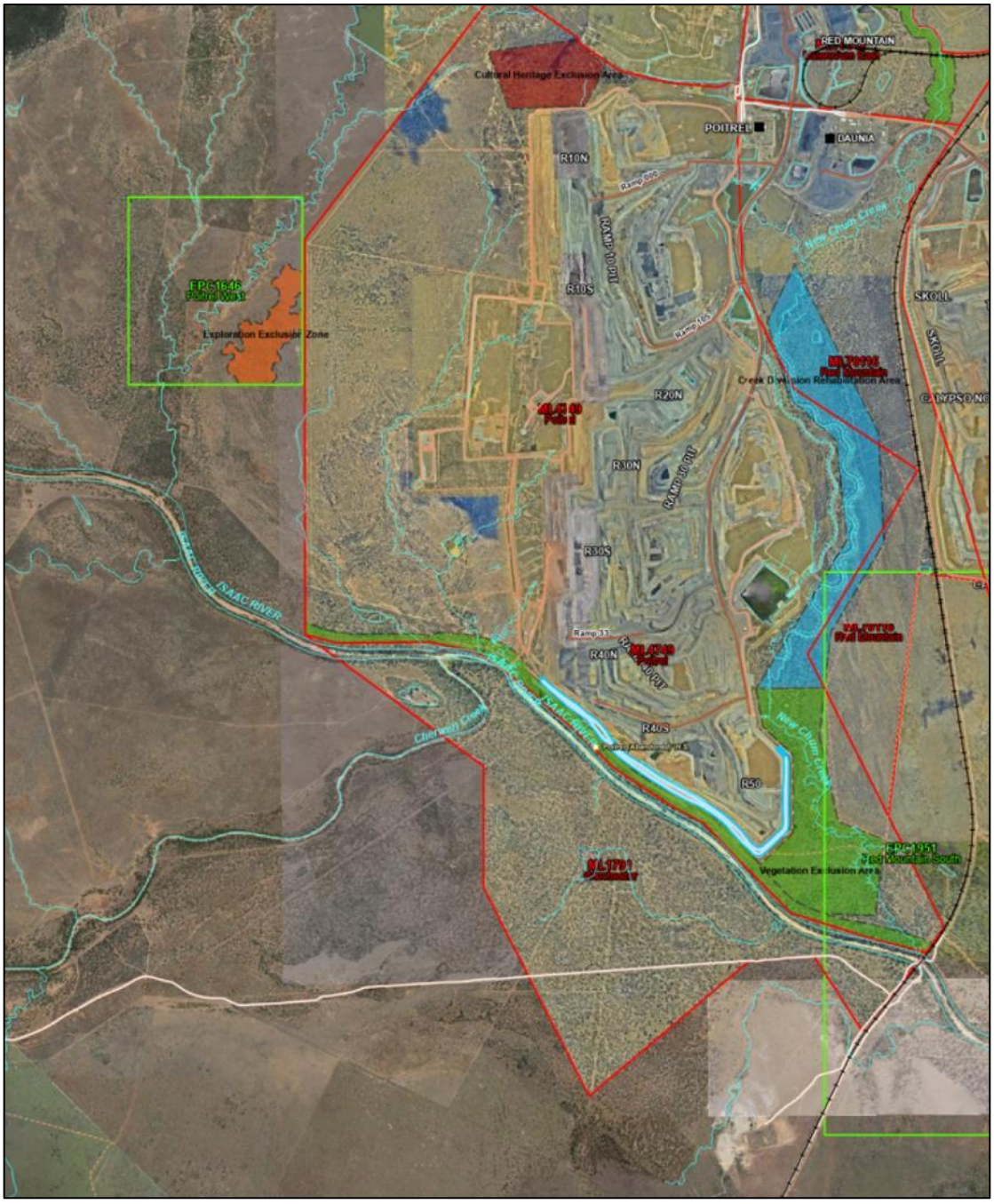

Figure A2. PTM site layout (October 2021).

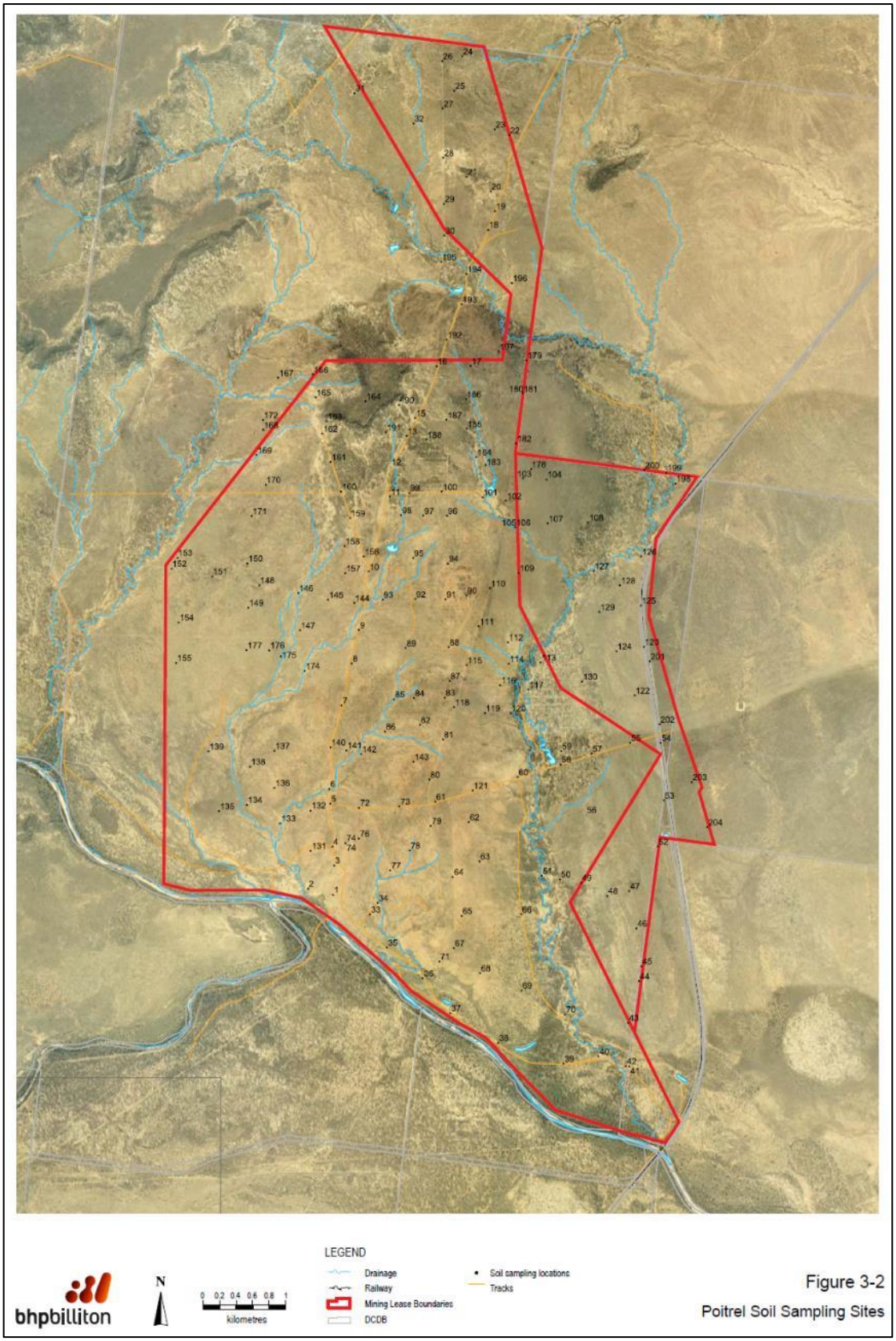

Figure A3. Pre-mined soil sampling locations (BHP Billiton, 2005).

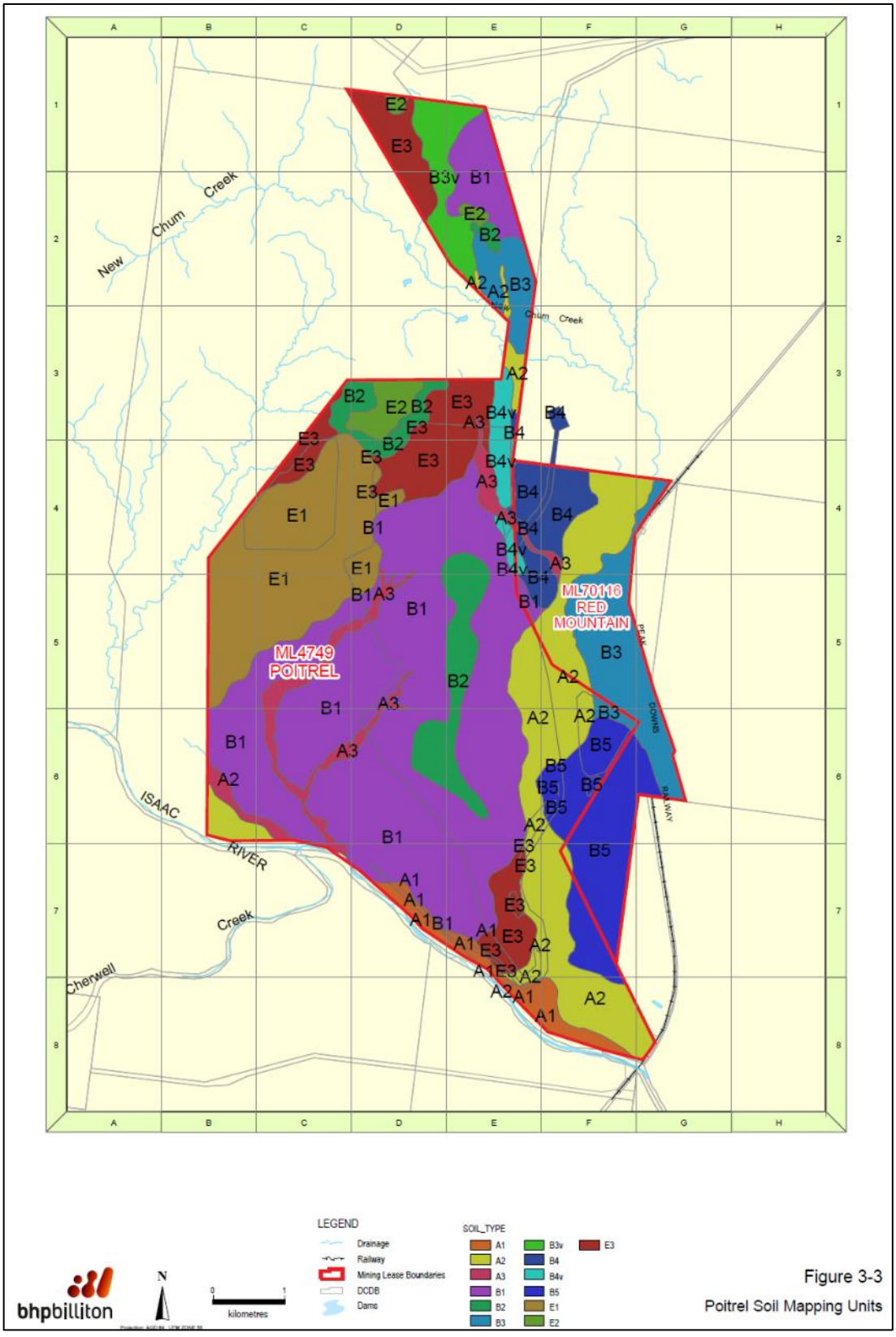

Figure A4. Pre-mined soil mapping units (BHP Billiton, 2005).

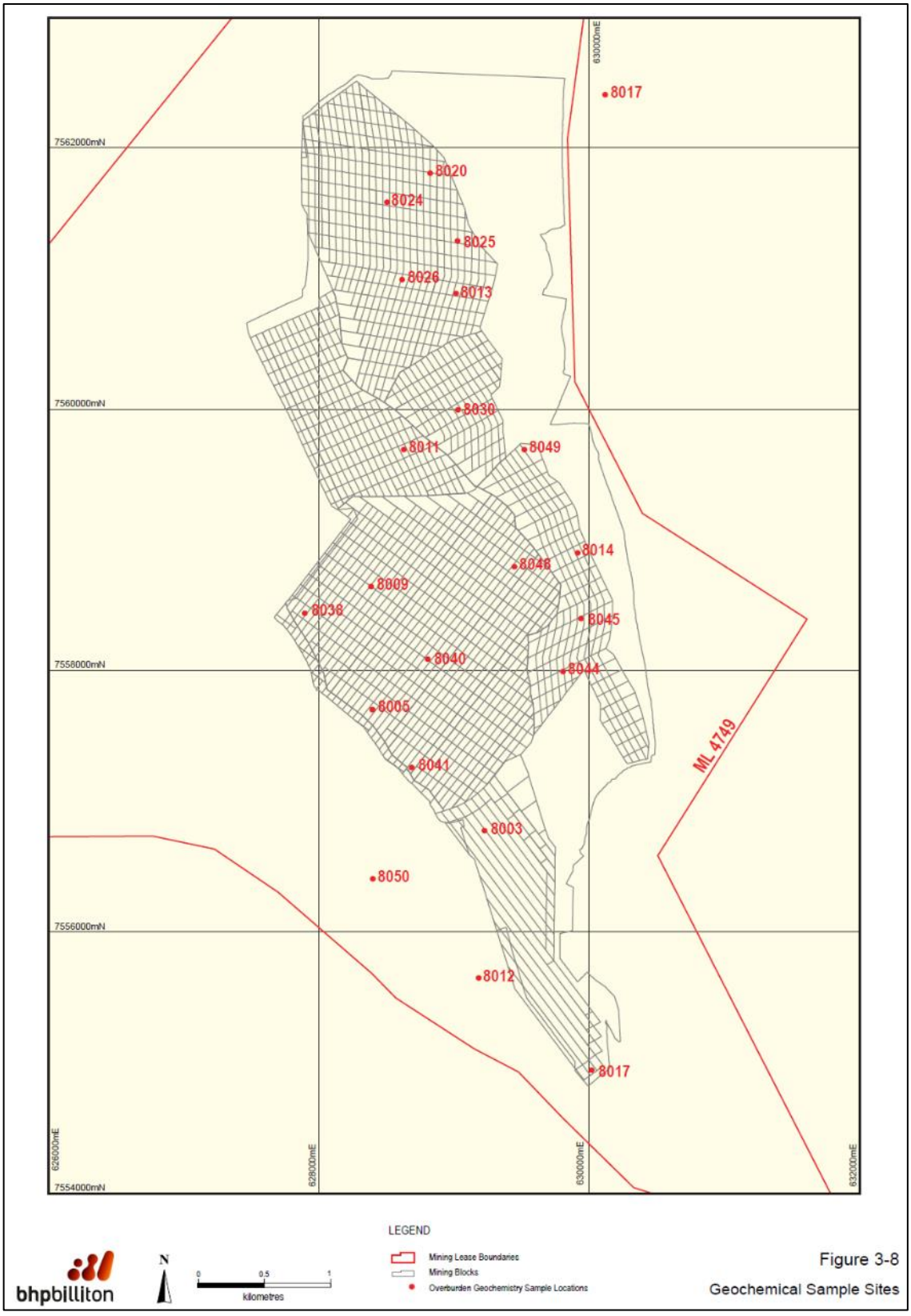

Figure A5. Spoil sampling locations for EIS (BHP Billiton, 2005).

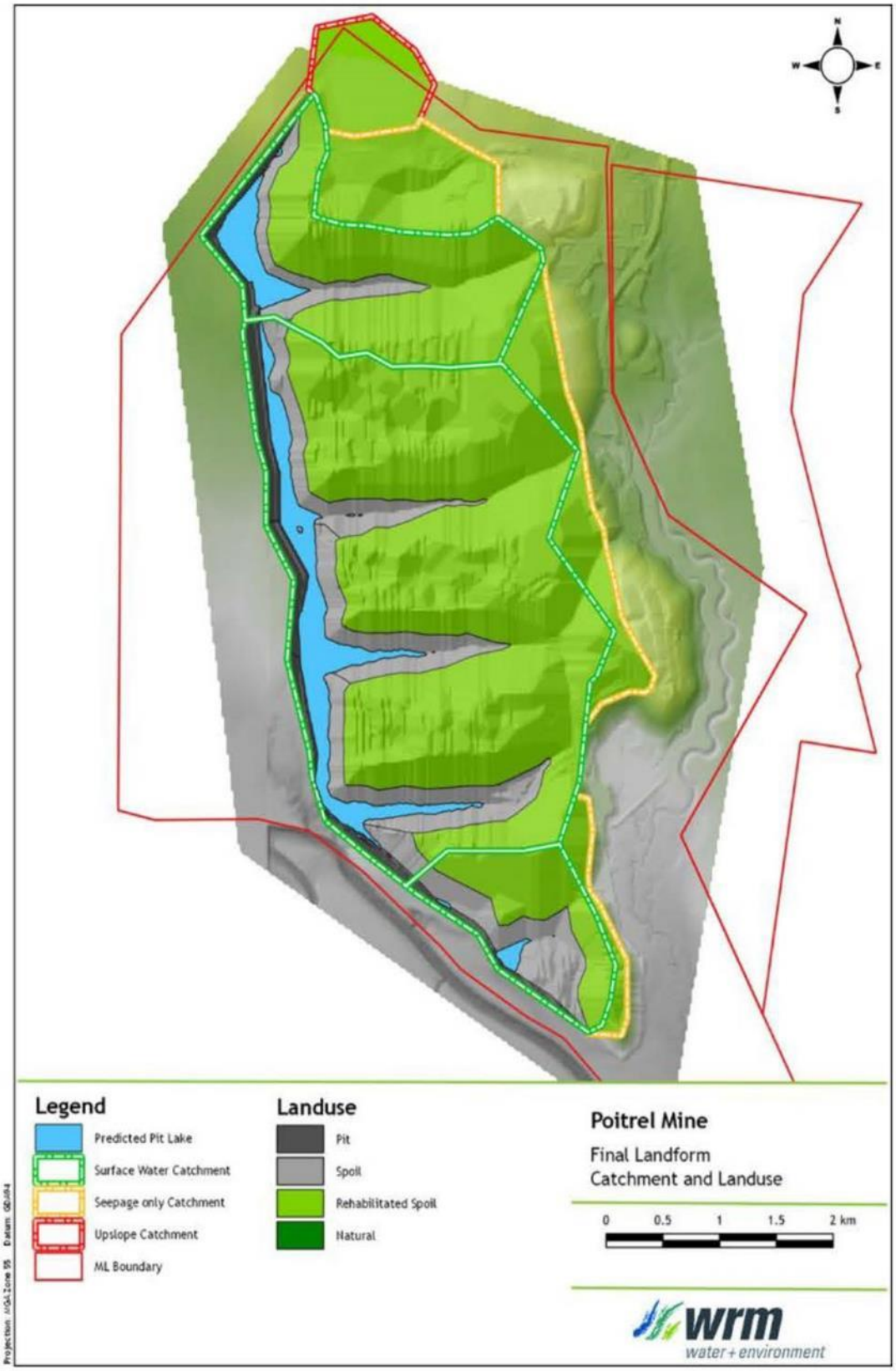

Figure A6. Landform concept for PTM.

APPENDIX B: DATA TABLES

Table B1. Sampling site locations.

Site ID	Type	UTM
st.43b	Topsoil stockpile	55 K 629893.11 7558458.143
st43a	Topsoil stockpile	55 K 630085.03 7558599.898
st41	Topsoil stockpile	55 K 629922.04 7558379.065
st.2	Topsoil stockpile	55 K 630016.32 7561690.485
st12	Topsoil stockpile	55 K 629308.48 7561904.664
st.20	Topsoil stockpile	55 K 628902.91 7562362.719
st52	Topsoil stockpile	55 K 628048.62 7557369.038
st27	Topsoil stockpile	55 K 628026.65 7557756.713
St.38	Topsoil stockpile	55 K 627956.14 7558827.384
st13	Topsoil stockpile	55 K 629277.86 7556663.096
st17b	Topsoil stockpile	55 K 629523.05 7560449.257
st17a	Topsoil stockpile	55 K 629449.18 7560834.848
st1	Topsoil stockpile	55 K 629775.44 7561208.599
st11	Topsoil stockpile	55 K 628232.22 7559375.391
st47	Topsoil stockpile	55 K 627595.17 7559106.689
st48b	Topsoil stockpile	55 K 627692.90 7559494.564
st6b	Topsoil stockpile	55 K 628223.11 7559655.137
st40b	Topsoil stockpile	55 K 627354.78 7559727.875
st6a	Topsoil stockpile	55 K 628149.10 7559465.923
st48a	Topsoil stockpile	55 K 627676.67 7559319.305
st40a	Topsoil stockpile	55 K 627671.32 7560212.025

Table B2. Morphological description of stockpiled soil materials. Part 1 of 2.

Field Order	Date	Site ID	Layer	Texture Group 1°	Texture Field	Colour (rapid)		Total Coarse Fragment %	Origin (i.e topsoil, subsoil, overburden); Parent Materials; and Proportions	Comments
						Primary	Secondary			
1	8.2.22	st40a	0.5	CLAY	Light Medium Clay	Grey	Brown	20-30	topoil	
			1.5	CLAY	Light Medium Clay	Grey	Brown	20-30	topoil	
			2.5	CLAY	Light Medium Clay	Grey	Brown	20-30	topoil	
			3.5	CLAY	Light Medium Clay	Red	Brown	20-30	topoil	
2	8.2.22	47	0.5	LOAM	Sandy Clay Loam	Grey	Pale Grey	10-20	topsoil	festone throughout. erosion, and surface hard.
			1.5	LOAM	Sandy Clay Loam	Grey	Pale Grey	10-20	topsoil	
			2.5	LOAM	Sandy Clay Loam	Grey	Pale Grey	10-20	topsoil	
3	8.2.22	48a	0.5	LOAM	Sandy Loam	Grey	Pale Grey	20-30	topsoil	festone and stone throughout, grasscover
			1.5	LOAM	Sandy Loam	Grey	Pale Grey	20-30	topsoil	
			2.5	LOAM	Sandy Loam	Grey	Pale Grey	20-30	topsoil	
4	8.2.22	48b	0.5	LOAM	Sandy Loam	Pale Red	Grey	10-20	topsoil.	stone and fe stone.
			1.5	LOAM	Sandy Loam	Pale Red	Grey	10-20	topsoil	
			2.5	LOAM	Sandy Loam	Pale Red	Grey	10-20	topsoil	
5	8.2.22	48c	0.5	LOAM	Sandy Loam	Yellow	Pale Red	5-10	topsoil	rock, festone and quartz ans silicon based rocks all over surface
			1.5	LOAM	Sandy Loam	Yellow	Pale Red	5-10	topsoil	
			2.5	LOAM	Clay Loam Sandy	Yellow	Pale Red	5-10	topsoil	
6	8.2.22	40b	o.5	CLAY	Clay Loam	Red	Pale Brown	<2	topsoil.	
			1.5	CLAY	Clay Loam	Red	Pale Brown	<2	topsoil	
			2.5	CLAY	Clay Loam	Red	Pale Brown	<2	topsoil	
7	8.2.22	6a	0.5	CLAY	Light Medium Clay	Red	Dark Brown	<2	topsoil	cracking clay surface, stones. h.dense cover of grasses. caco3, large clods
			1.5	CLAY	Light Medium Clay	Red	Dark Brown	<2	topsoil	
			2.5	CLAY	Light Medium Clay	Red	Dark Brown	<2	topsoil	
8	8.2.22	6b	0.5	CLAY	Light Medium Clay	Pale Red	Dark Brown	<2	topsoil	direction of depth piles is 1 2 3 anti clockwise
			1.5	CLAY	Light Medium Clay	Pale Red	Dark Brown	<2	topsoil	
			2.5	CLAY	Light Medium Clay	Pale Red	Dark Brown	<2	topsoil	
9	8.2.22	6c	0.5	CLAY	Light Medium Clay	Pale Red	Brown	2-5	topsoil	yellow red cracking clay attop. rep of area.
			1.5	CLAY	Light Medium Clay	Pale Red	Brown	2-5	topsoil	
			2.5	CLAY	Light Medium Clay	Pale Red	Brown	2-5	topsoil	direcion of depth piles top left anticlockwise
10	8.2.22	st11	0	CLAY	Light Medium Clay	Dark Brown	Dark Grey	<2	topsoil	topsoil piles bulked.
			1.5	CLAY	Light Medium Clay	Dark Brown	Dark Grey	<2	topsoil	
			2.5	CLAY	Light Medium Clay	Dark Brown	Dark Grey	<2	topsoil	
11	9.2.22	st38	0.5	CLAY	Sandy Clay Loam	Red	Brown	5-10	topsoil	lots stone on surface areas well covered in grass.
			1.5	CLAY	Sandy Clay Loam	Red	Brown	5-10	topsoil	
			2.5	CLAY	Light Medium Clay	Grey	Brown	5-10	topsoil	

Table B2. Morphological description of stockpiled soil materials. Part 2 of 2.

Field Order	Date	Site ID	Layer	Texture Group 1°	Texture Field	Colour (rapid)		Total Coarse Fragment %	Origin (i.e topsoil, subsoil, overburden); Parent Materials; and Proportions	Comments
						Primary	Secondary			
12	9..2.22	st27	0	CLAY	Silty Clay Loam	Brown	Red	<2	topsoil	surface is crusted,stoney andgrass covered.
			1.5	CLAY	Silty Clay Loam	Red	Brown	<2	topsoil	
			2.5	CLAY	Silty Clay Loam	Red	Brown	<2	topsoil	
13	9.2.22	st.52	0.5	CLAY	Silty Clay Loam	Grey	Brown	<2	topsoil	stones and weed growth, dead wwes.
			1.5	CLAY	Light Clay	Red	Brown	<2	topsoil	
14	9.2.22	st20	0.5	CLAY	Light Medium Clay	Brown	Grey	<2	topsoil	weathered standstone through topsoil. large peds wth white sandstone
			1.5	CLAY	Light Medium Clay	Brown	Grey	<2	topsoil	edge material or salts.
			2.5	CLAY	Light Medium Clay	Brown	Grey	<2	topsoil	
15	9.2.22	st.12	0.5	CLAY	Silty Clay Loam	Pale Yellow	Brown	10-20	topsoil.	area well covered by dead .grasses.
			1.5	CLAY	Silty Clay Loam	Pale Yellow	Brown	<2	topsoil	
			2.5	CLAY	Silty Clay Loam	Pale Red	Brown	<2	topsoil	
16	9.2.22	st.2	0.5	CLAY	Clay Loam	Pale Yellow	Red	2-5	topsoil	topsoil in area bulked together , not paddock dumped.
			1.5	CLAY	Clay Loam	Pale Yellow	Red	5-10	topsoil	
			2.5	CLAY	Clay Loam	Pale Yellow	Red	10-20	topsoil	
17	9.2.22	st.41	0.5	CLAY	Sandy Clay Loam	Red	Pale Yellow	<2	topsoil	salt precipitate
			1.5	CLAY	Sandy Clay Loam	Red	Pale Yellow	<2	topsoil	rocks and arew well covered in grass
			2.5	CLAY	Sandy Clay Loam	Red	Pale Yellow	5-10	topsoil	
18	9.2.22	st43a	0.5	CLAY	Sandy Clay Loam	Brown	Red	20-30	topsoil	lot of rock
			1.5	CLAY	Sandy Clay Loam	Brown	Red	10-20	topsoil	area well covered in grass.
			2.5	CLAY	Sandy Clay Loam	Brown	Red	10-20	topsoil	
19	9.2.22	st43b	0.5	CLAY	Sandy Clay Loam	Pale Red	Pale Yellow	5-10	topsoil	grass well est. rock throughout
			1.5	CLAY	Sandy Clay Loam	Pale Red	Pale Yellow	10-20	topsoil	sandy, fine sand visible
			2.5	CLAY	Sandy Clay Loam	Pale Red	Pale Yellow	10-20	topsoil	
20	10.2.22	st.1	0.5	CLAY	Sandy Loam	Red	Brown	0	topsoil	topsoil in bulked area, covered in grasses, leaf litter. old site. fine texture
			1.5	CLAY	Sandy Loam	Red	Brown	<2	topsoil	sand, loam, clay increase towards base.
			2.5	CLAY	Sandy Clay Loam	Red	Brown	0	topsoil	
21	10.2.22	st.17a	0.5	CLAY	Sandy Clay Loam	Brown	Red	<2	topsoil, rocks on surface	topsoil stockpiles. high percentage of grass cover.
			1.5	CLAY	Clay Loam	Brown	Red	<2		fine sand, forms ribbon but loses cohesion
			2.5	CLAY	Clay Loam	Brown	Red	<2		clay can be seen, plastic, fine sand on fingers
22	10.2.22	st.17b	0.5	CLAY	Light Clay	Brown	Red	<2	topsoil	rocks across surface, grass well established.
			1.5	CLAY	Light Clay	Brown	Red	<2		fine sand. peds holding together well.
			2.5	CLAY	Light Clay	Brown	Red	<2		
23	10.2.22	st.13	0.5	CLAY	Silty Loam	Pale Brown	Red	<2	topsoil	access via cutting through 2 .bunds
			1.5	CLAY	Silty Loam	Pale Brown	Red	<2		
			2.5	CLAY	Silty Loam	Pale Brown	Red	<2		

Table B3. Laboratory analysis data for topsoil stockpiles. Part 1 of 4.

TABLE B3. Laboratory Results ALL SITES													
	Lab No	220726-5		220726-9		220726-13		220726-17		220726-21		220726-25	
	Sample ID	st40a		st47		st48a		st48b		st40b		st6b	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		SCL		SCL		SL		CL		LMC	
Analyses	**Unit**												
pH - Water	pH units	8.48	*M.Alk*	7.21	*Neutral*	6.91	*Neutral*	8.45	*M.Alk*	8.22	*M.Alk*	8.42	*M.Alk*
Electrical Conductivity	dS/m	0.26	*M.Sal*	0.12	*L.Sal*	0.14	*L.Sal*	0.12	*L.Sal*	0.15	*L.Sal*	0.28	*M.Sal*
Chloride	mg/kg	59.4	*VL.Sal*	47.3	*VL.Sal*	58.2	*VL.Sal*	32.2	*VL.Sal*	53.1	*VL.Sal*	69.0	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	996.0	*L*	430.0	*VL*	471.0	*VL*	396.0	*VL*	974.0	*L*	1331.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	202.0	*	188.0	*	186.0	*	168.0	*	230.0	*	218.0	*
Phosphorus - Colwell extr	mg/kg	11.3	*L*	14.0	*L*	5.6	*L*	3.9	*L*	5.4	*L*	8.09	*L*
Potassium - Colwell ext	mg/kg	167.00	*L*	222.00	*M*	145.00	*L*	124.00	*L*	102.00	*VL*	106.00	*VL*
Sulphur - KCl	mg/kg	9.3	*M*	7.6	*L*	11.4	*M*	7.3	*L*	5.8	*L*	11.4	*M*
Organic Carbon	%	1.30	*M*	0.60	*L*	0.83	*L*	0.29	*EL*	1.40	*M*	1.36	*M*
Copper	mg/kg	1.08	*M*	0.66	*M*	0.66	*M*	0.34	*M*	1.06	*M*	1.26	*M*
Iron	mg/kg	8.48	*	14.10	*	12.00	*	5.46	*	7.64	*	5.32	*
Manganese	mg/kg	5.60	*M*	12.40	*M*	9.06	*M*	5.86	*M*	10.40	*M*	6.54	*M*
Zinc	mg/kg	0.32	*L*	0.34	*L*	2.32	*M*	0.20	*VL*	0.36	*L*	0.26	*VL*
Boron	mg/kg	0.96	*L*	0.40	*VL*	0.36	*VL*	0.20	*VL*	0.64	*L*	0.90	*L*
Cation Extraction Method	Rayment& Lyons	15C1	*	15A1	*	15A1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	19.3	*M*	8.0	*L*	5.8	*VL*	6.5	*L*	15.6	*M*	24.2	*M*
Ex Calcium Percent	%	68.38	*Normal*	69.34	*Normal*	72.43	*Normal*	78.34	*Normal*	70.25	*Normal*	75.23	*Normal*
Ex Magnesium Percent	%	25.32	*H*	23.20	*H*	19.81	*H*	15.05	*H*	24.18	*H*	20.01	*H*
Ex Potassium Percent	%	1.42	*Normal*	3.81	*Normal*	4.64	*Normal*	3.68	*Normal*	1.25	*Normal*	1.00	*L*
Ex Sodium Percent	%	4.82	*N.Sodic*	3.5	*N.Sodic*	2.9	*N.Sodic*	2.76	*N.Sodic*	4.25	*N.Sodic*	3.71	*N.Sodic*
Ex Aluminium Percent	%	0.06	*VL*	0.14	*VL*	0.19	*VL*	0.17	*VL*	0.07	*VL*	0.05	*VL*
Exchangeable Calcium	meq/100g	13.19	*H*	5.56	*M*	4.21	*L*	5.08	*M*	10.99	*H*	18.24	*H*
Exchangeable Magnesium	meq/100g	4.88	*H*	1.86	*M*	1.15	*M*	0.98	*L*	3.78	*H*	4.85	*H*
Exchangeable Potassium	meq/100g	0.27	*L*	0.31	*M*	0.27	*L*	0.24	*L*	0.20	*VL*	0.24	*L*
Exchangeable Sodium	meq/100g	0.93	*H*	0.28	*L*	0.17	*L*	0.18	*L*	0.67	*M*	0.90	*H*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*
Calcium/Magnesium Ratio	-	2.7	*Low Ca*	3.0	*Low Ca*	3.7	*Low Ca*	5.2	*Balanced*	2.9	*Low Ca*	3.8	*Low Ca*
Emerson Aggregate	Class	7.0	*Stable*	3b	*Slight Disp*	5.0	*Slaking*	3b	*Slight Disp*	7.0	*Stable*	7	*Stable*
Phosphorus Buffer Index	mg/kg	93.2	*	51.7	*	37.9	*	21.1	*	83.8	*	105	*

Table B3. Laboratory analysis data for topsoil stockpiles. Part 2 of 4.

TABLE B3. Laboratory Results ALL SITES													
	Lab No	220726-29		220726-33		220726-37		220726-41		220726-44		220726-48	
	Sample ID	st6c		st11		st38		st27		st52		st20	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		MC		LMC		ZCL		MC		LMC	
Analyses	**Unit**												
pH - Water	pH units	8.45	*M.Alk*	8.37	*M.Alk*	8.11	*M.Alk*	7.26	*Neutral*	8.11	*M.Alk*	8.39	*M.Alk*
Electrical Conductivity	dS/m	0.15	*L.Sal*	0.17	*L.Sal*	0.25	*M.Sal*	0.21	*M.Sal*	0.15	*L.Sal*	0.22	*L.Sal*
Chloride	mg/kg	22.4	*VL.Sal*	23.4	*VL.Sal*	129.0	*L.Sal*	41.8	*VL.Sal*	32.0	*VL.Sal*	93.8	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	720.0	*L*	1008.0	*L*	889.0	*L*	1308.0	*L*	1384.0	*L*	999.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	179.0	*	172.0	*	189.0	*	227.0	*	208.0	*	210.0	*
Phosphorus - Colwell extr	mg/kg	6.06	*L*	6.69	*L*	4.93	*L*	8.34	*L*	8.21	*L*	7.75	*L*
Potassium - Colwell ext	mg/kg	83.70	*VL*	99.40	*VL*	87.40	*VL*	364.00	*H*	146.00	*L*	107.00	*VL*
Sulphur - KCl	mg/kg	5.7	*L*	7.3	*L*	8.9	*M*	12.4	*H*	7.6	*L*	9.8	*M*
Organic Carbon	%	0.76	*L*	1.27	*M*	1.09	*M*	1.58	*M*	1.82	*H*	1.19	*M*
Copper	mg/kg	0.9	*M*	1.08	*M*	0.8	*M*	0.67	*M*	0.7	*M*	1.02	*M*
Iron	mg/kg	6.94	*	7.92	*	8.14	*	12.30	*	5.82	*	4.80	*
Manganese	mg/kg	5.94	*M*	6.94	*M*	8.54	*M*	14.40	*M*	6.42	*M*	6.18	*M*
Zinc	mg/kg	2.22	*M*	0.22	*VL*	0.34	*L*	0.80	*M*	0.34	*L*	0.44	*L*
Boron	mg/kg	0.64	*L*	<0.20	*FALSE*	0.54	*L*	0.42	*VL*	<0.20	*FALSE*	1.04	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15A1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	16.0	*M*	24.6	*M*	14.0	*M*	11.7	*L*	18.7	*M*	17.9	*M*
Ex Calcium Percent	%	81.01	*H*	75.36	*Normal*	74.37	*Normal*	74.11	*Normal*	77.53	*Normal*	68.83	*Normal*
Ex Magnesium Percent	%	15.45	*H*	21.18	*H*	20.14	*H*	18.63	*H*	17.98	*H*	25.26	*H*
Ex Potassium Percent	%	1.13	*Normal*	0.87	*L*	1.34	*Normal*	5.86	*H*	1.64	*Normal*	1.15	*Normal*
Ex Sodium Percent	%	2.34	*N.Sodic*	2.54	*N.Sodic*	4.07	*N.Sodic*	1.3	*N.Sodic*	2.79	*N.Sodic*	4.69	*N.Sodic*
Ex Aluminium Percent	%	0.07	*VL*	0.05	*VL*	0.08	*VL*	0.09	*VL*	0.06	*VL*	0.06	*VL*
Exchangeable Calcium	meq/100g	12.94	*H*	18.56	*H*	10.40	*H*	8.69	*M*	14.52	*H*	12.31	*H*
Exchangeable Magnesium	meq/100g	2.47	*M*	5.22	*H*	2.82	*M*	2.18	*M*	3.37	*H*	4.52	*H*
Exchangeable Potassium	meq/100g	0.18	*VL*	0.21	*L*	0.19	*VL*	0.69	*M*	0.31	*M*	0.21	*L*
Exchangeable Sodium	meq/100g	0.37	*M*	0.63	*M*	0.57	*M*	0.15	*L*	0.52	*M*	0.84	*H*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*
Calcium/Magnesium Ratio	-	5.2	*Balanced*	3.6	*Low Ca*	3.7	*Low Ca*	4.0	*Low Ca*	4.3	*Balanced*	2.7	*Low Ca*
Emerson Aggregate	Class	7	*Stable*	7	*Stable*	7	*Stable*	7	*Stable*	7	*Stable*	5	*Slaking*
Phosphorus Buffer Index	mg/kg	88.9	*	126	*	64.7	*	55.9	*	88.1	*	78.9	*

Table B3. Laboratory analysis data for topsoil stockpiles. Part 3 of 4.

TABLE B3. Laboratory Results ALL SITES													
	Lab No	220726-52		220726-56		220726-60		220726-64		220726-68		220726-72	
	Sample ID	st12		st.2		st.41		st43a		st43b		st1	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		CL		LMC		SCL		SCL		MC	
Analyses	**Unit**												
pH - Water	pH units	7.09	*Neutral*	7.6	*L.Alk*	7.58	*L.Alk*	8.4	*M.Alk*	8.05	*M.Alk*	7.68	*L.Alk*
Electrical Conductivity	dS/m	0.2	*L.Sal*	0.14	*L.Sal*	0.09	*VL.Sal*	0.17	*L.Sal*	0.13	*L.Sal*	0.12	*L.Sal*
Chloride	mg/kg	82.0	*VL.Sal*	68.3	*VL.Sal*	39.9	*VL.Sal*	59.4	*VL.Sal*	64.2	*VL.Sal*	35.3	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	795.0	*L*	991.0	*L*	270.0	*VL*	986.0	*L*	550.0	*L*	877.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	304.0	*	329.0	*	177.0	*	201.0	*	185.0	*	252.0	*
Phosphorus - Colwell extr	mg/kg	8.85	*L*	11.9	*L*	15.5	*L*	8.47	*L*	6.56	*L*	6.31	*L*
Potassium - Colwell ext	mg/kg	79.50	*VL*	113.00	*L*	120.00	*L*	104.00	*VL*	117.00	*L*	150.00	*L*
Sulphur - KCl	mg/kg	22.7	*VH*	14.7	*H*	7.5	*L*	12.3	*H*	9.9	*M*	12.1	*H*
Organic Carbon	%	1.04	*M*	1.1	*M*	0.57	*VL*	1.27	*M*	0.83	*L*	1	*M*
Copper	mg/kg	1.18	*M*	1.32	*M*	0.64	*M*	1.02	*M*	0.68	*M*	0.96	*M*
Iron	mg/kg	15.00	*	14.80	*	10.20	*	7.38	*	6.52	*	7.37	*
Manganese	mg/kg	12.40	*M*	14.20	*M*	16.20	*M*	8.38	*M*	8.24	*M*	16.80	*M*
Zinc	mg/kg	0.52	*L*	0.64	*L*	0.26	*VL*	0.34	*L*	0.34	*L*	0.46	*L*
Boron	mg/kg	0.56	*L*	0.66	*L*	0.58	*L*	0.64	*L*	0.74	*L*	0.54	*L*
Cation Extraction Method	Rayment& Lyons	15A1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	12.2	*M*	10.1	*L*	5.5	*VL*	15.9	*M*	10.5	*L*	13.6	*M*
Ex Calcium Percent	%	73.03	*Normal*	77.77	*Normal*	69.39	*Normal*	77.41	*Normal*	77.06	*Normal*	86.00	*H*
Ex Magnesium Percent	%	20.75	*H*	16.93	*H*	22.13	*H*	17.31	*H*	17.23	*H*	10.51	*Normal*
Ex Potassium Percent	%	1.90	*Normal*	2.06	*Normal*	3.92	*Normal*	1.45	*Normal*	2.18	*Normal*	2.22	*Normal*
Ex Sodium Percent	%	4.2	*N.Sodic*	3.13	*N.Sodic*	4.36	*N.Sodic*	3.75	*N.Sodic*	3.42	*N.Sodic*	1.20	*N.Sodic*
Ex Aluminium Percent	%	0.09	*VL*	0.11	*VL*	0.20	*VL*	0.07	*VL*	0.11	*VL*	0.08	*VL*
Exchangeable Calcium	meq/100g	8.95	*M*	7.89	*M*	3.82	*L*	12.30	*H*	8.13	*M*	11.73	*H*
Exchangeable Magnesium	meq/100g	2.54	*M*	1.72	*M*	1.22	*M*	2.75	*M*	1.82	*M*	1.43	*M*
Exchangeable Potassium	meq/100g	0.23	*L*	0.21	*L*	0.22	*L*	0.23	*L*	0.23	*L*	0.30	*M*
Exchangeable Sodium	meq/100g	0.52	*M*	0.32	*M*	0.24	*L*	0.60	*M*	0.36	*M*	0.16	*L*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*
Calcium/Magnesium Ratio	-	3.5	*Low Ca*	4.6	*Balanced*	3.1	*Low Ca*	4.5	*Balanced*	4.5	*Balanced*	8.2	*Low Mg*
Emerson Aggregate	Class	7	*Stable*	7	*Stable*	3b	*Slight Disp*	7	*Stable*	7	*Stable*	4	*Slaking*
Phosphorus Buffer Index	mg/kg	51.4	*	64.9	*	51.5	*	89.2	*	59.6	*	71.8	*

Table B3. Laboratory analysis data for topsoil stockpiles. Part 4 of 4.

TABLE B3. Laboratory Results ALL SITES											
	Lab No	220726-76		220726-80		220726-84		**Mean**		**Min**	**Max**
	Sample ID	st17a		st17b		st13					
	Sample Depth (m)	Composite		Composite		Composite					
	Field Texture	MC		LMC		MC					
Analyses	**Unit**										
pH - Water	pH units	8.45	*M.Alk*	8.49	*M.Alk*	7.85	*L.Alk*	*8.0*	*M.Alk*	*6.9*	*8.5*
Electrical Conductivity	dS/m	0.22	*L.Sal*	0.18	*L.Sal*	0.17	*L.Sal*	*0.17*	*L.Sal*	*0.09*	*0.28*
Chloride	mg/kg	85.9	*VL.Sal*	69.6	*VL.Sal*	38.1	*VL.Sal*	*57*	*VL.Sal*	*22*	*129*
Total Nitrogen - Kjeldahl	mg/kg	931.0	*L*	552.0	*L*	891.0	*L*	*845*	*L*	*270*	*1384*
Total Phosphorus - Nitric/Perchloric	mg/kg	192.0	*	192.0	*	224.0	*	*211*	*	*168*	*329*
Phosphorus - Colwell extr	mg/kg	3.93	*L*	3.68	*L*	14.3	*L*	*8*		*4*	*16*
Potassium - Colwell ext	mg/kg	81.90	*VL*	76.20	*VL*	104.00	*VL*	*129*		*76*	*364*
Sulphur - KCl	mg/kg	9.4	*M*	10.1	*M*	8.7	*M*	*10.09*	*M*	*5.71*	*22.70*
Organic Carbon	%	1.05	*M*	0.91	*L*	1.01	*M*	*1.06*	*M*	*0.29*	*1.82*
Copper	mg/kg	0.88	*M*	0.68	*M*	0.88	*M*	*0.88*	*M*	*0.34*	*1.32*
Iron	mg/kg	5.60	*	4.87	*	6.16	*	*8*	*	*5*	*15*
Manganese	mg/kg	5.38	*M*	4.54	*M*	8.24	*M*	*9.17*	*M*	*4.54*	*16.80*
Zinc	mg/kg	0.26	*VL*	0.22	*VL*	0.30	*L*	*0.55*	*L*	*0.20*	*2.32*
Boron	mg/kg	0.92	*L*	1.02	*M*	0.80	*L*	*0.66*	*L*	*0.20*	*1.04*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	*	*	*	*
Cation Exchange Capacity	meq/100g	22.0	*M*	15.3	*M*	13.1	*M*	*14.3*	*M*	*5.5*	*24.6*
Ex Calcium Percent	%	69.80	*Normal*	70.59	*Normal*	76.70	*Normal*	*74.4*	*Normal*	*68.4*	*86.0*
Ex Magnesium Percent	%	24.05	*H*	23.99	*H*	18.89	*H*	*19.9*	*H*	*10.5*	*25.3*
Ex Potassium Percent	%	1.15	*Normal*	1.24	*Normal*	1.71	*Normal*	*2.2*	*Normal*	*0.9*	*5.9*
Ex Sodium Percent	%	4.94	*N.Sodic*	4.11	*N.Sodic*	2.62	*N.Sodic*	*3.4*	*N.Sodic*	*1.2*	*4.9*
Ex Aluminium Percent	%	0.05	*VL*	0.07	*VL*	0.08	*VL*	*0.1*	*VL*	*0.0*	*0.2*
Exchangeable Calcium	meq/100g	15.36	*H*	10.82	*H*	10.09	*H*	*10.7*	*H*	*3.8*	*18.6*
Exchangeable Magnesium	meq/100g	5.29	*H*	3.68	*H*	2.48	*M*	*2.9*	*M*	*1.0*	*5.3*
Exchangeable Potassium	meq/100g	0.25	*L*	0.19	*VL*	0.22	*L*	*0.3*	*L*	*0.2*	*0.7*
Exchangeable Sodium	meq/100g	1.09	*H*	0.63	*M*	0.34	*M*	*0.5*	*M*	*0.2*	*1.1*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	*0.0*	*H*	*0.0*	*0.0*
Calcium/Magnesium Ratio	-	2.9	*Low Ca*	2.9	*Low Ca*	4.1	*Balanced*	*4.0*	*Low Ca*	*2.7*	*8.2*
Emerson Aggregate	Class	7	*Stable*	4	*Slaking*	4	*Slaking*	*	*	*	*
Phosphorus Buffer Index	mg/kg	84.9	*	80.9	*	79	*	*	*	*	*

Table B4. Laboratory analysis data for discrete red/brown clay topsoil stockpile samples.

TABLE B4. Laboratory Results ALL SITES																					
	Lab No	220726-1		220726-2		220726-3		220726-4		220726-18		220726-19		220726-20		220726-22		220726-23		220726-24	
	Sample ID	st40a		st40a		st40a		st40a		st40b		st40b		st40b		st6b		st6b		st6b	
	Sample Depth (m)	0.5-1.0		1.5-2.0		2.5-3.0		3.5-4.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0	
	Field Texture	LMC		LMC		LMC		LMC		SCL		SCL		SCL		LMC		LMC		LMC	
Analyses	**Unit**																				
pH - Water	pH units	8.38	*M.Alk*	8.57	*H.Alk*	8.51	*H.Alk*	8.34	*M.Alk*	8.10	*M.Alk*	8.12	*M.Alk*	8.31	*M.Alk*	8.50	*H.Alk*	8.31	*M.Alk*	8.35	*M.Alk*
Electrical Conductivity	dS/m	0.24	*M.Sal*	0.24	*M.Sal*	0.24	*M.Sal*	0.31	*M.Sal*	0.14	*L.Sal*	0.13	*L.Sal*	0.18	*L.Sal*	0.22	*L.Sal*	0.35	*M.Sal*	0.31	*M.Sal*
	Lab No	220726-26		220726-27		220726-28		220726-30		220726-31		220726-32		220726-34		220726-35		220726-36		220726-38	
	Sample ID	st6c		st6c		st6c		st11		st11		st11		st38		st38		st38		st27	
	Sample Depth (m)	0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0	
	Field Texture	LMC		LMC		LMC		LMC		LMC		LMC		SCL		SCL		LMC		ZCL	
Analyses	**Unit**																				
pH - Water	pH units	8.43	*M.Alk*	8.4	*M.Alk*	8.38	*M.Alk*	8.47	*M.Alk*	8.35	*M.Alk*	8.38	*M.Alk*	7.9	*M.Alk*	8.36	*M.Alk*	8.01	*H.Alk*	7.2	*H.Alk*
Electrical Conductivity	dS/m	0.15	*L.Sal*	0.14	*L.Sal*	0.17	*L.Sal*	0.15	*L.Sal*	0.17	*L.Sal*	0.17	*L.Sal*	0.17	*L.Sal*	0.19	*M.Sal*	0.33	*M.Sal*	0.25	*M.Sal*
	Lab No	220726-39		220726-40		220726-42		220726-43		220726-45		220726-46		220726-47		220726-49		220726-50		220726-51	
	Sample ID	st27		st27		st52		st52		st20		st20		st20		st12		st12		st12	
	Sample Depth (m)	1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0	
	Field Texture	ZCL		ZCL		ZCL		LC		LMC		LMC		LMC		ZCL		ZCL		ZCL	
Analyses	**Unit**																				
pH - Water	pH units	7	*H.Alk*	7.39	*H.Alk*	8.39	*H.Alk*	7.88	*H.Alk*	8.35	*H.Alk*	8.59	*H.Alk*	8.48	*H.Alk*	7.71	*H.Alk*	6.89	*H.Alk*	7.17	*H.Alk*
Electrical Conductivity	dS/m	0.2	*M.Sal*	0.18	*M.Sal*	0.19	*M.Sal*	0.15	*M.Sal*	0.17	*M.Sal*	0.17	*M.Sal*	0.27	*M.Sal*	0.17	*M.Sal*	0.2	*M.Sal*	0.21	*M.Sal*
	Lab No	220726-53		220726-54		220726-55		220726-57		220726-58		220726-59		220726-61		220726-62		220726-63		220726-65	
	Sample ID	st.2		st.2		st.2		st.41		st.41		st.41		st43a		st43a		st43a		st43b	
	Sample Depth (m)	0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0	
	Field Texture	CL		CL		CL		SCL		SCL		SCL		SCL		SCL		SCL		SCL	
Analyses	**Unit**																				
pH - Water	pH units	8.26	*H.Alk*	7.3	*H.Alk*	7.36	*H.Alk*	8.02	*H.Alk*	8.05	*H.Alk*	7.52	*H.Alk*	8.54	*H.Alk*	8.47	*H.Alk*	8.24	*H.Alk*	6.93	*H.Alk*
Electrical Conductivity	dS/m	0.12	*M.Sal*	0.2	*M.Sal*	0.14	*M.Sal*	0.13	*M.Sal*	0.11	*M.Sal*	0.08	*M.Sal*	0.15	*M.Sal*	0.17	*M.Sal*	0.17	*M.Sal*	0.11	*M.Sal*
	Lab No	220726-66		220726-67		220726-69		220726-70		220726-71		220726-73		220726-74		220726-75		220726-77		220726-78	
	Sample ID	st43b		st43b		st1		st1		st1		st17a		st17a		st17a		st17b		st17b	
	Sample Depth (m)	1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0	
	Field Texture	SCL		SCL		SL		SL		SCL		SCL		CL		CL		LC		LC	
Analyses	**Unit**																				
pH - Water	pH units	8.04	*H.Alk*	7.91	*H.Alk*	7.34	*H.Alk*	7.69	*H.Alk*	8.02	*H.Alk*	8.82	*H.Alk*	8.28	*H.Alk*	8.45	*H.Alk*	8.59	*H.Alk*	8.4	*H.Alk*
Electrical Conductivity	dS/m	0.13	*M.Sal*	0.13	*M.Sal*	0.04	*M.Sal*	0.15	*M.Sal*	0.18	*M.Sal*	0.13	*M.Sal*	0.31	*M.Sal*	0.29	*M.Sal*	0.21	*M.Sal*	0.2	*M.Sal*
	Lab No	220726-79		220726-81		220726-82		220726-83		**Mean**		**LCL 95%**	**UCL 95%**	**Std Dev**	**CI 95% (+/-)**	**10%ile**		**90%ile**		**Min**	**Max**
	Sample ID	st17b		st13		st13		st13													
	Sample Depth (m)	2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0													
	Field Texture	LC		ZL		ZL		ZL													
Analyses	**Unit**																				
pH - Water	pH units	8.74	*H.Alk*	8.1	*H.Alk*	7.97	*H.Alk*	8.01	*H.Alk*	*8.1*	*M.Alk*	*7.9*	*8.2*	*0.5*	*0.1*	*7.3*	*Neutral*	*8.5*	*H.Alk*	*6.9*	*8.8*
Electrical Conductivity	dS/m	0.16	*M.Sal*	0.14	*M.Sal*	0.18	*M.Sal*	0.17	*M.Sal*	*0.18*	*L.Sal*	*0.17*	*0.20*	*0.06*	*0.02*	*0.13*	*L.Sal*	*0.28*	*M.Sal*	*0.04*	*0.35*

Table B5. Laboratory analysis data for discrete red/grey loam topsoil stockpile samples.

TABLE B5. Laboratory Results ALL SITES																
	Lab No	220726-6		220726-7		220726-8		220726-		220726-		220726-		220726-		220726-
	Sample ID	st47		st47		st47		st48a		st48a		st48a		st48b		st48b
	Sample Depth (m)	0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0
	Field Texture	SCL		SCL		SCL		SL		SL		SL		SL		SL
Analyses	**Unit**															
pH - Water	pH units	7.22	*Neutral*	7.48	*L.Alk*	7.58	*L.Alk*	7.06	*Neutral*	7.16	*Neutral*	7.23	*Neutral*	8.29	*M.Alk*	8.51	*H.Alk*
Electrical Conductivity	dS/m	0.11	*L.Sal*	0.11	*L.Sal*	0.12	*L.Sal*	0.12	*L.Sal*	0.12	*L.Sal*	0.09	*L.Sal*	0.12	*L.Sal*	0.13	*L.Sal*
	Lab No	220726-16		**Mean**		**LCL 95%**	**UCL 95%**	**Std Dev**	**Count**	**CI 95% (+/-)**	**10%ile**		**90%ile**		**Min**	**Max**	
	Sample ID	st48b															
	Sample Depth (m)	2.5-3.0															
	Field Texture	SL															
Analyses	**Unit**																
pH - Water	pH units	8.52	*H.Alk*	*7.7*	*L.Alk*	*7.3*	*8.1*	*0.6*	*9*	*0.4*	*7.1*	*Neutral*	*8.5*	*H.Alk*	*7.1*	*8.5*	
Electrical Conductivity	dS/m	0.14	*L.Sal*	*0.12*	*L.Sal*	*0.11*	*0.13*	*0.01*	*9*	*0.01*	*0.11*	*L.Sal*	*0.13*	*L.Sal*	*0.09*	*0.14*	

Appendix 5 Voids in Floodplain Assessment (26 April 2022)

POITREL MINE

Transitional Progressive Rehabilitation and Closure Plan
Voids in Floodplain Assessment

Prepared for:

BHP Metcoal Holdings Pty Ltd

SLR Ref: 620.30403.00000-R01
Version No: -v1.0
April 2022

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with BHP Metcoal Holdings Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30403.00000-R01-v1.0	26 April 2022	H Munck	MD	MD
620.30403.00000-R01-v0.1	11 March 2022	H Munck	MD	MD

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APPENDICES

Appendix A Pre-lodgement BHP/DES Workshop for PRCPs – Floodplain modelling and flood risks – Memorandum
Appendix B TUFLOW Model Results

1 Introduction

SLR was engaged by BHP to undertake floodplain modelling at Poitrel Mine (PTM). The modelling was undertaken to inform the Transitional Progressive Rehabilitation and Closure Plan (PRCP) for PTM.

PTM is located in Central Queensland, approximately 20 kilometres east of Moranbah, and immediately adjacent to Daunia Mine (DNM) which is located to the east. PTM is located within the catchment of the Isaac River. The Isaac River is located immediately to the south of the site. **Figure 1** illustrates the location of PTM and key surrounding features.

The assessment detailed in this document was undertaken specifically to address the voids in floodplain modelling as part of the PRCP requirements for PTM.

1.1 Aims and Objectives

Poitrel Mine requires a PRCP to be completed in accordance with PTM's Environmental Authority (EA), (No. EPML00963013). The EA is held by the BHP Billtion Mitsui Coal Pty Ltd (BMC). The EA relates to PTM on Mining Leases (ML) 4749 and 70116. As part of the PRCP for PTM, it is proposed to incorporate a single final void as a Non-Use Management Areas (NUMA). **Figure 1** illustrates the location and extent of the proposed final void.

To meet the requirements of the Environmental Protection Act 1994 (EP Act) and Environmental Protection Regulation 2019 (EP Regulation), floodplain modelling is required for all relevant watercourses in the vicinity of voids, to assess the flood immunity and extents for the final landform conditions.

The scope of this project is to undertake floodplain modelling of the relevant watercourses as defined by the EP Regulation in relation to the proposed voids, including the following key tasks.

- Undertake a catchment study for each proposed void in the floodplain, including determining the pre-mining landform and developing or updating hydrologic modelling to be consistent with the requirements of Australian Rainfall and Runoff (AR&R 2019). The study includes watercourses classified as stream order four or higher, and their contributing tributaries.
- Develop hydraulic models for the purpose of identifying flood risks posed to the proposed voids. The purpose of this is to define the baseline flood risks caused by the relevant watercourse(s), which will be used to assess the inundation risk in the 0.1% Annual Exceedance Probability (AEP) flood event for each void, informed by the re-constructed pre-mining topography.
- Produce a Voids in Floodplain Model Report detailing the methodology and findings of the above assessments, including all relevant mapping of flood extents, levels and depths. GIS data and models will also be provided as an output of this assessment.

The assessments detailed in this report were undertaken and reviewed by appropriately qualified persons.

1.2 Input Data

Data for the assessment was provided by BHP and included pre-mining topographic data, design surface data for the PRCP landform and aerial imagery for PTM.

Further data was obtained for use in the assessment from public sources, including additional topographic data, rainfall data, catchment specific hydrologic data and stream flow data. Further detail on the data utilised in the assessment is provided in **Section 3.**

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0 1,000 2,000 3,000 4,000 5,000 Meters

27-Jan-2022 Scale: 1:100,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend
- EA Boundary
- Final Void Extent
- Watercourse

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

Project Location

Figure 1

H:\Projects-SLR\620-BNE\620.30403.00000 BHP Transitional PRC Plan - Voids in Flo\06 SLR Data\01 CAD\GIS\GIS\Figures\DauniaPoitrel\620.30403 PTM Location A3L v1.mxd

1.3 Relevant Documentation

This assessment was undertaken in accordance with the following guidelines and documentation:

- *Environmental Protection Act 1994;*
- *Environmental Protection Regulation 2019;*
- *'Guideline – Progressive Rehabilitation and Closure Plans*', Department of Environment and Science (DES), March 2021 (PRCP Guideline);
- *'Information Sheet – Environmental Protection Act 1994 – Voids in Flood Plains'*, Department of Environment and Science, March 2020 (Voids in Flood Plains Information Sheet); and
- *'Australian Rainfall and Runoff (2019)'* (ARR).

In addition to the documentation listed above, the assessment was undertaken in accordance with the methodology that was agreed between BHP and DES during the pre-lodgement workshop for PRCPs (**Appendix A**).

1.4 Assumptions and Limitations

This assessment was undertaken specifically for the purposes for undertaking floodplain modelling of relevant watercourses in accordance with the requirements of the EP Act and EP Regulation. The following assumptions and limitations apply to this assessment.

- The accuracy of the assessment is reliant on the accuracy of the utilised data, as detailed in **Section 3**. SLR has assumed all source data to be fit for purpose and sufficiently accurate for the purpose of this assessment. Except where noted, no verification of accuracy of the information has been carried out. In the event that some of the information which was relied upon for this assessment is found to be inaccurate, then some or all of the findings may change.
- Floodplain modelling was undertaken only for relevant watercourses as defined in the Voids in Floodplain Information Sheet, i.e. watercourses with a stream order of 4 or higher under the Strahler stream order classification system.
- Generation of the model landform for the assessment was undertaken in accordance with the Voids in Flood Plains Information Sheet. Due to the requirement to include artificial features outside of the subject Mine Lease, the modelled floodplain may differ from the true pre-mining floodplain in areas where adjacent artificial features effect a relevant watercourse (for example, the Isaac River floodplain is affected by the adjacent artificial features of the Daunia Mine site).
- The hydraulic model was based on 1 Second Derived SRTM topographic data in some areas due to the limited extent of available LiDAR Data. SRTM data for the site has a vertical accuracy of +/-5-10m. The accuracy of the model results is limited to the accuracy adopted topographic data.
- Consideration was made as to the potential effects of groundwater on the floodplain extent. It was considered that groundwater will have no significant impact on the extent of the floodplain. An initial rainfall loss of 0 mm was adopted in the hydrologic studies. This assumption represents fully saturated catchment conditions (i.e. soil stores at the surface were full), which was considered to be a conservative approach. It was considered that the occurrence of elevated the baseflow conditions of the River would have no impact on peak flood levels, particularly in a 0.1% AEP event.

- Although the analyses undertaken as detailed in this report were done so with the appropriate care and professionalism, this report shall only be used for the purposes intended. The analyses detailed in this report were undertaken solely for the purpose of addressing the requirements for voids in floodplain modelling for Poitrel Mine in accordance with the relevant documentation as detailed in **Section 1.3**.
- This report should be read in full and no excerpts are to be taken as representative of the findings. This report has been prepared on behalf of BHP Metcoal Holdings Pty Ltd and SLR accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1.5 Document Structure

The structure of this report is set out as follows:

- **Section 2** - Relevant legislation and guidelines;
- **Section 3** - Data review and gap analysis, including details of the model landform development methodology and results;
- **Section 4** - Hydrologic modelling of the Isaac River catchment, including calibration methodology;
- **Section 5** - Hydraulic modelling of Isaac River, including results and outcomes of the floodplain modelling in relation to the proposed final voids; and
- **Section 6** – Summary of the study and conclusions.

Details of each component of the assessment are provided below.

2 Legislation and Guidelines

2.1 Relevant Legislation and Guidelines

This assessment has been undertaken in accordance with the following legislation and guidelines:

- *Environmental Protection Act 1994;*
- *Environmental Protection Regulation 2019;*
- *'Information Sheet – Environmental Protection Act 1994 – Voids in Flood Plains'*, Department of Environment and Science, March 2020; and
- *'Guideline – Progressive Rehabilitation and Closure Plans*', Department of Environment and Science, March 2021 (PRCP Guideline).

The Environmental Protection Act 1994 states:

'In accordance with section 126D(3) of the EP Act, 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 the rehabilitation of the land to a stable condition.'

The Environmental Protection Regulation 2019 section 41C(3) also states:

"The administering authority must treat the land as a flood plain to the extent the results of the flood plain modelling show that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% AEP for a relevant watercourse under the ARR."

Further guidance is provided in the PRCP Guideline and the Voids in Flood Plains Information Sheet.

Sections 3.4 and 3.6.1 of the PRCP Guideline both require a floodplain assessment to be carried out. Specifically, section 3.4 requires a Void in Floodplain assessment for all unapproved NUMA voids (i.e. floodplain assessment of the pre-mining landform), whilst section 3.6.1 requires a post-mining landform assessment irrespective whether a post-mining land use (PMLU) or NUMA is proposed.

2.2 Applicability to the Project

Based on the review of the EP Act, EP Regulation, PRCP Guideline and the Voids in Floodplains information sheets, it is considered that the legislative requirements set out in **Table 1** are applicable to the project.

Table 1 Applicable Legislative Requirements

Requirement	Application to the Project	Source
For transitional sites, a floodplain assessment is required where: - A void has been identified as a NUMA in a land outcome document but the location has not been specified; or - Where there are no land outcomes in the land outcome document.	The PRCP for Poitrel Mine includes a single final void which is proposed to be developed as a NUMA. Therefore, floodplain assessment is required.	PRCP Guideline Section 3.4

Requirement	Application to the Project	Source
Floodplains associated with a stream order 4 or greater are required to be modelled.	The following watercourses are of Strahler stream order 4 or greater and may affect the proposed voids: - Isaac River Therefore, the Isaac River is a relevant watercourse and floodplain modelling of the river was undertaken.	Voids in Flood Plains Information Sheet Section 5.
The modelling must not include any artificial features on the site. However, the modelling must include all existing and approved artificial features that, at the time of modelling, are located outside of the mining tenure boundary.	A Digital Elevation Model (DEM) of the area was created to be used as the model landform for the assessment. The model landform DEM was developed to represent the pre-mining topography within the Mining Lease (ML), and existing and future topography outside of the ML, including on adjacent MLs where applicable. The topography outside of the ML included existing and future artificial features, based on available data.	Voids in Flood Plains Information Sheet Section 4.
The requirement for a flood assessment under section 3.6.1 of the Guideline applies to the post mining landform across the whole site irrespective of whether a PMLU or a NUMA are proposed. Furthermore, section 3.6.1 is not only required to indicate flood risk but also to demonstrate the final landform (including waste rock dumps and diversions) will remain in a stable condition in a range of flood flow conditions.	Not included in the scope of this assessment.	PRCP Guideline Section 3.6.1.

2.3 Definitions and Terminology

Table 2 provides the definitions and terminology that are utilised in this assessment, in accordance with the PRCP Guideline and the Voids in Flood Plains Information Sheet.

Table 2 Definitions and Terminology

Term	Definition	Source
Voids	An area of land to be excavated in carrying out a mining activity. Therefore, all voids (PMLU or NUMA) are subject to the requirements of the EP Act.	Section 126D of the EP Act.
Flood plain	A void is considered to be located in a flood plain if the flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level in a 0.1% AEP for a relevant watercourse under the guideline Australian Rainfall and Runoff (2019) (ARR).	Section 41C of the EP Regulation; and PRCP Guideline Section 3.4.
Stable condition	- The land is safe and structurally stable; - There is no environmental harm being caused by anything on or in the land; and - The land can sustain a PMLU.	Section 126D(3) of the EP Act; and PRCP Guideline Section 3.6.3.
Relevant watercourse	(a) A watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or (b) If a watercourse mentioned in paragraph (a) is permanently diverted under – (i) A condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, section 98; or (ii) A water license or proposed water license under the Water Act 2000; the watercourse as permanently diverted.	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 5.
Flood plain modelling	For land the subject of a PRCP schedule, means modelling of the landform of the land – (a) Carried out under the ARR; (and) (b) Excluding any artificial features for the land	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 4.

Term	Definition	Source
Artificial feature	For land the subject of a PRCP schedule, means – (a) A structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or (b) A structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land if the relevant activities the subject of the PRCP schedule had not been carried out; or (c) A feature forming part of the landform of the land, other than the natural landform, if the feature interferes with or affects – (i) A relevant watercourse; or (ii) The natural flow of water on the land.	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 6.

3 Data Review and Gap Analysis

3.1 Available Data

A data package was provided to SLR by BHP for use in the assessment. The package included:

- GIS data containing watercourses with Strahler Stream Order 4 or greater;
- Pre-mining topography for PTM (2 metre interval contour data, date unknown);
- LiDAR DEM (0.25 metre cell spacing) for PTM, DNM and Isaac River Channel;
- Proposed PRCP landform DEM including final voids for PTM;
- Proposed PRCP landform DEM including final voids for the adjacent DNM; and
- PTM aerial imagery dated 1985.

Additional data was obtained from publicly available sources including:

- 1 second SRTM Derived Hydrological Digital Elevation Model topographic data (Geoscience Australia);
- Queensland road, rail and place names GIS datasets (Department of Resources (DR), 2021);
- GIS data containing watercourses for all Strahler Stream Orders (DR); and
- Historic gauged stream flow data for the Goonyella and Deverill Stream Gauges (DNRM).

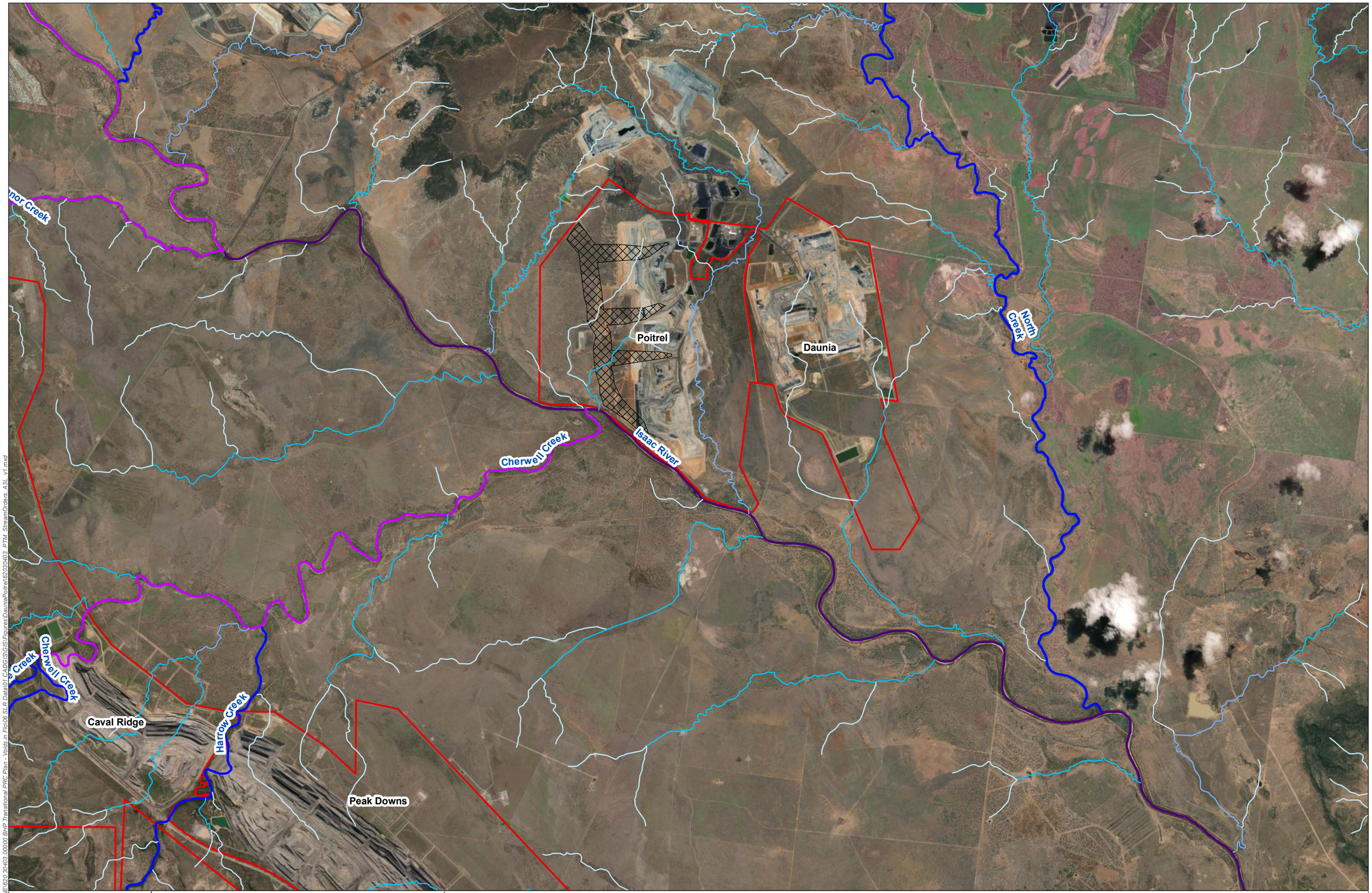
The provided data was analysed for suitability for the purposes of this assessment. The outcomes of the review are detailed below.

3.2 Watercourses

A review of the existing watercourses in the vicinity of PTM was undertaken using hydrologic streamline data provided by BHP and DR. The DR dataset contained Strahler Stream Order classifications for each watercourse, which ranged from order 1 to order 7 within the extent of the data, as illustrated in **Figure 2**. The review of both datasets showed that the following watercourses are of Strahler stream order 4 or greater and may affect the proposed voids:

- Isaac River; and
- Cherwell Creek.

Cherwell Creek is a tributary of the Isaac River and does not independently affect the site. Therefore, the Cherwell Creek catchment was included in the overall Isaac River catchment for the purposes of this assessment. The Isaac River was therefore the only relevant watercourse. In accordance with Section 3.4 of the PRCP guidelines, floodplain modelling of the Isaac River was undertaken.



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0 1,000 2,000 3,000 4,000 5,000 Meters

08-Mar-2022 Scale: 1:100,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- EA Boundary
- Final Void Extent

Strahler Stream Order

- 1
- 2
- 3
- 4
- 5
- 6

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

Watercourses
Strahler Stream Order Classification

Figure 2

3.3 Landforms

The 'pre-mining' contour data for Poitrel was processed into a 1 metre spaced DEM and combined with the Daunia final landform DEM, Isaac River LiDAR DEM and 1 second hydrologically enforced SRTM DEM to create the model DEM.. The model landform DEM is illustrated in **Figure 3.**

LiDAR data or detailed survey data are the preferred elevation data for use in two-dimensional hydraulic modelling. Review of the project data showed that the provided LiDAR data did not cover the full extent of the Isaac River floodplain, although did include the river channel and immediate overbank. Therefore, the LiDAR Data was adopted as the primary DEM data source, and SRTM data was adopted in areas of the model DEM that were not covered by either the LiDAR, pre-mining contours, or the Daunia PRCP landform DEMs.

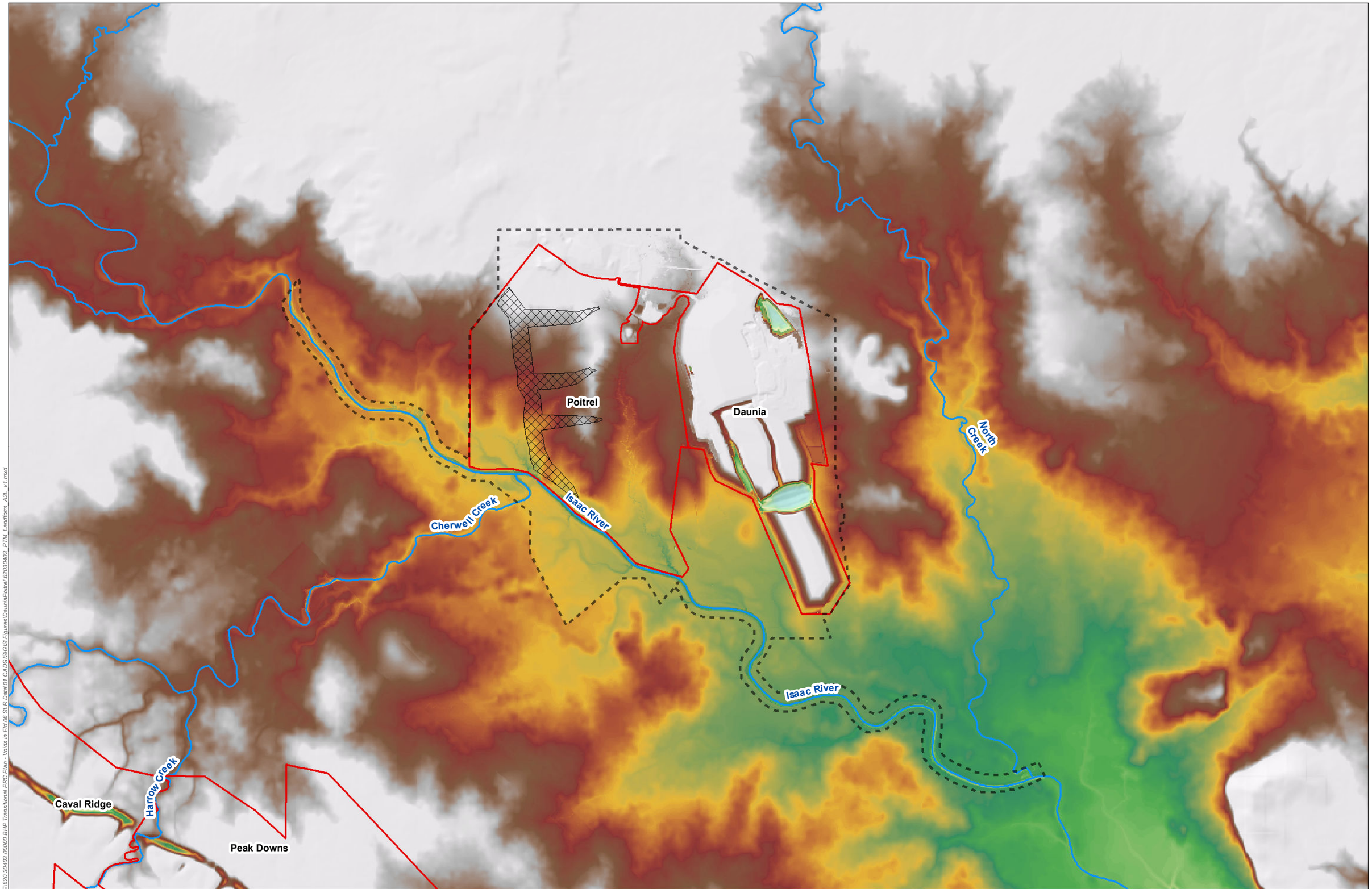
The SRTM data in the has a vertical accuracy of +/-5-10 metres (source: '*1 Second SRTM Derived Products User Guide',* Geoscience Australia, 2011). Comparison of the LiDAR and SRTM DEMs showed that the SRTM elevation data was generally higher by approximately 3 to 6 metres varying across the study area.. Subsequently, the SRTM data elevation was lowered by 3.8 metres to provide a generally consistent interface at the LiDAR data extents before being included in the model landform DEM.

3.4 Artificial Features

Existing and proposed artificial features within the model domain were identified based on the available information at the time of the assessment. A summary of the identified artificial features and relevant details are provided in **Table 3.** Consideration was made for each artificial feature to determine if the feature was necessary to include in the hydrologic and hydraulic models, based on the feature's respective influence on 0.1% AEP flooding conditions in the vicinity of the voids.

Table 3 Artificial Features

Artificial Feature / Description	Source	Hydraulic model inclusion status
On-tenure		
Poitrel Pit	PRCP Landform DEM (BHP)	All on lease artificial features not included in model as per EP Regulation requirements.
Waste Rock Dumps	PRCP Landform DEM (BHP)	
New Chum Creek Diversion	BHP	
Poitrel Mine Infrastructure	BHP	
Off-tenure		
Daunia PRCP Final Voids	Daunia PRCP Landform DEM (BHP)	Included (hydrologic and hydraulic model)
Daunia PRCP Waste Rock Dumps	Daunia PRCP Landform DEM (BHP)	Included (hydrologic and hydraulic model)
Goonyella System Railway	DR	Included (hydraulic model)
Peak Downs Highway	DR	Not included – no effect on 0.1% AEP flood levels in the vicinity of PTM



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0 1,000 2,000 3,000 4,000 5,000 Meters

08-Mar-2022 Scale: 1:100,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- EA Boundary
- Final Void Extent
- LiDAR Data Extent
- Watercourse

Topography (mAHD)

High : 282.89

Low : 52.5459

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

Model Landform

Figure 3

4 Hydrologic Modelling

4.1 Software

Hydrologic modelling was undertaken to estimate runoff hydrographs at various locations throughout the Isaac River catchment. The model was developed using the Watershed Bounded Network Model Version 2019 (WBNM). WBNM is an industry standard rainfall-runoff routing software package.

4.2 Model Setup

4.2.1 Approach

A WBNM model of the Isaac River to the point immediately upstream of its junction with Devlin Creek was developed.

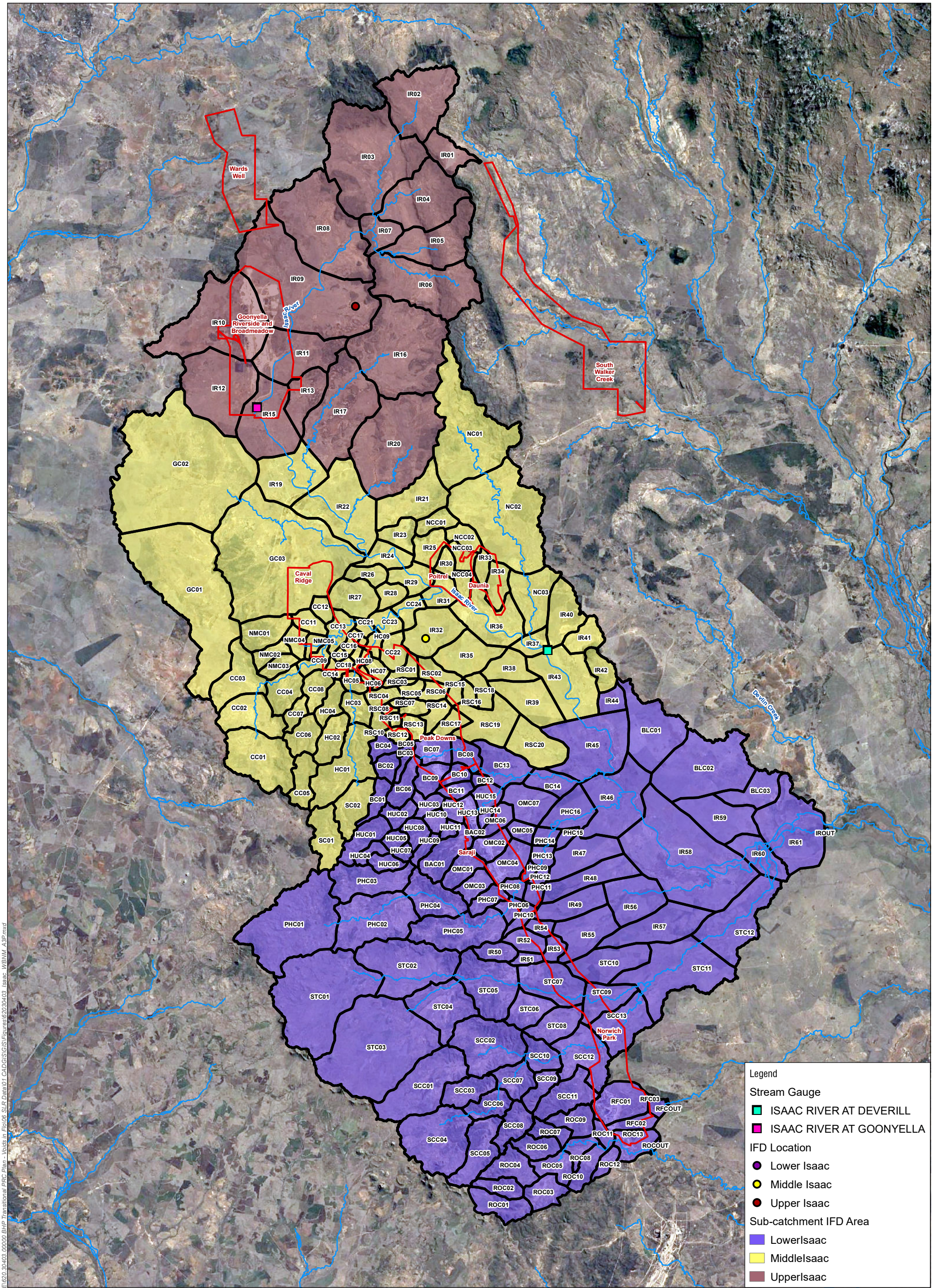
The model extent was selected to allow the model to be calibrated against the results of a Flood Frequency Analysis (FFA) undertaken at the nearest suitable location(s), being the Goonyella (130414A) and Deverill (130410A) stream gauges. This was considered appropriate given the 0.1% AEP flood event is the critical event for the assessment and the long period of record at the gauges provides the best estimation of peak flows with this exceedance probability. Further detail on the model calibration process is provided in **Section 4.3**.

4.2.2 Catchment Details

The Isaac River model covers a catchment area of approximately 8,300 km^2, of which sub-catchments were delineated using hydrologically enforced 1 second SRTM 30 metre DEM terrain data sourced from Geoscience Australia. The model extent and sub-catchment delineation are illustrated in **Figure 4**.

4.2.3 Intensity-Frequency-Duration Rainfall Data

Rainfall Intensity-Frequency-Duration (IFD) data for the catchment was sourced from the Bureau of Meteorology (BoM) online IFD data portal for a range of Annual Exceedance Probabilities (AEP). Spatial variability of IFD data was accounted for by sourcing data separately for the upper catchment, middle catchment and lower catchment of the model area. Each sub-catchment was allocated the IFD data of each relevant IFD location based on proximity, as illustrated in **Figure 4.**



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SLR
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0 10 20 Kilometers

10-Mar-2022 Scale:1:500,000

Sheet Size : A3 AGD 1966 AMG Zone 55

Legend

- WBNM Sub-catchments
- EA Boundary
- Watercourse

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

WBNM Layout
Isaac River Model

FIGURE 4

4.2.4 Losses

Storm rainfall loss data for the catchment was obtained from the ARR data hub. The initial and continuing losses are provided in **Table 4**. Based on the ARR Data Hub data, an initial loss of 0 mm was adopted for the 0.1% AEP event.

Table 4 Rainfall Losses

Global Storm Loss	Loss
Initial loss (pervious)	0 mm
Continuing loss (pervious)	1.0 mm/h

4.2.5 Lag Parameter

A catchment lag parameter of 1.90 was adopted in the WBNM model. The WBNM documentation recommends that a lag parameter value between 1.40 and 1.80 is suitable for most catchments, however if reliable calibration data is available (as was the case for this assessment), the lag parameter should be adjusted to provide accurate calibration of the model.

4.2.6 Storm Events

The 0.1% AEP event was the primary design storm event for this assessment. In accordance with ARR, Probable Maximum Flood (PMF) temporal patterns were adopted for the 0.1% AEP event. ARR recommends the Generalised Short Duration Method (GSDM) for events with a duration up to 6 hours, and the Revised Generalised Tropical Storm Method (GTSMR) for durations of 24 hours or more. There is no set guidance for which method to adopt for storms with durations between 6 and 24 hours, therefore the GSDM temporal pattern was adopted for all durations up to and including the 12 hour duration, and the GTSMR temporal patterns for durations of between 12 hours and 72 hours.

4.2.7 Aerial Reduction Factor

Aerial reduction factors were applied to the model based on the catchment area draining to the Deverill gauge (refer **Section 4.3.1**).

4.3 Calibration

4.3.1 Flood Frequency Analysis

An FFA was undertaken using recorded streamflow data sourced from the Department of Regional Development, Manufacturing and Water (DRDMW). Two gauge locations exist on the Isaac River within the catchment of the area of assessment, located at Goonyella (130414A) and Deverill (130410A). The locations of the gauges are illustrated in **Figure 4.** The Deverill gauge is located roughly 15 km downstream of PTM.

The Goonyella gauge has continuous streamflow records beginning in 1983 (38 years), while the Deverill gauge has records beginning in 1968 (53 years). It was noted during the analysis that the catchment to the Deverill gauge, including the Goonyella gauge, has been modified significantly by various mining operations since approximately 2002. The WBNM model was developed based on SRTM topographic data which generally predates 2002, therefore streamflow data from 2003 onwards was excluded from the Deverill gauge data in the FFA. With these records excluded, a total of 35 years data was available for use from the Deverill gauge. The full 38 years of record was adopted for the Goonyella gauge, as excluding the post-2002 flows would leave only 20 years of data, which was considered insufficient.

For both gauges, a Log-Pearson III (LP3) flood frequency distribution was fitted to the annual maximum data series. For each gauge, low flow outliers were excluded from the data series using the Grubbs Beck Test method, prior to fitting the distribution.

4.3.2 Calibration Results

Results of the flood frequency analysis, in comparison to the results of the WBNM hydrologic model, are illustrated in **Figure 5** and **Figure 6.**

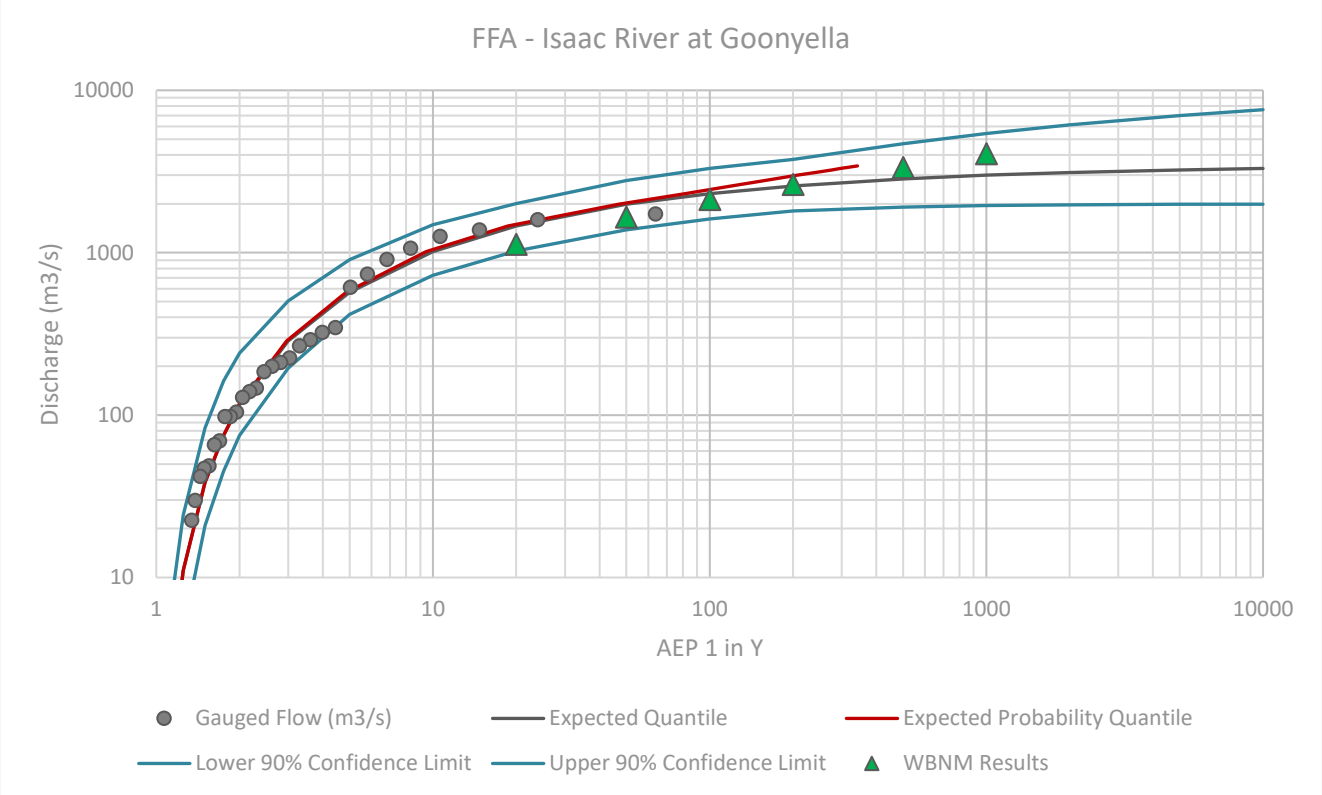


Figure 5 Flood Frequency Analysis Results – Isaac River at Goonyella Gauge

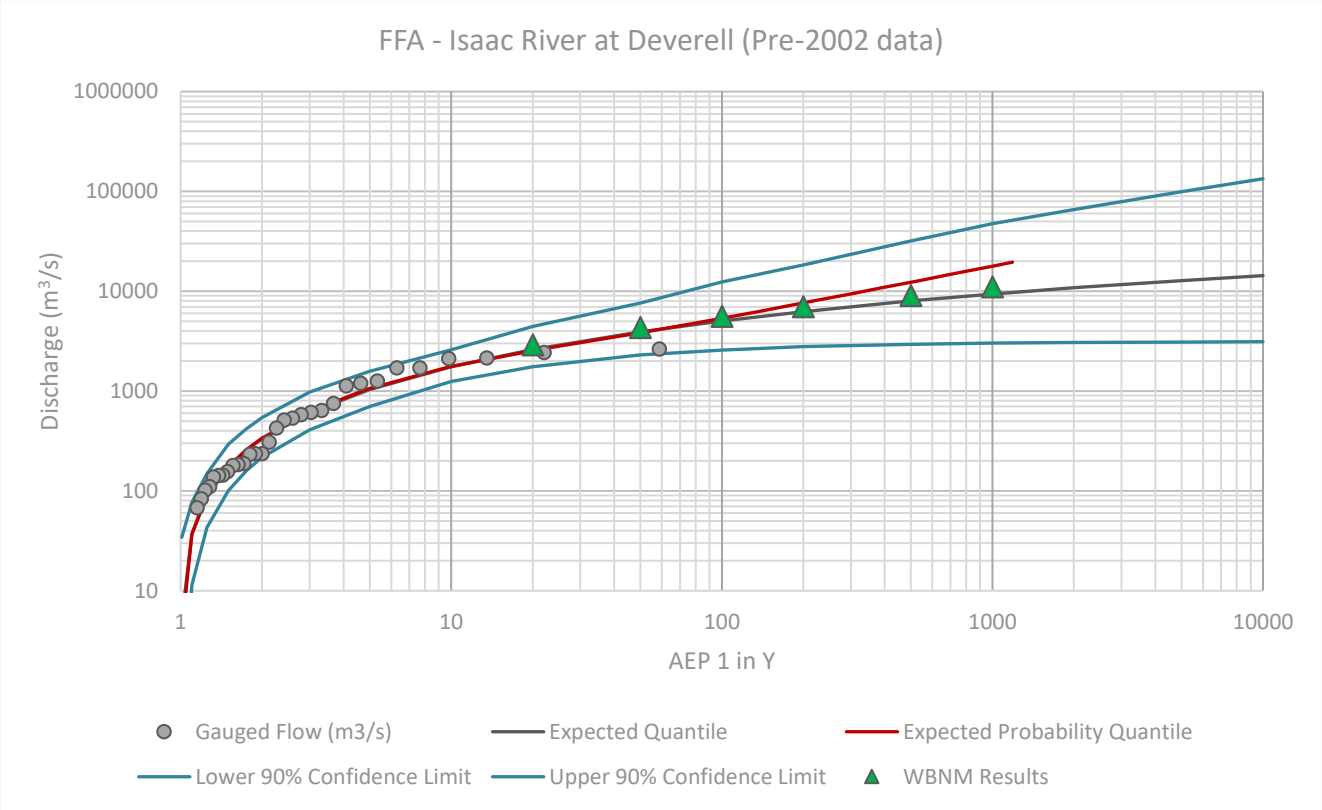


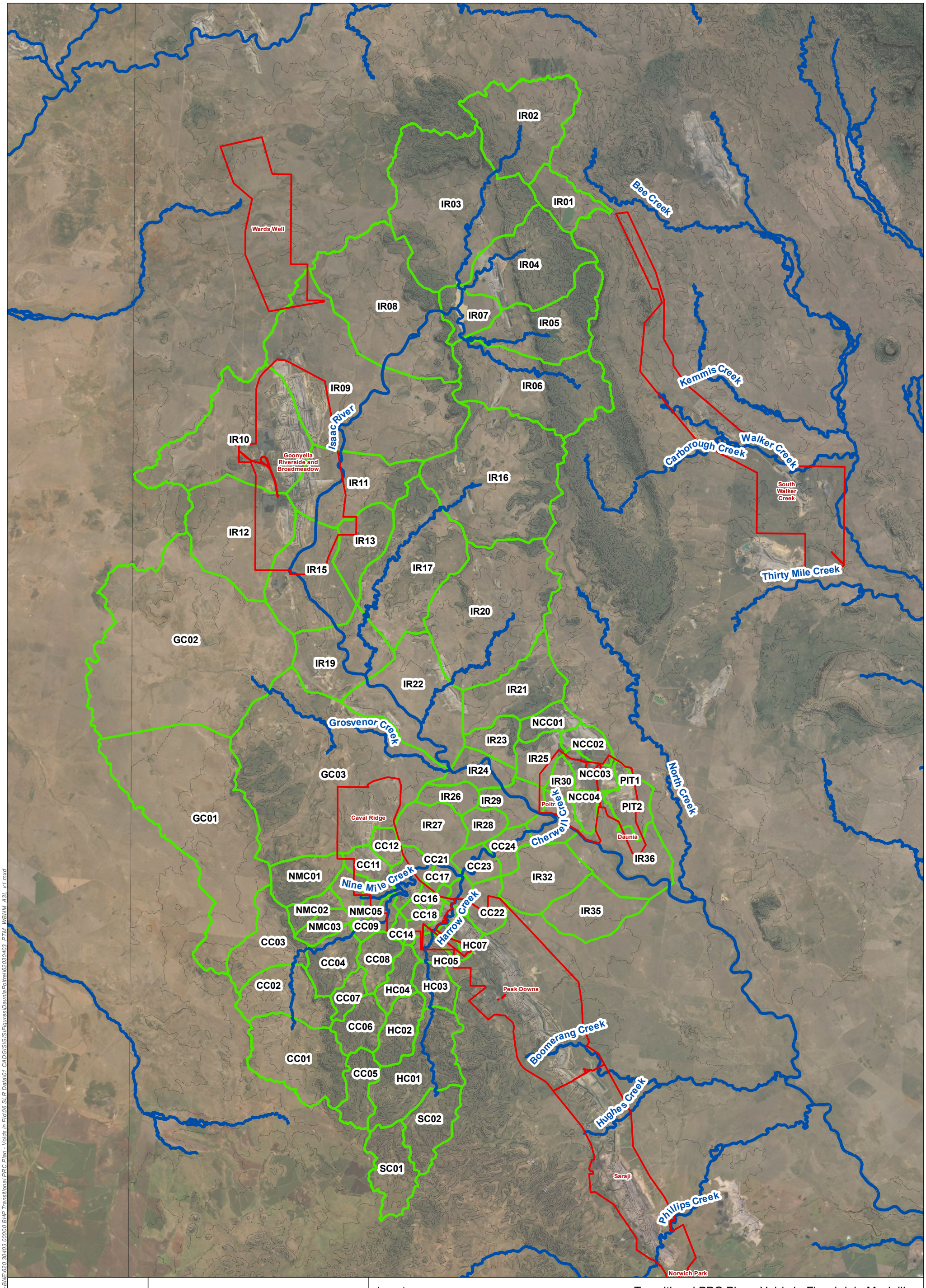
Figure 6 Flood Frequency Analysis Results – Isaac River at Deverill Gauge

As illustrated by the above, the WBNM model produced results in line with the results of the FFAs, particularly with the results of the Deverill gauge data. Therefore, the model was considered suitable for use for the purposes of this assessment.

4.4 Poitrel Mine Assessment Sub-model

A sub-model of the Isaac River hydrologic model was developed for the study area to account for the changes in sub-catchment delineation due to the consideration of the artificial features of the adjacent Daunia PRCP landform. Sub-catchments downstream of the study area were also removed from the sub-model given their inclusion provides no meaningful information for the assessment of flow hydrographs in the vicinity of PTM.

All model parameters were retained from the Isaac River model. The model extent and sub-catchment delineation of the sub-model are illustrated in **Figure 7**.



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0 5 10 15 Kilometers

27-Jan-2022 Scale:1:350,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- WBNM Sub-catchments
- EA Boundary
- Stream Order 4 or Greater
- SRTM 30m Contours

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

WBNM Layout
Poitrel Mine Sub-Model

FIGURE 7

5 Hydraulic Modelling

5.1 Software

A hydraulic model of the Isaac River in the vicinity of PTM was developed for the purpose of assessing pre-mining flood extents.

The industry standard hydrodynamic modelling software TUFLOW (Build 2020-10-AA) was utilised for the hydraulic modelling. The sub-grid sampling (SGS) feature of TUFLOW suited the modelling required for the assessment. SGS provides an increased definition of model terrain and flow conveyance, enabling model resolution to be improved without significant increases in model runtimes.

5.2 Model Setup

5.2.1 Topography

The model landform DEM as detailed in **Section 3** was utilised as the topography for the models. The DEM for the model area is shown in **Figure 9.** Drainage features of this DEM were reinforced using gully lines to ensure reasonable conveyance within the watercourses.

As detailed in **Section 3**, SRTM topographic data was utilised for areas in the model where preferable topographic data was not available. Based on comparisons to the available LiDAR data in the study area, the SRTM data was lowered by 3.8 m to interface with the LiDAR data. In some areas where the difference between the SRTM data and LiDAR data was more or less than the adopted 3.8 m adjustment, irregular steps in the model DEM were observed.

A sensitivity assessment was carried out to investigate the sensitivity of the model results to the model terrain. For the assessment, the SRTM data was lowered by 6 m from the raw data elevations. The results showed that the floodplain extent was generally consistent with the base model scenario.

5.2.2 Model Grid Cell Size

A grid cell size of 10 metres was adopted for the models. In combination with a 1 metre SGS sampling distance, this was considered to provide adequate model resolution for the purposes of the analysis undertaken, while providing a reasonable runtime.

5.2.3 Hydraulic Roughness

Hydraulic roughness across the model area was assessed based on the supplied aerial imagery from 1985. This was the most suitable available imagery for the area and was considered a decent representation of the pre-mining land use. The Manning's roughness values adopted for the various land use types within the model domains are shown in **Table 5** and in **Figure 10.**

Table 5 TUFLOW Model Manning's Roughness Values

Land Use	Manning's n Value
Sparse Vegetation	0.06
Dense Vegetation	0.08
Creek Beds	0.05
Pits / Waterbodies	0.02
Bare land	0.03

5.2.4 Downstream Boundaries

The downstream model boundary was situated approximately 1 km downstream of PTM. A stage-discharge relationship was adopted based on the topography gradient of 0.1% at the boundary location. The location and extent of the downstream boundary is shown in **Figure 9**.

A sensitivity assessment was carried out on the downstream boundary assumptions. For the assessment, the model was simulated with a flood surface gradient of 1% applied at the downstream boundary. The results of the sensitivity assessment are detailed in **Section 5.3.1**.

5.2.5 Model Inflows

Flow hydrographs for the model were extracted from the WBNM model for each sub-catchment. These hydrographs were applied as inflow boundaries, as either total or local inflows where relevant, to the hydraulic model at appropriate locations, as shown in **Figure 9**.

Flow results of the hydraulic model at the downstream boundary were compared with flows produced by the WBNM model at the outlet of the corresponding sub-catchment (IR36). This was undertaken for the critical duration event and indicates that the TUFLOW model calculates similar flows, and the general trends of the hydrographs were similar. **Figure 8** illustrates the comparison.

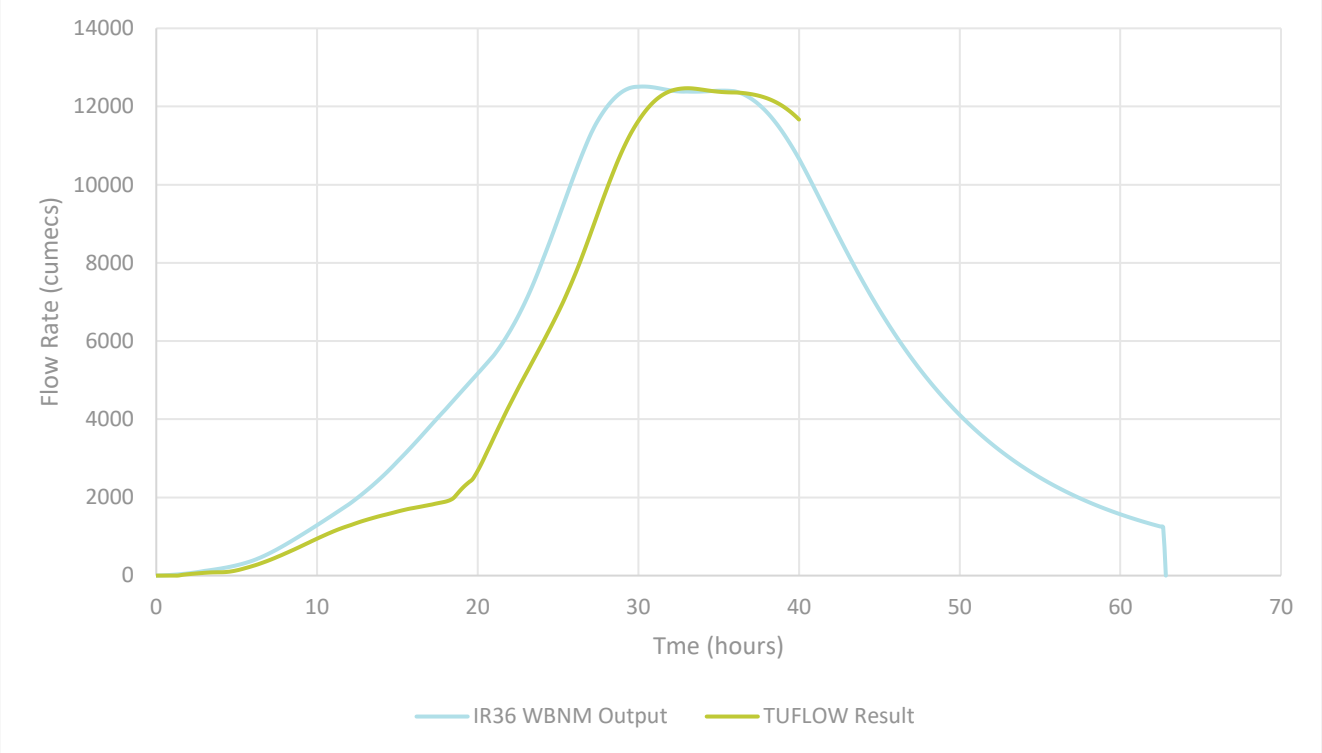

Figure 8 36 hour 0.1% AEP WBNM and TUFLOW Model Results Comparison

5.2.6 Critical Storm Durations

In accordance with the recommendations of ARR, a suite of design storm events were simulated in the hydraulic models for the 0.1% AEP event and durations between 1 and 48 hours. The results of the various storm durations were cross-referenced to determine the critical duration for the focal point of the model, i.e. the proposed void locations. The results showed that the 36 hour storm duration was the critical event for the Isaac River at in the vicinity of PTM.

5.3 Results

The results of the Isaac River TUFLOW model for peak water surface levels and depths for the 0.1% AEP event are illustrated in **Appendix B**. The results illustrate that in some areas the proposed NUMA void for PTM is located within the modelled floodplain of the Isaac River.

Figure 11 illustrates in further detail the extent of the 0.1% AEP floodplain in the vicinity of the final void. The encroachment of the void into the floodplain occurs in the south. The majority of the void footprint is located outside of the floodplain extent.

The results of the hydraulic model are dependent on the underlying topographic data used to create the model DEM. As previously detailed, preferred LiDAR data was available in limited areas within the model domain, and large areas of the floodplain were represented in the mode DEM by SRTM topographic data. If additional LiDAR data was sourced and implemented in the hydraulic model, the resulting 0.1% AEP floodplain extent may vary from the results of this assessment.

5.3.1 Sensitivity Analyses

Three sensitivity scenarios were assessed using the hydraulic model, as discussed in **Section 5.2**. The results of the model sensitivity scenarios are illustrated in **Figure 12** and **Figure 13**.

Downstream Boundary Sensitivity – the results showed that peak flood levels upstream of the Goonyella System Railway in the vicinity of the site were consistent with those of the base model scenario. Thus, the adopted boundary condition did not affect the calculated results in the area of interest.

Model Topographic Data Sensitivity - The results showed that the floodplain extent was marginally reduced, although generally consistent with the base model scenario. The minor difference in floodplain extent ultimately would not change the outcome of the assessment.

Poitrel

Pit

Daunia

North Creek

IR29|Tot

IR30|Loc

Isaac River

Cherwell Creek

IR31|Loc

CC24|Tot

NCC04|Tot

IR32|Loc

Bridge

Isaac River

IR36|Loc

IR35|Loc

Harrow Creek

Caval Ridge

Harrow Creek

Peak Downs

Caval Ridge

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0 1,000 2,000 3,000 4,000 5,000 Meters

31-Jan-2022 Scale: 1:80,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- TUFLOW Model Extent
- Upstream Inflow
- Local Inflows
- Downstream Boundary
- Gully Points
- Gully Line
- Bridge
- Final Void Extent
- EA Boundary

Topography (mAHD)

High : 325

Low : 50

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

TUFLOW Model Layout

Figure 9

Poitrel

Daunia

North Creek

Cherwell Creek

Isaac River

Isaac River

Harrow Creek

Caval Ridge

Harrow Creek

Peak Downs

Caval Ridge

0 1,000 2,000 3,000 4,000 5,000 Meters

27-Jan-2022 Scale: 1:80,000

Sheet Size : A3 AGD 1984 AMG Zone 55

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Legend

EA Boundary

TUFLOW Model Extent

Manning's n Value

0.06 0.03

0.08 0.02

0.05

0.02

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

TUFLOW Model
Hydraulic Roughness

Figure 10

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Daunia

Poitrel

Daunia

Isaac River

Cherwell Creek

0 375 750 1,125 1,500 1,875 Meters

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Sheet Size : A3 AGD 1984 AMG Zone 55

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Legend

- EA Boundary
- Final Void Extent
- TUFLOW Model Extent

Depth (m)

< 0.5	4.0 - 6.0	> 12.0
0.5 - 1.0	6.0 - 8.0	
1.0 - 2.0	8.0 - 10.0	
2.0 - 4.0	10.0 - 12.0	

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

TUFLOW Model Results
Peak Flood Inundation Extent and Depths - 0.1% AEP

Figure 11

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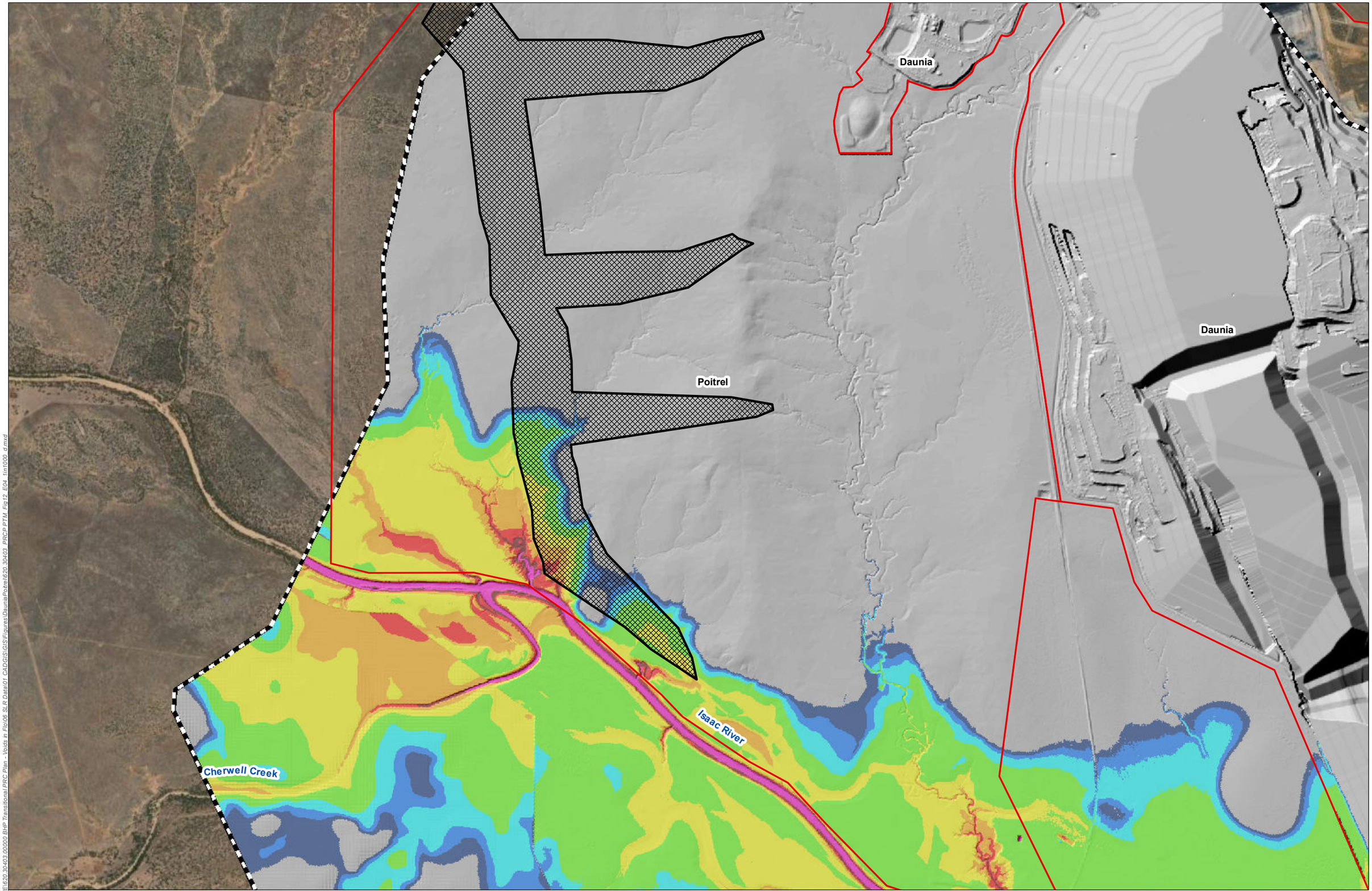

0 375 750 1,125 1,500 1,875 Meters

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Legend

- EA Boundary
- Final Void Extent
- TUFLOW Model Extent

Depth (m)

< 0.5	4.0 - 6.0	> 12.0
0.5 - 1.0	6.0 - 8.0	
1.0 - 2.0	8.0 - 10.0	
2.0 - 4.0	10.0 - 12.0	

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

TUFLOW Model Results - Sensitivity Scenario - Model Topography
Peak Flood Inundation Extent and Depths - 0.1% AEP

Figure 12

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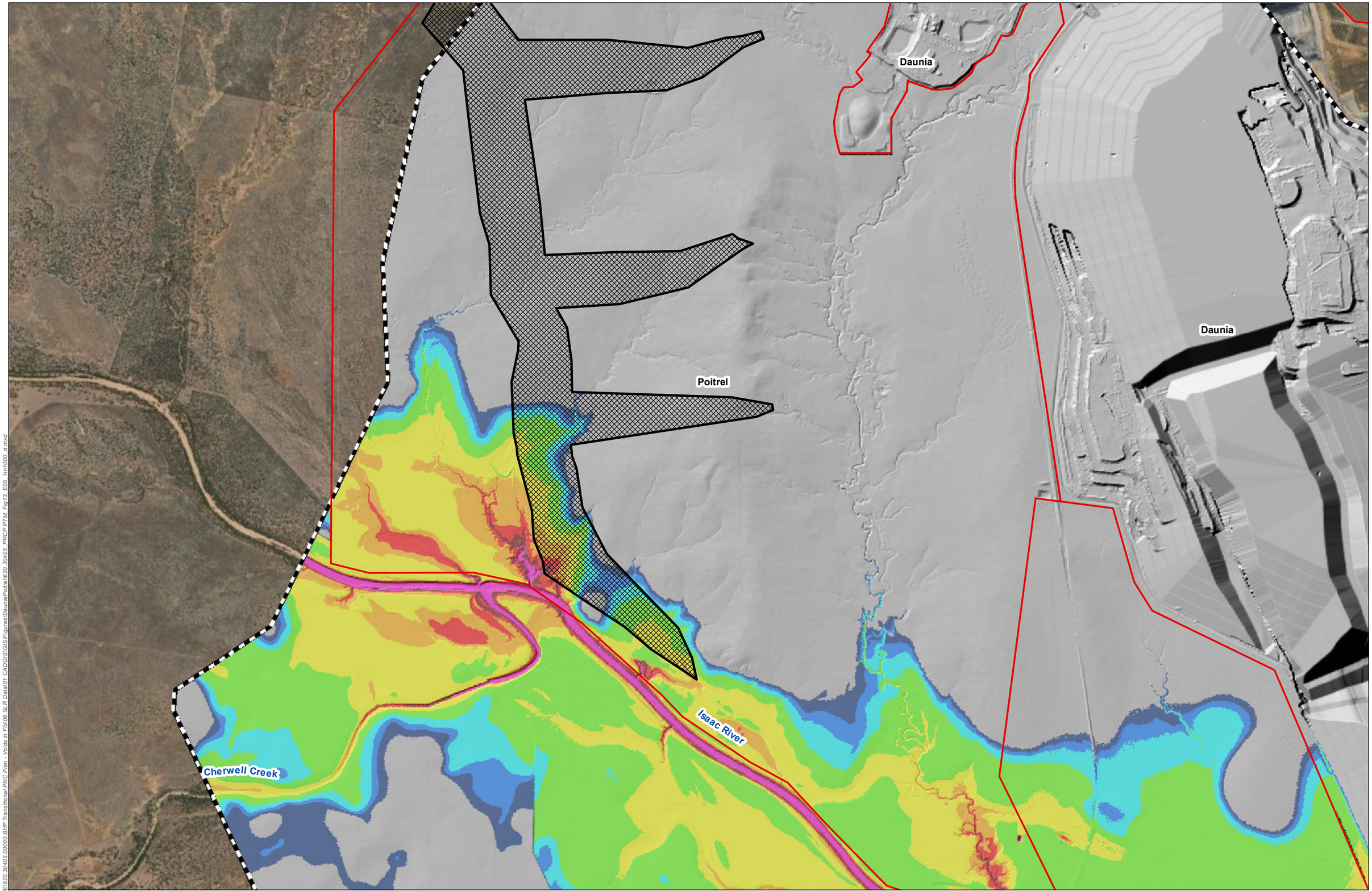

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0 375 750 1,125 1,500 1,875 Meters

26-Apr-2022 Scale: 1:30,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- EA Boundary
- Final Void Extent
- TUFLOW Model Extent

Depth (m)

< 0.5	4.0 - 6.0	> 12.0
0.5 - 1.0	6.0 - 8.0	
1.0 - 2.0	8.0 - 10.0	
2.0 - 4.0	10.0 - 12.0	

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

TUFLOW Model Results - Sensitivity Scenario - Downstream Boundary
Peak Flood Inundation Extent and Depths - 0.1% AEP

Figure 13

6 Summary

As part of the PRCP for Poitrel Mine, it is proposed to incorporate a single final void as a NUMA. Therefore, in accordance with the EP Act and EP Regulation and specifically Section 3.4 of the PRCP Guideline, floodplain modelling has been undertaken for the Isaac River which was identified as the only relevant watercourse that may affect the void.

Data for the assessment was provided by BHP, and sourced from various public providers including BoM, DRDMW and Geoscience Australia. The data was reviewed and modified for use where appropriate. Model landforms were developed to account for artificial features outside of the mine EA boundary, and pre-mining topography within the EA based on the information available at the time of the study.

A hydrologic assessment was undertaken for the portion of the Isaac River catchment that encompasses the Mine. The model was calibrated against the results of Flood Frequency Analyses undertaken using data obtained at Goonyella and Deverill stream gauge stations located on the Isaac River.

A hydraulic model was developed for the Isaac River in the vicinity of PTM. Hydrographs extracted from the hydrologic model at relevant locations were applied as inflows to the hydraulic model. The hydraulic model topography was created using a combination of historic pre-mining survey data, Daunia Mine PRCP DEM, LiDAR DEM and SRTM DEM. SRTM data was utilised due to the limited extent of the provided LiDAR DEM which is the preferred topographic data source for hydraulic modelling. The accuracy of hydraulic model results were therefore limited to the accuracy of the available topographic data sets.

Consideration was made as to the potential effects of groundwater on the floodplain extent. It was considered that groundwater will have no significant impact on the extent of the floodplain. An initial rainfall loss of 0 mm was adopted in the hydrologic studies. This assumption represents fully saturated catchment conditions (i.e. soil stores at the surface were full), which was considered to be a conservative approach.

The results of the hydraulic model provided the predicted 0.1% AEP flood event inundation extent. Predicted peak flood levels and depths were also produced by the hydraulic model. The results showed the proposed NUMA void is partially located within the floodplain of the Isaac River.

APPENDIX A

Pre-lodgement BHP/DES Workshop for PRCPs – Floodplain modelling and flood risks – Memorandum

Voids in flood plains

The PRCP guideline Section 3.4 outlines considerations to be included for PRC plan submissions relating specifically to voids in flood plains. Table 1 lists the key points that will be considered based on the guideline for flood modelling for voids and subsequent inclusion in the PRC plan submissions for relevant BHP sites.

Table 1: Guideline considerations for Voids in Floodplains

Guideline Considerations	**BHP PRCP Deliverables**
Voids located in floodplain to be rehabilitated to a stable condition	✓
Sites with a void proposed as a NUMA will have flood plain modelling*	✓
Flood plain modelled with peak water level 0.1% AEP	✓
Flood plain modelled for relevant watercourse – stream order 4 or higher including permanent diversions	✓
Modelling carried out under the ARR	✓
Modelling to exclude any *artificial features* for the land within the tenure boundary	✓
Modelling to include catchment data outside of the tenure including all existing and approved artificial features (as per Information Sheet)	BHP to use best endeavours
Modelling to include the location of the watercourse after the temporary diversions has been removed (as per Information Sheet)	Modelling to include watercourse classified as stream order 4 or higher, or current approved permanent diversions (stream order 4 or higher). Temporary diversions are not included in this modelling.
Flood plain model report developed by an appropriately qualified person	✓
Flood model report to contain:	
Details provided of the data used to develop the model in accordance with section 4.13.3. of the ARR	✓
Identification of all *artificial features* proposed or present within the tenure boundary	✓
Identification of all watercourses within the immediate catchment with the Strahler method of stream ordering applied	✓
Identification of any approved permanent watercourse diversions within the tenure boundaries and the relevant approval of the diversion	✓
Consideration of how groundwater may impact the flood plain extent	✓
A hydrologic model	Model report only
A hydraulic model	Model report only
Model assumptions and limitations	✓
Model calibration and sensitivity analysis	✓
Spatial data outlining the extent of the flood plain.	✓

* Unless the conditions of the applicability to transitional PRC plans are met for where flood plain modelling is not required.

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The PRCP Guideline Section 3.4 describes that “Flood plain modelling is required for all sites with a void proposed as a NUMA” with “the level modelled as the peak water level 0.1% AEP for a relevant watercourse”.

BHP will complete flood plain modelling in accordance with the ARR, and a model report for all sites with a void proposed as a NUMA. In accordance with the EP Regulation, the flood plain will be treated as the land where flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% Annual Exceedance Probability (AEP) for a relevant watercourse under the Australian Rainfall and Runoff Guideline (2019).

Artificial Feature

The PRCP Guideline details flood plain modelling must “exclude any artificial features for the land within the tenure boundary”. An artificial feature is detailed as:

> ***Artificial feature**, for land the subject of a PRCP schedule, means—*
> *(a) a structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or*
> *(b) a structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land if the relevant activities the subject of the PRCP schedule had not been carried out; or*
> *(c) a feature forming part of the landform of the land, other than the natural landform, if the feature interferes with or affects—*
> *(i) a relevant watercourse; or*
> *(ii) the natural flow of water on the land.*

The DES have advised that the intent of the policy is that flood plain modelling must be based on pre-mining state. Therefore, temporary structures including those that will require a level of maintenance after the land is surrendered within the tenure boundary, will not be included in the flood plain modelling. Additionally, a feature that does not form part of the natural landform and interferes or affects a relevant water course or the natural flow of water on the land will not be included in the flood plain modelling. In accordance with the definition of artificial feature, the structures or features that will not be included in the flood plain modelling may include::

- final dumps
- final voids
- final subsidence
- creek diversions (in the current temporary approved state)

If a watercourse diversion over the course of the future mine life requires further approval, then new information will be provided at that point.

Whilst the DES have confirmed their position, BHP maintain that this may result in an impracticable application of the flood plain modelling, and could fail to ensure the relevant risks associated with flood plains are properly addressed and managed.

Relevant Watercourse

BHP have confirmed with the DES and both are in agreement that the flood plain modelling will include the relevant watercourses, as defined under the EP Regulation:

> ***Relevant watercourse*** *means—*
> *(a) a watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or*
> *(b) if a watercourse mentioned in paragraph (a) is permanently diverted under—*
> *(i) a condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, section 98; or*
> *(ii) a water licence or proposed water licence under the Water Act 2000;*
> *the watercourse as permanently diverted.*

The DES have advised that the statement in the information sheet regarding "The application for voids in the flood plain of streams with a stream order of three and lower are still assessed against the decision criteria in the EP Act and may be refused", is in relation to rehabilitation practices for flooding.

Spatial Extent of Modelling

The information sheet details the need for considering catchment data outside of the relevant tenure in determining the extent of the flood plain model and final mapped flood plain extent.

As the spatial extent of data that is required for each catchment and model is a highly technical matter. The DES and BHP are in agreement that BHP will default to the expert judgement of those performing the flood modelling in determining this extent.

With respect to artificial features outside of the tenure boundary, the information sheet details that the flood plain model includes a combination of data:

- within the mining tenure boundary, to exclude any artificial features;
- outside of the mining tenure boundary to include all existing and approved artificial features.

BHP is unclear on what is intended, because it potentially results in an unrealistic hybrid scenario containing both past and future features being modelled. For example, BMA's Saraji Mine PRCP *must not* include flood modelling with Saraji's artificial features, but also *must* include the artificial features on the adjacent BMA Peak Downs Mine. BHP has several sites this will be relevant to and foreshadows that this requirement may result in flood plain modelling results that appear unusual when compared between PRCP's. This is because every site will likely need to be modelled separately and will produce flood plain modelling results that could well differ in the flood plain extent shown in an adjacent site's PRCP. Further afield, an example is the Burton Gorge Dam operated by Peabody upstream of BMA's Goonyella Riverside Mine on the Isaac River that will be included in the model.

Nonetheless, BHP will use best endeavours to obtain information on artificial features outside of the mining tenure boundary for inclusion in the flood plain modelling. In addition to this, the flood plain modelling undertaken by BHP will include artificial features obtained outside of the mining tenure boundary based on current as at time of modelling.

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APPENDIX B

Isaac River TUFLOW Model Results

Poitrel

Pit

Daunia

North Creek

Cherwell Creek

Isaac River

Isaac River

Harrow Creek

Harrow Creek

Peak Downs

Caval Ridge

H:\Projects-SLR\620-BNE\620.30403_00000 BHP Transitional PRC Plan - Voids in Flo\06 SLR Data\01 CAD\GIS\GIS Figures\Daunia\Poitrel\Output\MXDs\620.30403_PRCP PTM B1_E03_1in1000_h.mxd

SLR
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0 1,000 2,000 3,000 4,000 5,000 Meters

26-Apr-2022 Scale: 1:80,000

Sheet Size : A3 AGD 1984 AMG Zone 55

Legend

- EA Boundary
- TUFLOW Model Extent

Level (m AHD)

- < 185.0
- 185.0 - 187.5
- 187.5 - 190.0
- 190.0 - 192.5
- 192.5 - 195.0
- 195.0 - 197.5
- 197.5 - 200.0
- > 200.0

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

Peak Flood Levels - 0.1% AEP

Appendix B1

Poitrel

Pit

Daunia

North Creek

Isaac River

Cherwell Creek

Isaac River

Harrow Creek

Harrow Creek

Peak Downs

Caval Ridge

0 1,000 2,000 3,000 4,000 5,000 Meters

26-Apr-2022 Scale: 1:80,000

Sheet Size : A3 AGD 1984 AMG Zone 55

SLR
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Legend

EA Boundary

TUFLOW Model Extent

Depth (m)

< 0.5	4.0 - 6.0	> 12.0
0.5 - 1.0	6.0 - 8.0	
1.0 - 2.0	8.0 - 10.0	
2.0 - 4.0	10.0 - 12.0	

Transitional PRC Plan - Voids in Floodplain Modelling
Poitrel Mine

Peak Flood Depths - 0.1% AEP

Appendix B2

H:\Projects-SLR\620.BNE\620.30403.00000 BHP Transitional PRC Plan - Voids in Flo\06 SLR Data\01 CAD\GIS\GIS\Figures\DauniaPoitrel\Output\MXDs\620.30403_PRCP PTM B2_E03_1in1000_d.mxd

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Appendix 6 Waste Characterisation (26 June 2024)

Mine Waste Characterisation Report

Poitrel Coal Mine

Prepared for: Stanmore SMC Pty Ltd

MINE WASTE AND
WATER MANAGEMENT

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Mine Waste Characterisation Report

Poitrel Coal Mine

Prepared for: **Stanmore SMC Pty Ltd**

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This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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Definitions

Acronym	Definition
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity, expressed as kg H_2SO_4 per tonne of sample.
CHPP	Coal Handling and Preparation Plant
Coarse Reject	Coarse coal waste produced through coal processing sourced from the D&R screen and the spirals rejects dewatering screen.
CRS	Chromium reducible sulfur, the analytical test to measure sulfide (unoxidised) sulfur.
Dispersive	Dispersive soil and rock materials are structurally unstable and disperse into basic particles such as sand, silt and clay in water. When a dispersive soil is wet, the basic structure has a tendency to collapse, whereas when it is dry it is prone to surface sealing and crusting.
EA	Environmental Authority (EPML00716913)
EDMS	Environmental Database Management System
EIS	Environmental Impact Statement.
Hazardous substance	A substance which has the potential to harm the health of persons in the workplace and/or adversely impact the environment.
Mining Waste	Any mining and coal handling and processing related waste, including: overburden, interburden, partings, coarse reject, fine rejects and miscellaneous waste rock material;
Mtpa	Million tonnes per annum;
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acidic conditions.
NAF (Barren)	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acidic conditions. Barren of oxidisable sulfur.
NAG	Net Acid Generation
NAPP	Net Acid Producing Potential
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acidic conditions.
ROM	Run of Mine
Slaking	Disintegration of unconfined soil or rock after exposure to air and subsequent immersion in water.
Sodic	Sodic soil and rock materials are characterized by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor

	physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SSE	Site Senior Executive
Fine rejects	Fine coal waste produced through coal processing sourced from the Fine rejects Thickener underflow.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
Uncertain	Geochemical classification criterion for a sample where the potential to generate acid conditions remains uncertain and may require further analysis.

1 Introduction

1.1 Purpose

RGS Environmental Pty Ltd (RGS) has prepared this Mine Waste Characterisation Report (MWCR) for Stanmore SMC Pty Ltd (Stanmore) operations at Poitrel Coal Mine (PTM). The MWCR details how Stanmore will manage its mining wastes (i.e., overburden, interburden, coarse rejects and fine rejects) during mining operations. The report characterises the geochemical and physical properties of the mine waste to ensure that mining wastes are managed in accordance with legislative and other requirements as described in this document., This includes the requirements of Environmental Authority (EA) number EPML 00963013 (DES, 2024), to align with relevant technical guidelines (AMIRA, 2002; DME, 1995; DEHP, 2013; DES, 2013, 2014, 2018, 2020, 2023; COA, 2016a,b,c; INAP, 2024 and MEND, 2009) and in a manner that minimises any environmental and health risks.

1.2 Background

PTM is located 35 km east of Moranbah in Queensland on the Poitrel Mining Lease (ML) 4749 and Red Mountain Mining Lease ML 70116 (Error! Reference source not found.). PTM commenced operations in 2006 under a previous Proponent with Stanmore taking ownership in 2023. PTM is currently producing up to 3.8 million tonnes per annum (Mtpa) of coal with a nominal annual average of approximately 3 Mtpa using an excavator and truck fleet. The product is a coking and pulverized coal injection (PCI) that is produced for the export market. PTM has an expected mine life of approximately 20 years, however, further exploration may extend the life of the mine, subject to future approvals and assessment processes.

The PTM site layout is provided in **Figure 1-1**. The mine operates 3-4 active pits at any one time, which are up to 80 m deep. For the initial box cuts, waste rock dumps external to the pit (ex-pit waste dumps) were constructed to the east and west of the mining area. Progressive backfilling of the pits with overburden (in-pit waste dumps) is undertaken progressively. A conceptual final landform comprising ex-pit dumps and in-pit dumps has been developed (**Section 6**).

The PTM Closure Management Plan (BHP, 2019) and other internal site documents (i.e., sampling and characterisation of mine waste materials) describe the existing knowledge base for material characterisation, and relevant closure considerations. Under Condition E5c of the EA (DES, 2024), the Rehabilitation Management Plan the PTM must specify spoil characteristics, soil analysis, and soil separation for use on rehabilitation.

Condition F39 of the EA states that the holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage (also referred to as acid, saline, and metalliferous drainage (AMD)). In addition, EA condition E13 states that contaminants must not be released to land in a manner that constitutes a nuisance, material harm, or serious environmental harm (which would include AMD).

The development of this MWCR will aid Stanmore in identifying any potential sources of contaminants in the mine waste materials and will inform the ongoing management measures required to appropriately manage waste and ensure compliance with operational and closure requirements.

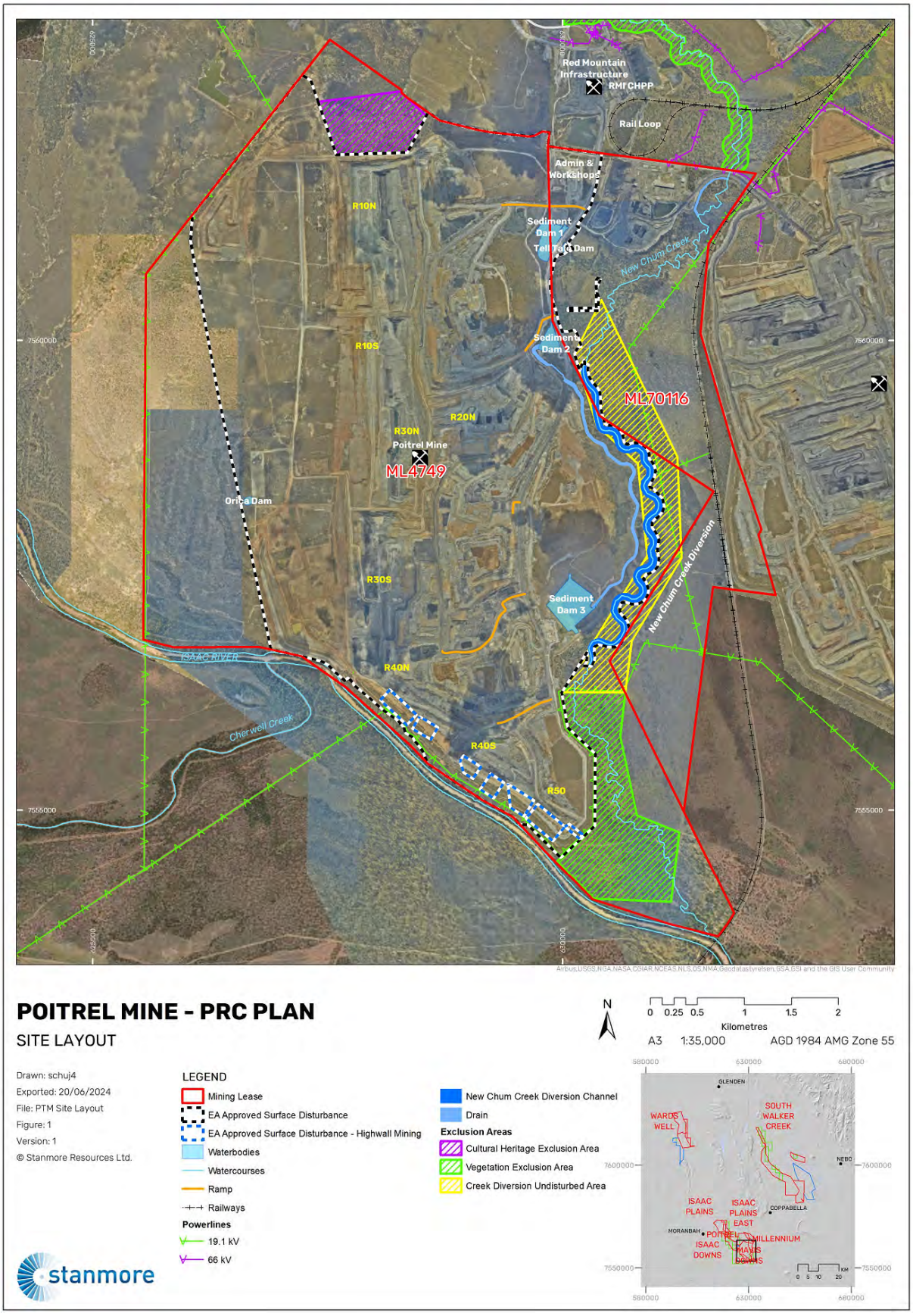

Figure 1-1: Project location and site layout

1.3 Summary

This MWCR provides information on the characterisation of mine waste materials and addresses how these materials will be managed during operations and post closure, as required by legislative and other requirements.

1.4 Regulation and license conditions

1.4.1 Environmental Authority EPML00963013 - Poitrel Mine

Stanmore operates PTM under EA EPML00963013 and has approval for coal extraction at a rate of up to 7.0 Mtpa of run-of-mine (ROM) coal from ML70116 and ML4749.

This MWCR also provides information that can be used to address conditions of the EA relating to Condition E5, the Rehabilitation Management Plan and E12, the Post Closure Management Plan.

1.4.2 Rehabilitation Management Plan: Condition – E5

Under Condition E5, PTM must specify spoil characteristics, soil analysis, and soil separation for use on rehabilitation. The material specifications of spoil and soil requires characterisation in terms of soil quality and geochemical and physical properties.

1.4.3 Post Closure Management Plan: Conditions E12b and E13

Under Condition E12b, the Post Closure Management Plan for PTM must include the following elements:

Monitoring of:

1. Surface water quality;
2. Groundwater quality;
3. Seepage rates;
4. Erosion rates;
5. The integrity and effectiveness of final cover systems; and,
6. The health and resilience of native vegetation cover.

Under Condition E13 – preventing contaminant release to land, contaminants must not be released to land in a manner that constitutes a nuisance, material harm, or serious environmental harm.

Once approved, the PRCP schedule will replace these requirements from the EA.

1.4.4 Water Contaminant Release: Condition F1

Under Condition F1, contaminants that will have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the mining activities, except as permitted under the conditions of the EA.

1.4.5 Saline drainage: Condition F38

Under Condition F38, the EA holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.

1.4.6 Acid rock drainage: Condition F39

Under Condition F39, the EA holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.

1.4.7 Requirements of the Progressive Rehabilitation and Closure Plan

PTM is required to develop a transitional Progressive Rehabilitation and Closure Plan (PRCP) in accordance with the requirements of the *Mineral and Energy Resources (Financial Provisioning) Act 2018 (MERFP Act).*

This requirements for the PRCP are described in the *Environmental Protection Act 1994 (EP Act)* and the *Progressive Rehabilitation and Closure Plan Guideline (PRCP Guideline) (DES, 2023*).

The content in this MWCR to satisfies the requirements for Waste Characterisation as described in section 3.6.1 of the PRCP Guideline. Specifically, the PRCP requirement for waste characterisation requires all mined material be classified on propensity to be potentially acid or non-acid forming, to generate neutral metalliferous or saline drainage, and its susceptibility to weathering. The characterisation of waste material should continue throughout the operation of the mine and should include the following:

- static tests, such as:
    - chemical composition (whole rock and elemental analysis)
    - mineralogical analysis and acid base accounting (paste pH, sulfur speciation, neutralising potential (NP) or acid neutralising capacity (ANC) and total inorganic carbon)
    - net acid generation
    - water extraction (batch extraction) tests – with solution assay
- kinetic tests, such as:
    - humidity cell leach testing
    - column leach testing.

1.5 Document Control and Review Process

Based on actual risk, this MWCR will be reviewed and updated every three years by a suitably qualified person and be progressively updated and implemented to align with new information as relevant (i.e. drilling programs, rejects sampling) (**Table 1-1**).

Table 1-1: MWCR Version Control and Approval

Document Control			
Revision	**Signatory**	**Role**	**Company approval (Signed and dated)**
Revision 001	Principal Environmental Approvals	Document Owner	

Table 1-2 progressively tracks amendments to the MWCR over the life of the mine, and, if any substantive changes have been made or are proposed to be recorded.

Changes made to the MWCR will be documented to allow subsequent managers to understand the history of the site and follow the progressive management and operation of the mine areas.

Table 1-2: MWCR Amendments

Document Control			
Revision	**Signatory**	**Requirement for amendment**	**Reference to amendment**
Revision 001	Principal Environmental Approvals		

RGS certifies that this MWCR is feasible and meets the intent of the PRCP conditions (i.e., the MWCR will enable Stanmore to continue to progressively characterise, mine and place the mined materials so that their potential to contribute to (or to mitigate) environmental harm can be determined.

In addition to the geochemical characterisation of materials currently being mined and processed, future revisions of the MWCR may include information on project based characterisation work required for the management of mine materials from extension areas, which are expected to be based on existing landforms construction techniques. For example, non-acid forming (NAF) characterised mine materials could be used to

encapsulate any future PAF mining wastes and limit the extent of any adverse impact on the receiving environment.

1.6 Integration of the MWCR with other Departments

Effective management of mining waste materials including materials that will be required to initiate and then maintain sustainable vegetation, requires communication between the environmental, geology, mine planning and technical services departments.

Without effective communication and clear workflow designation the MWCR will not meet its objectives. The information in **Table 1-3** shows the potential workflow and communication within and between PTM departments.

Table 1-3: MWCR departmental workflow

Department	Role	Tasks and responsibilities	Connections
Environment Department	Document control	Owner of the MWCR	→ Geology,
		Compilation and updating the MWCR and ensuring that the aim and objectives will be met i.e., auditing process	
		Ensuring the MWCR is integrated with the Plans being managed by other departments e.g., the PRCP and Water Management Plan	→ Planning, → Environmental, → Geology, → Tech. Services
		Ensure scheduled mining waste material sampling and analytical programs are planned, ahead of mining, on an as-required basis.	← Planning, ←→ Geology
		Work with the Geology Department to develop the MWCR to obtain necessary samples from in-fill drilling programs and/or blast hole drilling programs.	←→ Geology
		Document how changes to the MWCR will be tracked over time.	
	Life of mine planning	There will be a future regulatory requirement for a PRCP that must align with the short, medium, and long-term rehabilitation goals for the site.	← Planning
		The Environment Department must work with other departments and guide them to ensure that the operational mine plans to mine and produce coal align the legislative requirements of the Queensland Government *Mineral and Energy Resources (Financial Provisioning) Bill 2018* and the amendments to the *Environmental Protection Act 1994.*	←→ Planning ←→ Geology
	Material characterisation	Define the material types that will be mined (or processed) and need to be managed and rehabilitated to attain minimal financial liability and relinquishment. In general, all materials from the topsoil to the deepest mined surface should be included in the MWCR.	← Geology
		Document the specific sampling processes and the physical and geochemical analytical methods that will be adopted in consultation with the Geology Department.	←→ Geology
		Define the geochemical and physical criteria that will be used to classify the samples from drilling and sampling programs in consultation with the Geology Department.	←→ Geology
		Manage the interpretation and classification of the analytical data.	← Geology
	Financial Provisioning	Environmental Departments are typically required to manage environmental provisioning for rehabilitation and closure, and this requires reliable outputs from short, medium and long-term mine plans.	← Planning
Geology Department	Drilling and sampling	Utilise the MWCR to develop scheduled exploration and operational drilling and sampling plans.	← Environmental, (←→ Planning)
		Implement the exploration and operation drilling and sampling plans.	
	Update geology models	Compile the material characterisation data into the geology model(s).	← Environmental
		Provide the raw data and interpreted data to the Environmental Department.	→ Environmental
		Develop and report annual material balances and provide these to Environmental Department.	→ Environmental
		Provide the revised geology model to the mine planning team.	→ Planning
	Issue geology model and material balances	Provide updated material balances for all mined units to the Environment team to verify that the overall aim of the rehabilitation and closure plan can continue to be met e.g., for the active (current iteration) of the mine plan is there enough topsoil, subsoil and other necessary material to achieve complete rehabilitation over the life of mine.	→ Environmental
Mine Planning Department	Short-term mine planning and surveying	Mine planners will provide regular mine plans outlining where material is to be mined and dumped. They will also reconcile conformance in the Mining Department to the Operational Mine Plan and the MWCR. Mine Planners will then inform the Environment Department of Operational Mine Plan compliance to the MWCR.	→ Planning → Geology → Environmental
	Life of mine planning	Development and maintenance of schedule in the Operational Mine Plan and PRCP	←→ Geology, ←→ Environmental
	Scheduling	Utilise revised geology models to develop short, medium and long-term mine plans including plans for progressive rehabilitation and closure.	← Geology
		Mine planners will need to align with environmental design criteria associated with constructed landforms to ensure that the landforms are rehabilitated to a safe and stable landform that does not cause environmental harm and will conform to the objectives of the *Mineral and Energy Resources (Financial Provisioning) Bill 2018* (the Bill).	→ Environmental
		Mine planners will provide the numerical basis from the Operational Mine Plan and PRCP to the environmental department for annual financial reporting (internally and externally).	→ Environmental
		Mine planners will provide the schedules and plan to technical services to implement on the ground.	→ Tech. Services
Technical Services	Design and construction	Operation of the mine including implementation of rehabilitation plans.	← Planning, ← Environmental, ← Geology
Mining Department	Mine production	Consult with Technical Services and Environment Department to confirm production plans.	←→ Tech. Services ←→ Environmental
		Construct and develop the mine as per the Operational Mine Plan and the MWCR.	←→ Tech. Services ←→ Geology
		Construct waste rock dumps as per design in the Operational Mine Plan and the MWCR.	←→ Tech. Services ←→ Environmental
		Inform the Environment Department of any performance breaches of the MWCR.	←→ Tech. Services ←→ Environmental

2 Scope, aim, and objectives of the MWCR

2.1 Scope

The scope of the MWCR is to characterise and manage all mined units including overburden, interburden, coal, coal rejects (coarse and fine). This MWCR includes sub-units for topsoil, subsoil and extremely weathered to weathered rock materials that are present above the pre-mining groundwater level, and that are potentially required for successful rehabilitation.

Effective management leading to successful rehabilitation that will attain regulatory relinquishment or be considered as fit-for-purpose by a subsequent landowner will integrate the mining, placement and rehabilitation of the mined units.

To achieve effective management of the mining waste materials, this MWCR addresses the following requirements of the EA and PRCP, and/or will reference where more detailed information is available:

- Characterisation of the mined units and soil (EA Condition E5 c) (**Section 4**);
- The EA holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage (EA Condition F38) (**Sections 4 and 5**);
- The EA holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage (EA Condition F39) (**Sections 4 and 5**);
- Management of seepage from mining waste materials (details contained in the PTM Water Management Plan) (**Sections 4 and 5**);
- Safety hazards in rehabilitation are not significantly different to surrounding unmined landscape subject to the same land use (Table E1, referring to rehabilitation goals that are safe to humans and wildlife - details contained in the PTM Rehabilitation Management Plan) (**Section 5**);
- Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters (Table E1, referring to rehabilitation goals that are non-polluting - details contained in the PTM Water Management Plan) (**Section 5**);
- Residual voids 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 residual void itself and subject to any other condition within the EA (Condition E6 - details contained in the PTM Water Management Plan) (**Section 5**);
- Describe end of mine landform design plan and post mining land uses across the mine (EA Condition e5l) (**Section 6**)
- Rehabilitation objectives, design criteria, indicators for success and completion criteria (details contained in the PTM Rehabilitation Management Plan);
- Rehabilitation strategy documenting what the overall goal for rehabilitation will be over the life of mine (EA Condition E5 - details contained in the PTM Rehabilitation Management Plan);
- Location records and post placement verification of the mine scheduling to ensure that the placement and landform design criteria have been met (**Sections 6 and 0**);
- Review programs to check environmental performance and continuous improvement, and ensure that the aims of rehabilitation have been achieved (EA Condition E10 - details contained in the PTM Rehabilitation Management Plan) (**Section 8**); and,
- Document control defining how the document will be managed and how changes will be tracked over time (**Section 1.5**).

To achieve effective management of the mining waste materials, this MWCR addresses the following requirements of the PRCP, and/or will reference where more detailed information is available.

- The PRCP requirements for geochemical and chemical analysis is referenced on pages 20, 29, 30, 31, 33 and 70 and physical analysis is referenced on pages 29, 30 and 70.

2.2 Aim

The aim of this MWCR is to enable mining, coal processing and rehabilitation to be completed economically with minimal adverse environmental and health impacts on the land and water resources, and to lead to successful establishment of the post mining land use (PMLU) as defined in the PRCP.

To achieve this aim there will be an integrated planning approach coupling the work programs undertaken by environmental, exploration and operational geology and short, medium and long term mine planning departments.

With an integrated, cross-discipline planning approach at the site, implementation of the management aims will be effective in identifying and eliminating any subsequent environmental issues.

2.3 Objectives

The objectives of the MWCR are to document:

- When the MWCR will need to be updated;
- Changes to the MWCR and track when and why these changes occurred;
- Who will implement the tasks required to be undertaken by each department;
- Data collection from departmental tasks such as waste characterisation or developing material balances that will be stored and made accessible to other departments;
- How the data will be used and integrated with other Management Plans (e.g., Water Management Plan, Rehabilitation Management Plan or PRCP); and
- When the tasks in the MWCR are required to be undertaken and what the outputs will be.

2.4 Data Management

The material characterisation program will compile geochemical, physical and nutrient data. Typically, this data is collected by the site or provided by a commercial laboratory in pdf and spreadsheets that are then stored on a server. This can lead to the eventual loss of the data.

All geochemical, physical and any other relevant (e.g., nutrient) data associated with the characterisation of coal, coal roof, coal floor, coal partings, coal rejects (fine and coarse), topsoil, subsoil, and weathered waste rock units in the overburden and interburden will be stored in the relevant company databases.

3 Geology

The deposit at PTM occurs in the Late Permian Rangal Coal Measures in a drag syncline within the Burton Range fault system. PTM has three separate rock units: Permian rocks, Tertiary sediments, and post-Tertiary sediments. The regional geology is a basin-like structure with seams dipping gently to the west. Two major coal seams have been identified, the Leichhardt and the Vermont seams (BHPBilliton, 2005).

The depositional environment for the Leichhardt and Vermont seams is upper delta fluvial with minimal influx of marine sedimentation. This suggests the potential for acid drainage generation and impact associated with salinity is low. Unconsolidated, generally highly weathered Cainozoic sediments range in depth from 2 to 10m. They are generally 2 to 3m thick in the north of the site, with isolated thicker occurrences adjacent to drainage systems such as New Chum Creek, and between 4 and 10 m in the south of the site.

Unconsolidated sediments consist mainly of clays and sands. The base of weathering is generally 15 to 20 m deep. Below the weathered zone lies unweathered Permian, which is mainly inter-bedded sandstone and siltstone. The interburden thickness between the Leichhardt Seam and the Vermont Upper 1 Seam ranges from 12 to 24 m and is typically 14 to 20 m. The Yarrabee Tuff that could influence pit floor stability separates Vermont Upper 2 and Vermont Lower Seam.

Overburden consists of silty claystones and clayey to silty sandstones of low to medium strength along occasional thin bands of siderite-cemented siltstone and sandstone (**Table 3-1,** SLR 2022). The depth of weathering is typically 15 to 20 m, often demarcated by contact with a coal seam or ply. Weathered coal measures are usually leached and oxidised. In spoil dumps, coal measures rock fragments typically weather to sandy and cobbly clay. A typical stratigraphic profile is shown in **Figure 3-1.** (BHPbilliton, 2005).

Table 3-1: Stratigraphic units at Poitrel Mine

Period		Stratigraphic Unit		Description	Distribution
Cainozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand, and gravel	Surficial cover localised along Isaac River and Cherwell Creek
		Regolith – alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qr, Qr/b and TQa)		Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts, and muds derived weathered basalts	Surficial cover throughout much of PTM and surrounding areas
		Duaringa Formation (Tu)		Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, and basalt	Present to south and east of the project area
Triassic		Mimosa Group	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone	Isolated outcrop to the far south-east of the project area
			Rewan Group (Rr) Rewan Formation and Sagittarius Sandstone	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material	Outcrops or subcrops with the project area and central and northern zones.
Permian	Late	Blackwater Group	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone, and mudstone	Within project area; shallowest Permian unit at PTM
			Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff	Within project area; underlies Rangal Coal Measures at PTM
			Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone and coal	Within project area; underlies Fort Cooper Coal Measures at PTM
	Early to Middle	Back Creek Group (Pb)		Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite	Within/underlies project. Outcrops to the west

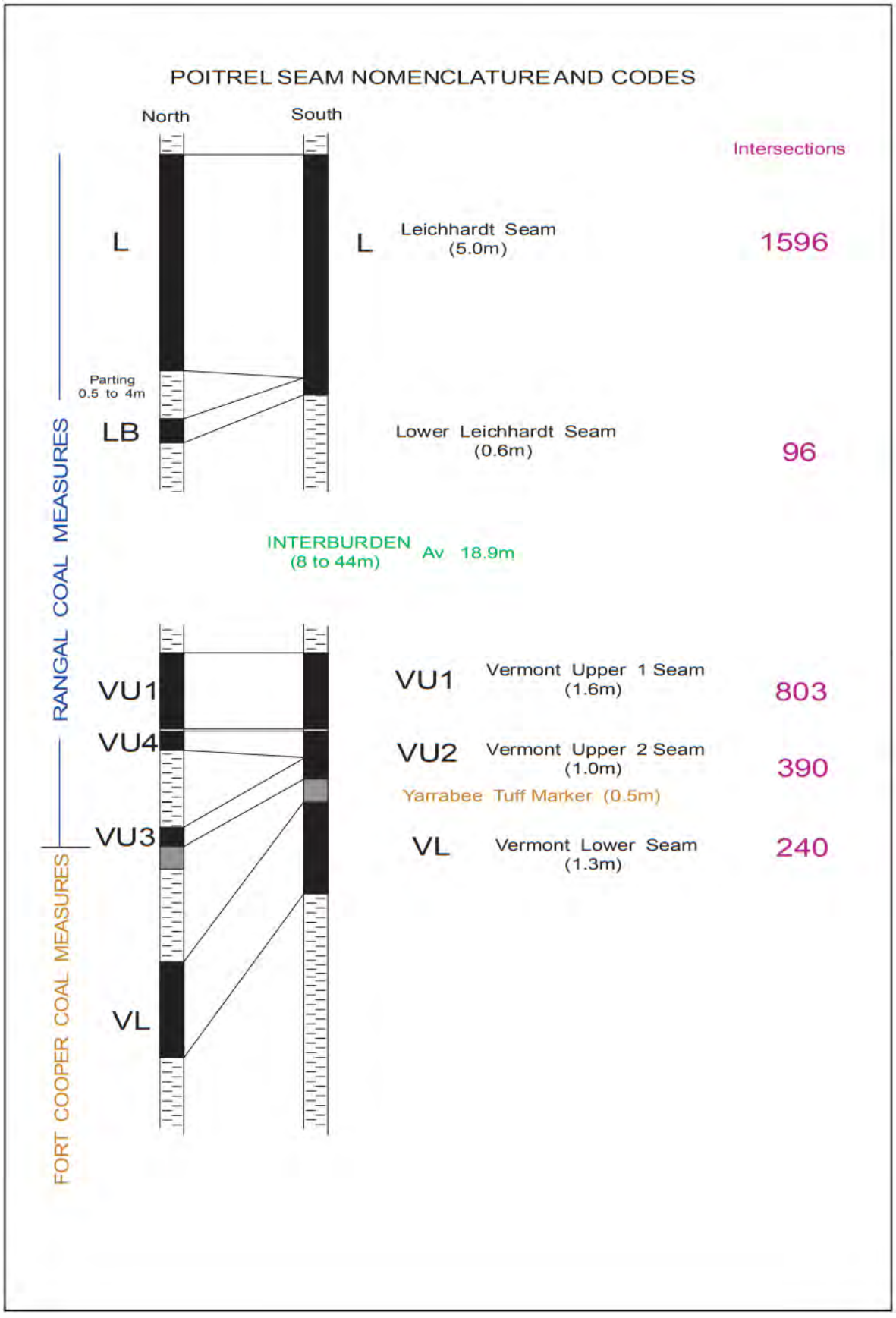

Figure 3-1: Poitrel coal seam nomenclature

4 Material characteristics

4.1 Soil quality assessment

The soil quality at PTM has been investigated in two major studies (**Table 4-1**).

Table 4-1: Soil studies conducted at PTM

Study	Year	Number of samples	Types of analyses
BHP EIS Soil Mapping Scale 1:25 000 (BHPBilliton, 2005)	2004-2005	203 individual sites 11 representative sites 2-3 depths each location	pH, EC, exchangeable cations, S, Cl, CEC, ESP, Ca/Mg ratio, organic matter, nitrates, plant-available P, DTPA metals + B, dispersion, PSD
Landloch Topsoil stockpile sampling (Landloch, 2022)	2022	23 stockpile sites 69 individual samples 21 composite samples	pH, EC, exchangeable cations, CEC, ESP, Total P, Total K, plant-available P, plant-available K, organic carbon, DTPA metals + B, Emerson Aggregate, P buffer index

4.1.1 Pre-mining soil survey (in-situ soil)

Prior to mining, a soil survey was undertaken in future disturbance areas within ML4749 (Poitrel) and ML70116 (Red Mountain) (BHPBilliton, 2005). Soil survey locations (n=203) are shown in **Figure 11-2** (**Attachment A**). Based on Australian soil classification criteria (Isbell, 2002), as well as geochemical and physical data (**Table 11-1** to **Table 11-11, Attachment A**), 13 soil types were identified in the project area. These soils are mapped in **Figure 4-1** and described in **Table 4-2**. The majority of soils disturbed by the current mining operation are types B1, B2, A1, A2, and E3.

The most common soil types are red dermosols and chromosols (B1 and B2), which are circumneutral, have low salinity (measured as electrical conductivity, EC), moderate cation exchange capacity (CEC), and are non-sodic as measured by the exchangeable sodium percentage (ESP). Soil textures, calculated by RGS from their particle size distribution (PSD) results, range from clay to sandy clay loam. Brown chromosols (E3) have similar properties but are slightly more alkaline (**Table 4-2**).

In the southern and eastern sections of the project area, soil types A1 and A2 are more prevalent. These are sandy soils that range from arenic rudosols (A1) to brown sodosols (A2). The rudosol soil has low salinity and low CEC, whereas the sodosol has relatively high EC and CEC in the subsoil (B Horizon, 50 cm depth, **Table 11-2**). These soils have slight sodicity, but lower than other soils in the project area (e.g., B3, B5).

Table 4-2: PTM in-situ soil types

Soil type	Australian soil class	Representative site	Typical characteristics				
			$pH_{1:5}$ (H_20)	$EC_{1:5}$ (µS/cm)	CEC (meq/100g)	ESP (%)	Soil texture
A1	Arenic Rudosol	Site 39	6.6 - 7.8	30	2.6 - 4.5	6.9 - 8.0	Sand
A2	Brown Sodosol	Site 41	6.4 - 8.3	20 - 1,000	5.7 - 42.4	3.0 - 8.6	Loamy Sand
A3	Brown Dermosol	Site 9	6.2 - 9.1	160 - 680	13.7- 46.1	3.8 - 8.9	Clay Loam
B1	Red Dermosol	Site 1	6.9 - 7.8	30 - 90	14.9 - 20.2	1.9 - 2.8	Clay
B2	Petroferric Red Chromosol	Site 90	6.5 - 6.6	110 - 420	12.4 - 14.0	4.1 - 5.6	Sandy Clay Loam
B3	Brown Dermosol	Site 18	7.6 - 9.0	120 - 1,130	28.0 - 38.8	3.1 - 14.6	Clay
B3v	Brown Dermosol	Site 24	8.4 – 9.0	540 - 770	2.7 – 41.6	6.3 – 6.7	Clay
B4	Black Vertosol	Site 178	7.5 – 8.9	110 - 150	45.2 – 67.2	1.3 – 3.4	Clay
B5	Crusty Black Vertosol	Site 43	7.9 – 9.0	150 – 1,190	36.3 – 46.4	2.8 – 11.4	Clay
E1	Brown Sodosol	Site 11	6.9 – 8.0	60 - 90	11.3 – 40.2	2.7 – 9.9	Sandy Loam
E2	Sodosol	Site 21	No chemical or physical data except field pH 6.0				
E3	Brown Chromosol	Site 5	7.2 – 8.4	90	19.9 – 39.3	1.9 – 2.9	Sandy Clay Loam

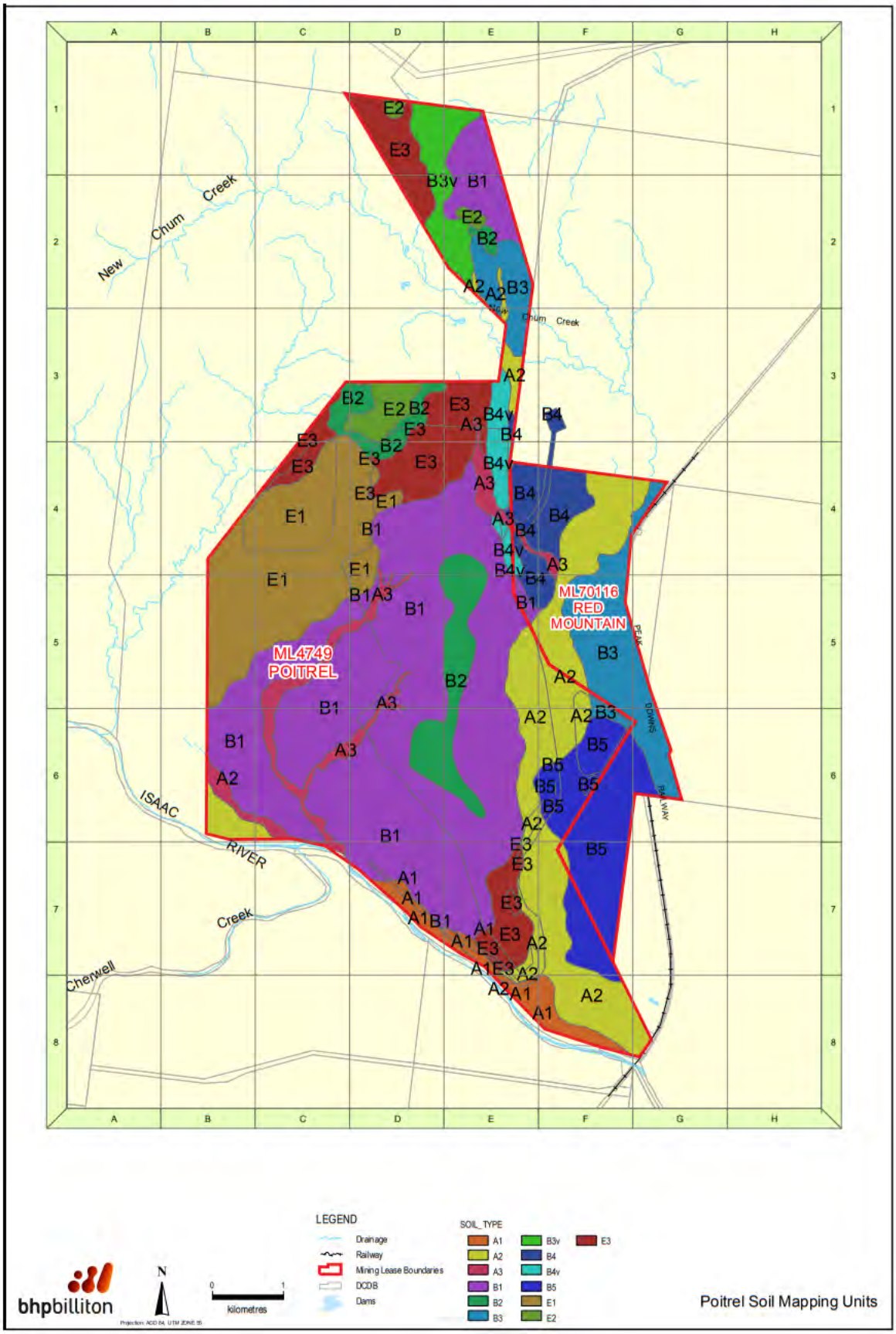

Figure 4-1: PTM soil mapping units

In general, the soils at PTM are low to moderate in nutrients (e.g., organic matter, and plant-available P) and are favourable compared to typical mining soils in the Bowen Basin. They are expected to support native vegetation as evidenced in undisturbed areas. The PTM soils are high in exchangeable cations and well-balanced in terms of exchangeable Ca and exchangeable Mg, inferring that they have good structural stability Guidelines for classifying soils by agricultural standards are provided in (**Table 4-3**, Hazelton and Murphy, 2016). Some typical ranges for soil nutrients measured in the topsoil across all 13 soil types at PTM are:

- Exchangeable Ca: 2.9 to 34.7 meq/100g (median 11.1 meq/100g)
- Exchangeable Mg: 1.0 to 7.8 meq/100g (median 3.2 meq/100g)
- Exchangeable K: 0.3 to 3.0 meq/100g (median 0.9 meq/100g)
- Exchangeable Na: 0.2 to 2.8 meq/100g (median 0.5 meq/100g)
- Ca/ Mg Ratio: 2.7 to 5.6 (median 4.0)
- Organic matter: 0.7 to 4.9 mg/kg (median 3.1 mg/kg)
- Plant-available P: 0 to 19 mg/kg (median 2 mg/kg)
- Nitrates (NO_3) as N: 2.9 to 116.2 mg/kg (median 19.8 mg/kg)

Table 4-3: Soil characterisation guidelines applied to PTM soil

Parameter	Very low	Low	Moderate	High	Very high
Exchangeable Ca (meq/100g)	0-2	2-5	5-10	10-20	>20
Exchangeable Mg (meq/100g)	0-0.3	0.3-1.0	1-3	3-8	>8
Exchangeable K (meq/100g)	0-0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2
Exchangeable Na (meq/100g)	0-0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2
Cation Exchange Capacity (CEC) (meq/100g)	<6	6-12	12-25	25-40	>40
	Non-sodic		Sodic	Strongly sodic	
Exchangeable Sodium Percentage (ESP) (%)	0-6		6-14	>14	
	Ca deficient	Ca (low)	Balanced	Mg (low)	Mg deficient
Ca/Mg ratio	<1	1-4	4-6	6-10	>10
	Mg deficient	Mg (low)	Balanced	K (low)	K deficient
Mg/K ratio	<0.6	0.6-1.2	1.2-1.8	1.8-2.4	>2.4

Notes: meq/100g = milli-equivalents per 100 grams of sample; CEC = Cation Exchange Capacity; ESP = Exchangeable Sodium Percentage.

In terms of physical properties, the PTM soils are typically variable in PSD and soil texture (excluding gravel) can vary from clay to sand. Dispersion (R1) ratios ranges from 0.28 to 0.77 and are generally described as low. Some soils (e.g. A2) are slightly more susceptible to erosion, however, they are still considered suitable for revegetation and potential grazing land use (**Section 6**). Clay-rich soils (e.g., B1, B2) are expected to have better water holding capacity than more sandy soils (A1, A2).

4.1.2 Topsoil stockpile quality sampling

Topsoil stockpile soil quality at PTM was investigated by Landloch (2022) to evaluate the materials in terms of suitability as growth media for rehabilitation. The approximate total volume of available stockpiled soil in 2022 was 2,793,354 m^3. The locations where stockpiles were sampled is shown in **Figure 11-2** (**Attachment A**). Topsoil stripping depths were recommended in BHPBilliton (2005). For thin, gravelly soil (e.g., B2) and soils with a sodic B horizon (e.g., A2), the recommended stripping depth was 10 to 15 cm. The majority of soils have a stripping depth of 30 to 40 cm, while the arenic rudosol (A1) could potentially be stripped to >2 m.

Once stripped and no longer in-situ, soils are difficult to classify. Topsoil stockpiles may contain a mixture of different soil types from various locations, and they no longer exhibit the structural properties that are an

important criteria of the Australian Soil Classification system. Nevertheless, Landloch (2022) was able to classify the topsoil stockpiles into two broad categories:

- Red/brown clays; and,
- Red/grey loams

Red/brown clays are the dominant topsoil material stockpiled at PTM. The generalised materials are dark brown, brown, or reddish brown with a texture of clay loam to medium clay. Gravel content is generally less than 10 %, although can be up to 20 % in some locations. All red/brown clays were classified as non-sodic and generally stable. RGS suggests that the red/brown clays likely originate from the B1 and B2 soil types.

Red/grey loams form a minor portion of the stockpiled topsoil material at PTM. Less than 15 % of samples collected were characterised as loams. The generalised topsoil materials are pale red, pale grey, or grey, with textures of sandy loam to sandy clay loam. Gravel content is 10 to 20 %. All red/grey loams were non-sodic but were susceptible to slaking and dispersion, thereby increasing the risk of erosion. It is likely that the red/grey loams originate from the A1, A2, or possibly E3 soil types.

Soil characterisation data for the topsoil stockpile samples is included in **Attachment A**. Key geochemical and physical properties of the materials are summarised in **Table 4-4** and verify that the soil properties of the in-situ materials (**Table 4-2**) are consistent with the topsoil stockpiles. This demonstrates good management technique of the topsoil stockpiles and supports the likelihood that the soils are maintaining their fertility over time.

Table 4-4: Summary of key geochemical and physical properties for topsoil

Analysis	Red/brown clay	Red/grey loam
$pH_{1:5}$ (H_20)	Neutral to strongly alkaline (7.1 – 8.5)	Neutral to strongly alkaline (6.9 – 8.5)
$EC_{1:5}$ (µS/cm)	Low to moderate (90 – 280)	Low (120 – 140)
ESP (%)	Non-sodic (1.2 – 4.9)	Non-sodic (2.8 – 3.5)
Total N (mg/kg)	Low to moderate (270 - 1,384)	Low (396 – 471)
Available P (mg/kg)	Low (4 – 16)	Low (4 – 14)
Available K (mg/kg)	Low to moderate (76 – 364)	Low to moderate (124 – 222)
Organic Carbon (%)	Low to moderate (0.57 – 1.82)	Low (0.29 – 0.83)
CEC (meq/100g)	Low to moderate (5.5 – 24.6)	Low (5.8 – 8.0)
Ca/Mg ratio	Low Ca to balanced (2.7 – 8)	Low Ca to balanced (3 – 5.2)
Particle size distribution	Clay content >30 % Rock content <20 %	Clay content <30% Rock content 10 – 20 %
Emerson Aggregate Class	Slightly dispersive to stable (Class 3b – Class 7)	Slightly dispersive to slaking (Class 3b – Class 5)

Notes: EC = Electrical Conductivity, meq/100g = milli-equivalents per 100 grams of sample; CEC = Cation Exchange Capacity; ESP = Exchangeable Sodium Percentage.

Landloch (2022) concluded that the topsoil materials are suitable as primary growth media with negligible limitations to plant growth. The topsoils are ideal for their intended purpose as a rehabilitation material.

4.1.3 Soil properties of overburden and interburden

It is useful to evaluate the soil quality of overburden and interburden materials, which may be considered as a secondary growth medium if soil volumes are insufficient. Properties of the overburden and interburden are considered in Landloch (2024b). RGS has reviewed soil data from 2005 historical drill holes (93 samples) (BHPbilliton 2005) and 2022 drill holes (47 samples) to inform this assessment (PTM, 2022). Data is provided in **Attachment A**. Drill hole locations are in **Figure 4-2**.

The lithology of the rock materials ranged from weathered saprolith materials and clay to fresh sandstone, siltstone, and mudstone. Samples were collected from shallow depths near the surface, to 109 m depth. In

general, the pH was alkaline, and only 2 samples from the 2022 drill holes had pH values less than 9. Salinity, measured as EC, was typically low (median 280 µS/cm) (**Table 4-5**).

There is some similarity between these parent rock materials and topsoil (**Section 4.1.2**). Soil characterisation guidelines referred to in **Table 4-6** verify that concentrations of exchangeable Ca, Mg, and K are high and would provide adequate nutrients for vegetation. However, unlike topsoil, the overburden and interburden materials have elevated exchangeable Na levels (median 2.9 meq/100g). Measured as ESP, sodicity values for overburden and interburden range from 22.4 % to 58.7 % and infer that the materials are strongly sodic. Emerson Aggregate class values are typically Class 2 or Class 3, suggesting that some dispersion is likely if overburden and interburden were to be exposed to surface conditions on exposed slopes.

Table 4-5: Key soil geochemical and physical properties for overburden and interburden

Analysis	Minimum	Maximum	Median
$pH_{1:5}$ (H_20)	Slightly acidic (5.0)	Strongly alkaline (9.9)	Alkaline (9.4)
$EC_{1:5}$ (µS/cm)	Low (118)	Moderate (502)	Low (280)
Exchangeable Ca (meq/100g)	0.8	27.3	12.6
Exchangeable Mg (meq/100g)	0.8	12.5	5.1
Exchangeable K (meq/100g)	0.2	2.7	0.8
Exchangeable Na (meq/100g)	0.5	10.4	2.9
ESP (%)	22.4	58.7	33.4
CEC (meq/100g)	1.3	38.3	18.0
Ca/Mg ratio	0.2	3.4	1.7
Emerson Aggregate Class	Unstable with high dispersion (Class 2)	Stable with moderate dispersion (Class 3)	Unstable with high dispersion (Class 2)

Table 4-6: Soil characterisation guidelines applied to PTM overburden and interburden

Parameter	Very low	Low	Moderate	High	Very high
Exchangeable Ca (meq/100g)	0-2	2-5	5-10	10-20	>20
Exchangeable Mg (meq/100g)	0-0.3	0.3-1.0	1-3	3-8	>8
Exchangeable K (meq/100g)	0-0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2
Exchangeable Na (meq/100g)	0-0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2
Cation Exchange Capacity (CEC) (meq/100g)	<6	6-12	12-25	25-40	>40
	Non-sodic		Sodic	Strongly sodic	
Exchangeable Sodium Percentage (ESP) (%)	0-6		6-14	>14	
	Ca deficient	Ca (low)	Balanced	Mg (low)	Mg deficient
Ca/Mg ratio	<1	1-4	4-6	6-10	>10
	Mg deficient	Mg (low)	Balanced	K (low)	K deficient
Mg/K ratio	<0.6	0.6-1.2	1.2-1.8	1.8-2.4	>2.4

4.2 Spoil geochemistry and physical assessment

4.2.1 Drill hole sampling locations

The sampling of potential spoil materials (consisting of overburden, interburden, and partings) was conducted by collecting drill core materials. The first drilling program where spoil materials were characterised included 21 holes that were drilled as a requirement for the 2005 Environmental Impact Statement (EIS). A more recent drilling campaign (2022) comprised 3 new drill holes and 244 samples that were subjected to a wider range of analyses. The drill hole locations of both the historical and recent drilling campaigns are shown in **Figure 4-2**.

Figure 4-2: Historical (2005) and FY22 drill hole locations (2022)

4.2.2 Static geochemistry results

Geochemical assessment of the 2005 drill hole samples comprised soil quality testing (discussed in **Section 4.1.3**) as well as multi-element assays (**Section 4.2.3.1**). The broader range of geochemical analyses performed on the 2022 drill hole samples is discussed in the following sections. Additional figures for individual drill holes are included in **Attachment B** (**Figure 11-3** to **Figure 11-6**).

4.2.2.1 Acid Base Accounting

pH: The $pH_{1:5}$ values for the overburden, interburden, and partings samples (n=244) are variable and range from 4.5 to 9.5, with a median value of 9.4 (**Figure 4-3**). Five samples (or 2 %) from drill hole 171870 are below pH 7.0, although this seems to be localised to a relative level (RL) between 135 and 145 m and is associated with Leichhardt coal plies (L3 and L4). The remaining samples (98 %) are typically above pH 7.0 and are expected to add some alkalinity to contact water.

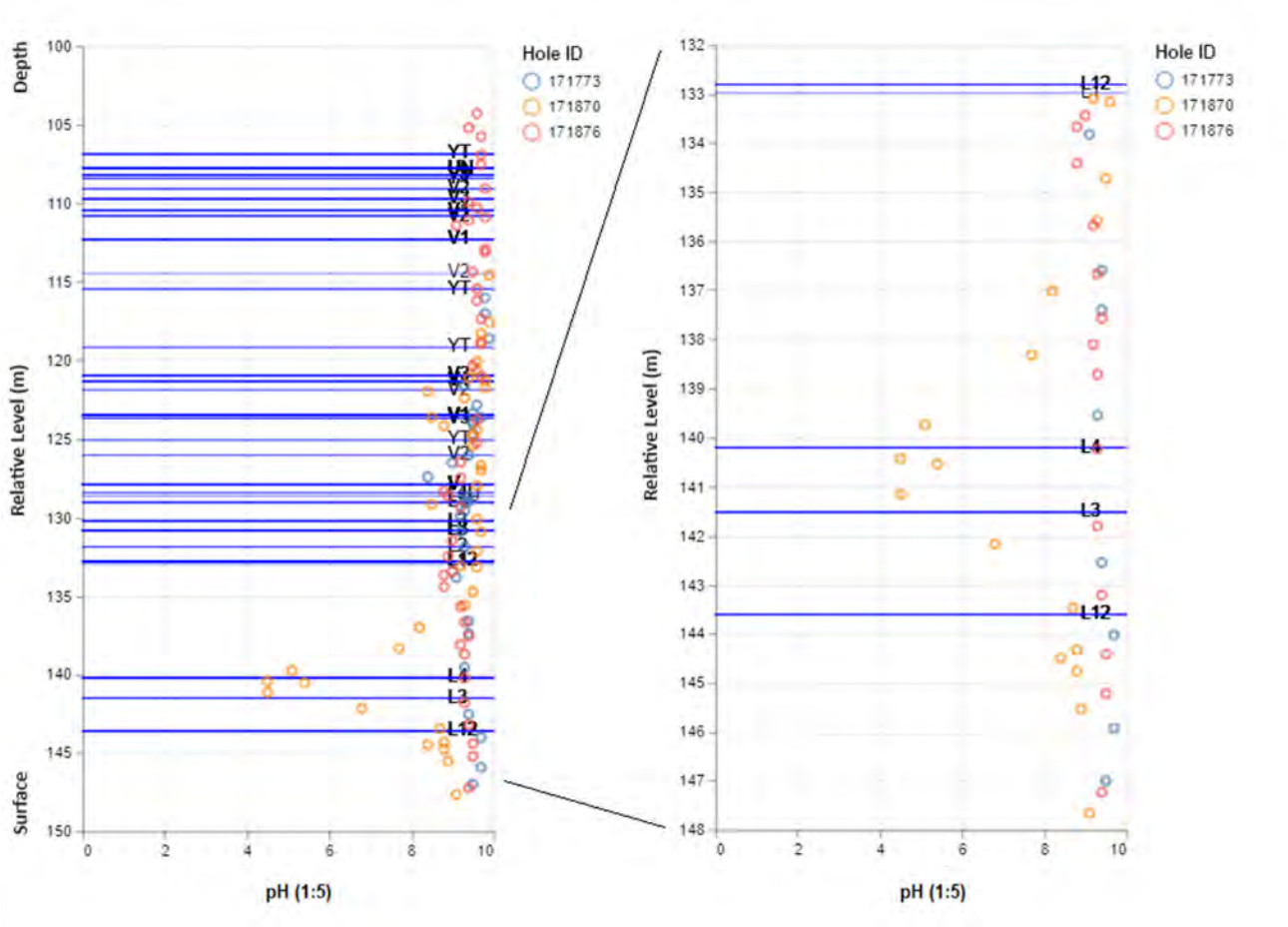

Figure 4-3: pH results for overburden, interburden, and partings

EC: The electrical conductivity ($EC_{1:5}$) values for the overburden, interburden, and partings samples are variable, range from 34 to 625 µS/cm and are typically low (median 264 µS/cm) (Figure 4-4). Slightly higher EC values (>400 µS/cm) are associated with the Yarrabee Tuff (YT) between RL 114 to 121 m. Materials near coal seams typically have low EC (<400 µS/cm), with the exception of one sample with 625 µS/cm near L3.

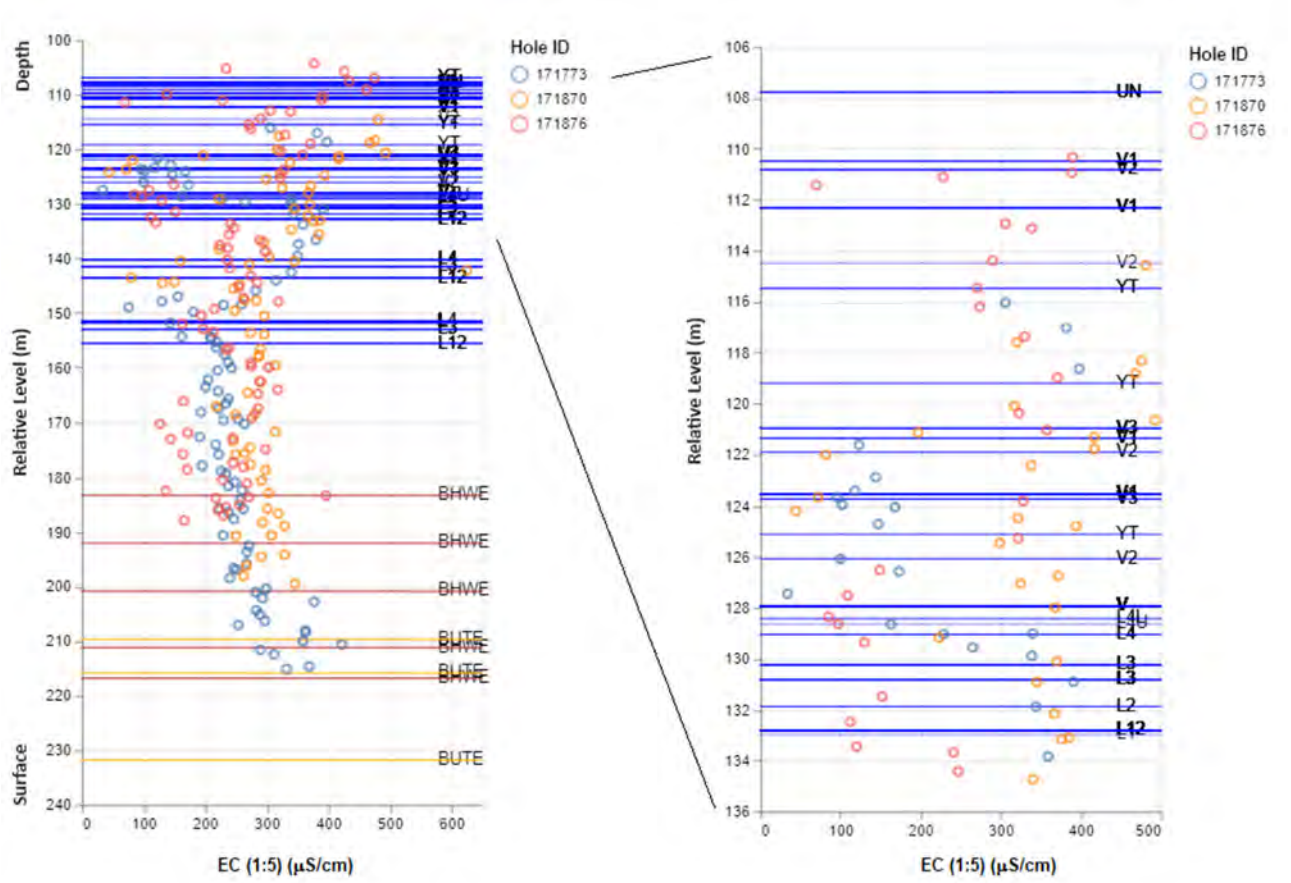

Figure 4-4: EC results for overburden, interburden, and partings

Total S: The total sulfur content of overburden, interburden, and partings samples ranges from <0.01 to 0.45 %S (median 0.01 %S) and is generally very low as shown in Figure 4-5. Materials with a total sulfur content less than or equal to 0.1 %S are essentially barren of sulfur and have negligible capacity to generate acidity[1] through sulfide oxidation when exposed to oxidising conditions. Only 24 samples (or 10 %) have >0.1 %S, indicating that the overwhelming majority of samples (90 %) are barren of sulfur.

Results in Figure 4-5 demonstrate that higher total sulfur values (0.1 to 0.45 %S) are typically associated with materials situated near the Leichhardt and Vermont coal seams. This trend between total S and proximity to coal seams is consistent across all three drill holes (**Figure 11-6, Attachment B**).

The relationship between total S and distance to the nearest coal seam is shown in **Figure 4-6**. The graph shows that the vast majority of higher total S concentrations (>0.1 %S) are within 0.5 m of a coal seam. Samples collected from a proximity of 1 m or more from a coal seam typically have 0.03 %S or less. This suggests that potential reject material (i.e., roof and floor) will have slightly higher total S than the majority of bulk spoil materials.

Sulfide S: The sulfide sulfur content of overburden, interburden, and partings samples was verified using the chromium reducible sulfur (S_{CR}) test. Samples with a total sulfur content greater than or equal to 0.1 %S (n=35) were selected for further testing using the S_{CR} method. The S_{CR} content of the 35 selected samples ranged from 0.006 to 0.501 %S_{CR}. Only 2 samples (or 1 %) had >0.1 %S_{CR}, which confirms that of the majority of total sulfur is likely to be present as non-acid generating forms of sulfur, such as sulfate or organic sulfur.

[1] The median crustal abundance of sulfur is 0.07 %S (Bowen 1979; INAP, 2023), which has been rounded.to 0.1 % S.

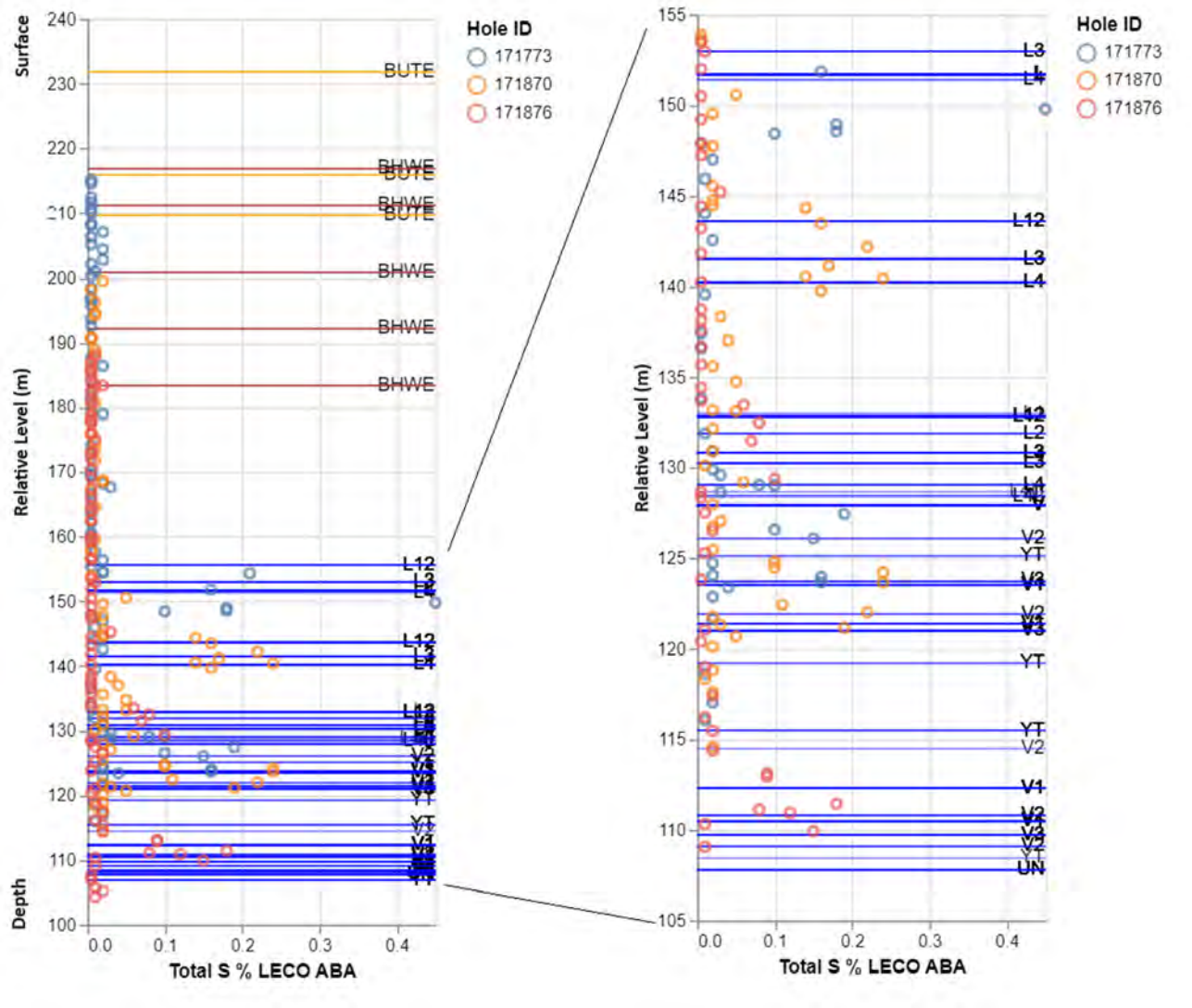

Figure 4-5: Total S results for overburden, interburden, and partings

MPA: Based on the total sulfur content, the Maximum Potential Acidity (MPA) that could be generated by the 244 samples of spoil materials has been calculated. The MPA ranges from 0.15 to 13.8 kg H_2SO_4/t; and has a low median value of 0.3 kg H_2SO_4/t. This indicates that the majority of samples have a low theoretical potential to produce acidity.

ANC: The Acid Neutralising Capacity (ANC) measures the amount of acid (as kg H_2SO_4 /t) that could be neutralised by acid neutralising minerals present in the sample materials. The ANC for the samples ranges from 1.8 to 492 kg H_2SO_4/t and has a median value of 28 kg H_2SO_4/t.

NAPP: The NAPP for the 244 samples has been calculated by subtracting the ANC from the MPA. Strongly positive NAPP values generally indicate some risk of acid production and that a material is classified as PAF. Strongly negative NAPP values generally indicate that a material is NAF or Acid Consuming (AC). NAPP values close to zero (i.e., between -5 and +5 kg H_2SO_4/t) have some inherent uncertainty in terms of material classification, although materials represented by these samples are expected to have a low risk and elevated factor of safety with respect to potential capacity to generate acid.

The NAPP value for the overburden, interburden, and partings samples ranges from -490 to +4.0 kg H_2SO_4/t (median -27.0 H_2SO_4/t) and is negative for all but 4 samples. Positive NAPP values are associated with materials located close to close seams and typically have relatively high total S and low ANC. The overwhelming majority of samples (98 %) have a negative NAPP value.

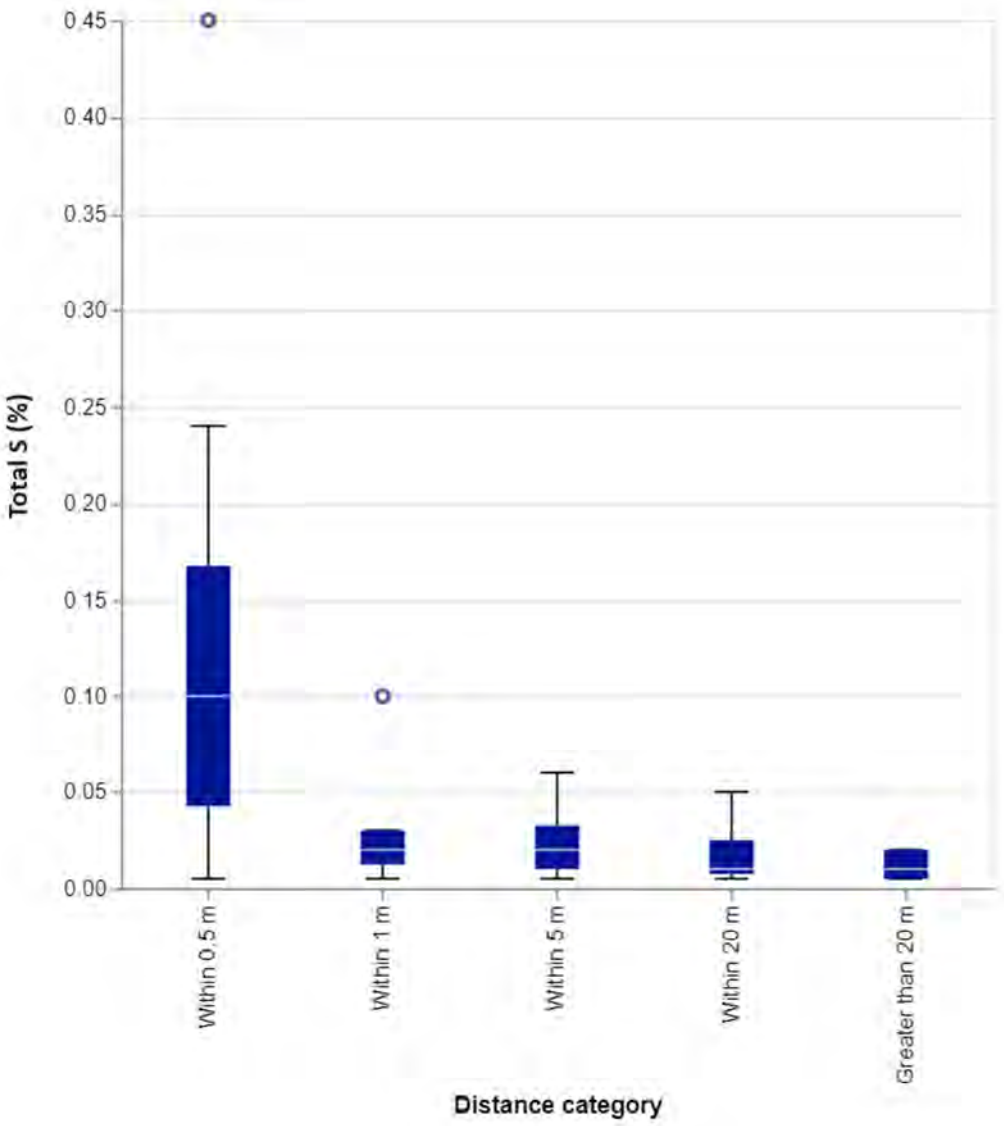

Figure 4-6: Relationship between coal seam proximity and Total S in overburden and interburden

ANC:MPA Ratio: The ANC:MPA ratio measures the proportion of ANC present in the sample compared to the MPA. If the ANC:MPA = 3 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[2]; COA, 2016). If the ANC:MPA ratio is less than 1, 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 risk of generating acid.

The ANC:MPA ratio for the 244 spoil material samples ranges from 0.3 to 3,043 and has a median value of 119. The majority of samples (95 %) have an ANC:MPA ratio of 3 or greater and are considered to have a negligible risk of AMD. From the remaining samples, 3 % have an ANC:MPA ratio between 2 and 3 (indicating low risk), and only 2 % have an ANC:MPA ratio of less than 2 (indicating possible or increased risk).

Geochemical Classification:

Table 4-7 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the 244 overburden, interburden, and partings samples from drill core subjected to static

[2] INAP considers that mine materials with an ANC/MPA ratio greater than 2 are likely to be NAF unless significant preferential exposure of sulfides along fracture planes occurs in combination with insufficiently reactive ANC.

geochemical testing. The results in **Table 4-7** demonstrate that that 220 of the 244 samples (90 %) are classified as NAF (Barren) as they have a low total sulfur (or where applicable, S_{CR}) content (≤ 0.1 %S). Some samples (22 out of 244 or 9 %) have marginally elevated total sulfur content (compared to background concentrations) but also have more than sufficient ANC to be classified as NAF. 2 samples (or 1 %) are classified as Uncertain.The Uncertain samples are coal (2 samples) from drill hole 171870.

Overall, most materials represented by the samples tested are expected to have a very low risk and increased factor of safety with respect to potential acid generation.

Table 4-7: Geochemical classification criteria for spoil materials from PTM

Geochemical Classification	Total Sulfur (%)	ANC: MPA Ratio	NAPP (kg H_2SO_4/t)	Number of Samples (n=244)	% Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	220	90 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	22	9 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	2	1 %
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

4.2.3 Multi-element testing

4.2.3.1 Multi-element concentration in solids

Multi-element analyses were completed on 93 selected individual samples from the 2005 drill holes and 63 selected individual samples from the 2022 drill holes. The program of work was completed to identify any elements that present at concentrations of environmental concern with respect to materials handling, storage, revegetation and water quality.

The multi-element results were compared to the median background concentration (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. The GAI quantifies an assay result for a particular element in terms of the median crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times median crustal abundance, as shown in **Table 4-8**.

Table 4-8: Geochemical Abundance Index enrichment factors

GAI	Enrichment Factor	GAI	Enrichment Factor
0	Less than 3-fold enrichment	**4**	24 – 48 fold enrichment
1	3 – 6 fold enrichment	**5**	48 – 96 fold enrichment
2	6 – 12 fold enrichment	**6**	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important 'trace' elements more so than with major rock-forming elements.

The GAI results indicate that most of the metals and metalloids tested in the samples have GAI values less than 3 and are therefore not enriched compared to unmineralised soils (Bowen, 1979; CRC, 2000; INAP, 2024). The only minor exception is calcium (Ca), which has a GAI value of 3 in a medium sandstone sample

from drill hole 171773. Calcite cement is noted in the geological logs of other samples in this drill hole and may also be present here.

4.2.3.2 Soluble water quality testing

Soluble multi-element test results are presented in **Table B4 (Attachment B)**.

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from mine materials on mine sites in Queensland. As such, RGS has compared the multi-element results in water extracts from 63 selected individual samples of mine materials from the PTM with Australian guideline values for freshwater aquatic ecosystems (95 % species protection level) and livestock drinking water (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge.

Acidity in the water extracts from the samples ranges from <1 to 617 mg/L (as $CaCO_3$ equivalent) and is highest in the poor quality coal samples from drill hole 171870. The total alkalinity in the water extracts is variable and ranges from 23 to 44,200 mg $CaCO_3$/L. The majority of the alkalinity in the samples is in the form of bicarbonate (HCO_3), although some materials also contain carbonate. The net alkalinity values for the samples are all positive apart from 3 samples comprised of the poor quality coal sample in drill hole 171870, and the units either side of it. This indicates that most sample materials have excess acid buffering capacity in the unlikely event that any acidity is generated by a mine material.

The concentrations of dissolved trace metals/metalloids tested in water extracts from the samples of mine materials are typically low and predominantly below the laboratory limit of reporting. Most dissolved metal/metalloid concentrations are below the applied water quality guideline criteria. The exceptions are aluminium (93 % of samples), arsenic (44 % of samples), which can have concentrations marginally greater than the applied freshwater aquatic ecosystem water quality guideline values for 95% species protection. Occasional concentrations of molybdenum (8 % of samples) and selenium (16 % of samples) can exceed the applied guideline values for livestock drinking water (ANZG, 2018), although the majority of samples have dissolved concentrations well below these values.

4.2.4 Kinetic leach testing

In 2023, BHP undertook kinetic leach column testing to assess the reaction kinetics and geochemical properties of co-disposed mixed plant reject (MPR) and mine spoil from various operations including PTM, Daunia, and South Walker Creek Mines. The material specifications of KLC 1-2 are summarized in **Table 4-9** to **Table 4-11** and demonstrate that the properties of spoil are consistent with those reported in **Section 4.2.2**, i.e., Spoil = 0.04% TS & 35 kg H_2SO_4/ t ANC.

Kinetic leach testing was undertaken on the columns over a 12-month period. Three leach events comprising the addition of deionised (DI) water to the columns at a volume scaled to the volume of sample in the columns occurred in the first month (Week 0, Week 2, and Week 4) to recover soluble and sparingly soluble minerals (i.e. products of the first-flush), followed by 11 monthly distilled, deionised water leach cycles (week 8, week 12, and onward), to produce a total of 14 leach events over twelve months.

Table 4-9: Kinetic leach column composition and mass by column section

KLC #	Column Section	Composition and Mass
KLC 1	Upper	3.75 kg Spoil
	Middle	7.5 kg MPR
	Lower	3.75 kg Spoil
KLC 2	Upper	3.75 kg Spoil
	Middle	7.5 kg Coarse Reject
	Lower	3.75 kg Spoil

Table 4-10: Kinetic leach testing sample sources and compositions

KLC #	Source Mine Group	Targeted Coal Measures	Composition
1	Daunia, Poitrel, and South Waler Creek Mines	Rangal Coal Measures	1 part MPR + 1 part Spoil
2	Daunia, Poitrel, and South Waler Creek Mines	Rangal Coal Measures	1 part Coarse Reject + 1 part Spoil

Table 4-11: Kinetic leach column sample material selection criteria and sample composition geochemistry

KLC #	Composition (sample specification)	Criteria (approximate only)
1	1 part MPR [1 part P75[3] TS & P25[4] ANC fine rejects + 4 part P75 TS & P25 ANC coarse reject] + 1 part Median TS & Median ANC Spoil	Tailing = 0.65% TS & 30 kg H_2SO_4/ t ANC Coarse Reject = 0.6% TS & 20 kg H_2SO_4/ t ANC Spoil = 0.04% TS & 35 kg H_2SO_4/ t ANC
2	1 part Coarse Reject [P75 TS & P25 ANC] + 1 part Spoil [Median TS & Median ANC]	Coarse Reject = 0.6% TS & 20 kg H_2SO_4/ t ANC Spoil = 0.04% TS & 35 kg H_2SO_4/ t ANC

Leachates collected during the kinetic testing program underwent the following analyses:

- pH
- EC
- Acidity as mg/L of $CaCO_3$
- Hydroxide, carbonate, bicarbonate, and total alkalinity as mg/L of $CaCO_3$
- Major ions (calcium, potassium, magnesium, sodium, chloride, fluoride, and sulfate)
- Total organic carbon
- Trace metals and metalloids (Al, As, B, Ba, Be, Bi, Cd, Ce, Cs, Co, Cr, Cu, Dy, Er, Eu, Gd, Ga, Hf, Ho, In, La, Li, Lu, Fe, Hg, Mn, Mo, Nd, Ni, Pr, Pb, Sb, Rb, Sm, Se, Ag, Sr, Te, Tb, Tl, Th, Tm, Sn, Ti, U, V, Yb, Y, Zn, Zr)

Matric potential, moisture content, temperature, EC, and redox potential values of materials in the KLCs were logged over the duration of the kinetic testing program.

Results from the kinetic testing are shown in **Figure 4-7** and demonstrate that leachate samples were neutral to slightly alkaline with median pH values ranging from approximately pH 7.5 to 8.5. Total alkalinity results for leach extracts from the columns suggest that the spoil portion of the KLCs is likely to be providing the bulk of the alkalinity observed. EC values of leach extracts generally stabilised around 1,000 µS/cm after the first twelve weeks of leaching. Major ion concentrations (Ca, Mg, K, Na, Cl, SO_4) tend to decrease over the first 12 weeks of the testing program then generally stabilise or continue to decrease over subsequent leach events.

Concentrations of metals and metalloids in leach extracts are generally low, with most results below the laboratory limits of detection. As with major ion concentrations, detectable metal and metalloid concentrations decline over the leach events of the initial 12 weeks. Most metal and metalloid concentrations then tend to stabilise. Exceptions to this general trend include barium in leachates from KLC 2, which generally increase over time. **Table 4-12** shows a summary of metals and metalloids relative to water guideline values.

[3] 75th percentile value

[4] 25th percentile value

Table 4-12: Metal and metalloid concentrations elevated in leachate samples relative to selected water guideline values

KLC #	KLC Composition	Guideline	Metals/Metalloids in Exceedance
1	MPR and Spoil	Freshwater Aquatic Ecosystem (95% species protection)	Cadmium, copper, selenium, and zinc
		Livestock Drinking Water	Selenium
2	Rangal Measures Coarse Reject and Spoil	Freshwater Aquatic Ecosystem (95% species protection)	Selenium and zinc
		Livestock Drinking Water	Selenium

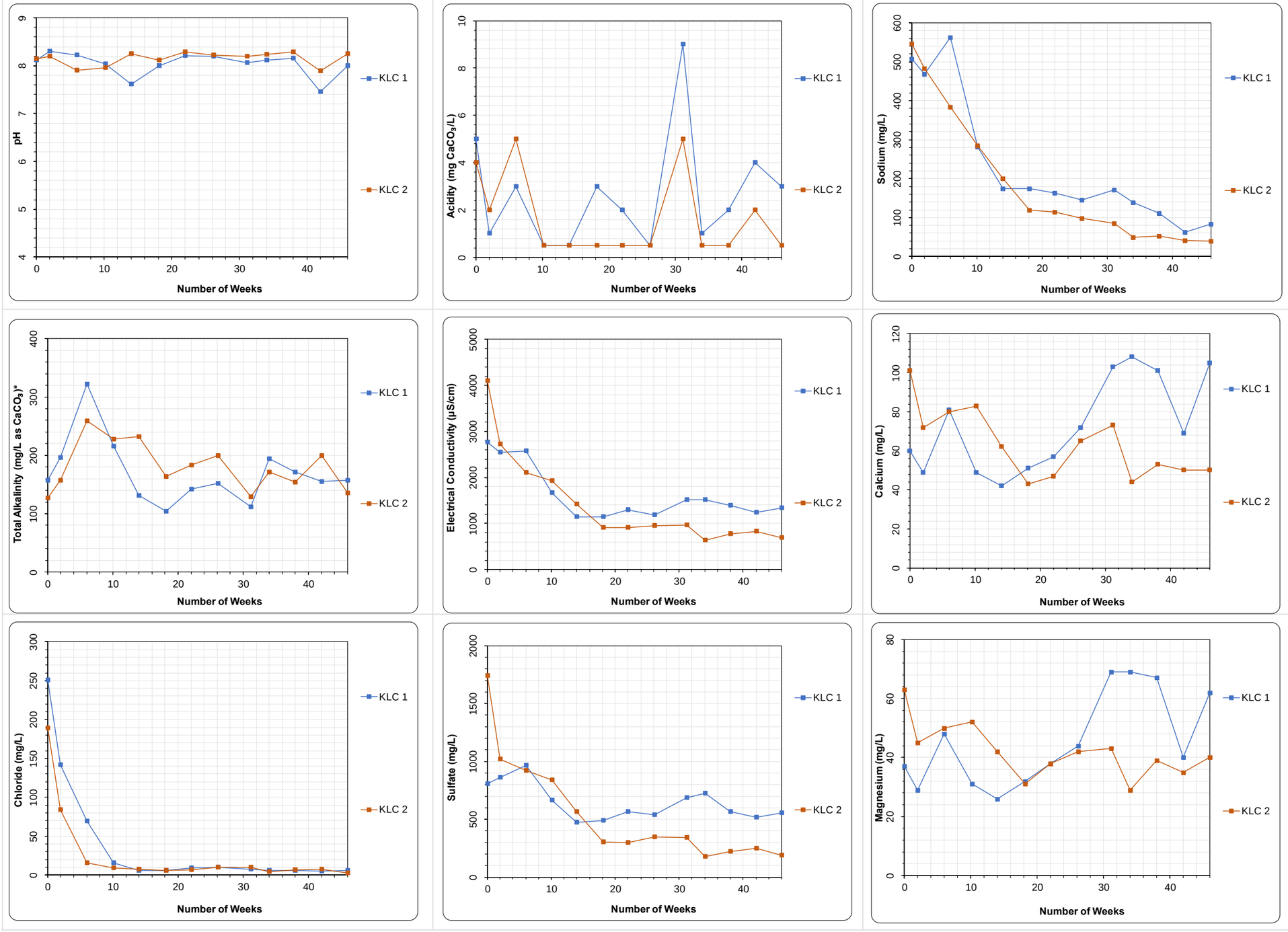

Figure 4-7: KLC plots for mixed spoil composites from PTM, Daunia, and South Walker Creek

4.2.5 Physical testing

Physical characterisation of the spoil materials (overburden and interburden) was undertaken as part of the EIS (BHPBilliton, 2005) and throughout the life of mine as reported by Landloch (2022). In terms of physical properties, spoil materials at PTM were found to be sodic and dispersive. Fresh Permian wastes are likely to be better suited to rehabilitate batter slopes.

Landloch (2022) identified two spoil management groups:

- Permian spoil (overburden); and,
- Weathered sediments and clay spoil (interburden).

Wastes at PTM were found to be very similar to the neighbouring Daunia Mine, which has undergone extensive material characterisation.

4.2.5.1 Permian spoil (overburden)

Permian spoil is a rocky material consisting primarily of sandstone, siltstone, and claystone with a clay content below 25 %, resulting in low water holding capacity. Permian spoil properties can vary depending on the strata location and degree of carbonaceous inclusions present. The materials are generally sodic and dispersive, however slake durability data indicated that only 25 % of Permian samples have a slake durability higher than 70 % (Landloch, 2022). If this material could be isolated, it may be useful to rock armour and stabilise steeper slopes.

4.2.5.2 Weathered sediments and clay spoil (interburden)

The weathered sediments and clay spoil materials contain portions of fragile rock and a have a clay content >35 %, resulting in moderate to high water holding capacity. The materials are often strongly sodic and dispersive and may be prone to hardsetting and to tunnelling and gully erosion. Due to their propensity for sodicity and dispersion, the materials are not suitable to be placed on the final rehabilitated surface.

Table 4-13: Summary of key physical properties for spoil at PTM

Analysis	Permian (overburden)	Weathered sediments and clay (interburden)
Clay content (%)	<25	>35
Rock content (%)	>30	<20
Slake durability	Moderate (50-75)	Low (<50)
Permeability	Very high	Low to moderate
Emerson Aggregate Class	Dispersive (Class 2)	Dispersive (Class 2)
Dispersion risk	Moderate	Moderate

4.2.6 Mineralogy

The QXRD results (in %) for overburden and interburden from three drill holes sampled in 2020 are summarised in **Table 4-14**. The table gives the sample depths where sulfides were identified in each drill hole, and the mineral compositions of those samples. The following trends in the data were observed:

- Drillhole 171773
  - Has two distinct (low) pyrite bearing zones between 66 – 67m and 103 – 104m
  - Coal deposits between 78m – 84m and 103 – 107m
- Drillhole 171870
  - Has two distinct (low) pyrite bearing zones between 22 – 23m and 91 – 93 m
  - Coal deposits between 72.3 – 77m and 92.3 – 94.3 m
- Drill hole 171876
  - Has three distinct (low) pyrite bearing zones between 24 -25m, 64 -65m, and 94 – 100m
  - Coal deposits between 77 – 81.8 m and 97.44 – 100.1m

Table 4-14: Selected QXRD results for overburden and interburden materials

Drillhole ID	PTM_171773	PTM_171773	PTM_171773	PTM_171870	PTM_171870	PTM_171876	PTM_171876	PTM_171876	PTM_171876
Depth	66.9 - 67.1m	101.7 - 101.9m	103.5 - 103.8m	22.6 - 23.2 m	91.8 - 92.4 m	24.3 - 24.5 m	64 - 64.2m	94.0 - 94.2m	99.3 - 99.6m
Lithology	Sandstone, with siltstone bands	Sandstone, with siltstone bands	Carbonaceous Mudstone	Sandstone, Siltstone & Clay	Mudstone	Sandstone	Siltstone with sandstone bands	Siltstone with rare sandstone bands	Carbonaceous Siltstone
Pyrite	0.1	0.1	0.4	0.1	0.3	0.1	0.1	0.2	0.4
Marcasite	0	0	0	0	0	0	0	0	0
Calcite	0.4	2.8	0	0.4	1.1	10.5	2.3	0	0
Ankerite	0	9.2	0	0	0	0	0.3	0.4	0
Siderite	0.9	9.5	3.3	1.3	4.2	0	13.4	11.6	2.1
Rhodocrosite	0.2	0	0	2.3	0	0.2	6.4	0	0
Albite	2.8	4.3	2.6	2.2	1.5	3.6	1.9	3.8	0.3
Chlorite	1.5	0.2	2	0.2	0.8	0.2	0	0	0
Illite-smectite	17.8	14.7	28.1	24.7	29.9	6.5	10.7	24.3	33
Kaolinite	22	8.6	13.3	19.6	8.3	19.6	17	12.1	16.4
Montmorillonite	11.9	9.5	11.1	8.2	15.1	1.3	8	9.1	17.8
Quartz	33.2	27.8	26.7	32.6	20.2	56.2	29.1	36.7	16.9
Anatase	1.2	0.4	0.9	1	0.5	0.8	0.8	0.8	0.7
Goethite	0	0	0	0.6	0	1	0.7	0	0
Amorphous/ coal	8	12.9	11.6	6.8	18.1	0	9.3	1	12.4
MPA	1.6	1.6	6.5	1.6	4.2	1.6	1.6	3.3	6.5
ANC	3.9	85.6	0.0	3.9	10.8	24.4	24.4	2.5	0.0
NAPP	-2.3	-84.0	6.5	-2.3	-5.9	-22.8	-22.8	0.7	6.5

4.3 Coarse and fine rejects assessment

4.3.1 Sampling

Coarse and fine rejects from the Coal Handling and Processing Plant (CHPP) were sampled in three separate sample programs in 2017-2018, 2020, and 2021-2022. The frequency of sampling was fortnightly over a four-month period. Eighty-seven (87) samples were collected in total, including mid and coarse reject, thickener underflow fine rejects, and dry fine rejects.

4.3.2 Static geochemistry results

A summary of the characteristics of the range of PTM coarse and fine coal rejects is provided graphically in **Figure 4-8** in accordance with the classification system presented in **Table 4-15** (based on S_{CR}). The geochemical properties leading to these classifications are discussed in the following sections.

Coarse rejects are predominantly NAF (46 to 76 %) and NAF-Barren (18 to 54 %), with a higher proportion of NAF-Barren samples presenting over time. One sample (or 6 %) was classified as Uncertain from the 2017-2018 test results. Similarly, fine rejectsare predominantly NAF (62 to 88 %), with a smaller proportion of NAF-Barren (6 to 38 %) relative to coarse reject materials. One sample (or 6 %) from the 2017-2018 fine reject samples, and one sample (or 6 %) from the 2020 samples were classified as Uncertain.

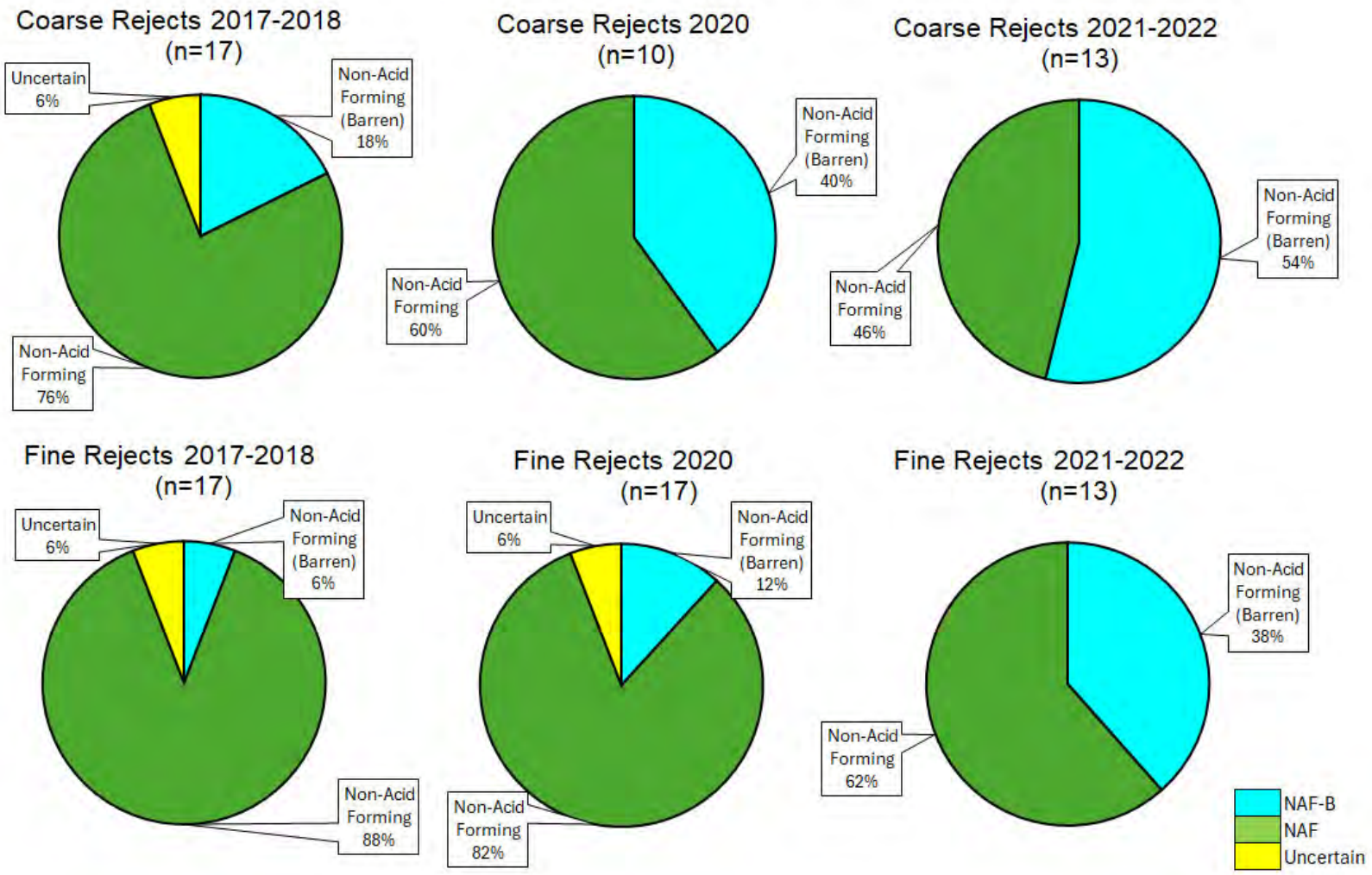

Figure 4-8: Geochemical classifications of PTM coarse and fine coal rejects

The classifications verify the high factor of safety and low risk of these materials in terms of potential to generate AMD. None of the 87 coarse and fine reject samples were classified as PAF-LC or PAF.

Acid Base Accounting graphs showing the static geochemical trends of coarse and fine rejects are included in **Figure 11-7** to **Figure 11-12** (**Attachment C**).

pH: The $pH_{1:5}$ value for the coarse rejects and fine rejects samples (n=87) is typically alkaline and ranges from 7.5 to 10.1, with a median value of 9.0 for coarse rejects and 8.8 for fine rejects (**Figure 11-7**). Only five samples are below pH 8. All samples are above pH 7.0 and are expected to add some alkalinity to contact water.

EC: The electrical conductivity ($EC_{1:5}$) value for the coarse rejects and fine rejects samples ranges from 100 to 1,420 µS/cm and are typically low (median 247 µS/cm for coarse rejects and 305 µS/cm for fine rejects) (**Figure 11-8**).

Total S: The total sulfur content of coarse and fine reject samples ranges from 0.11 to 2.61 %S (median 0.28 %S for coal rejects and 0.52 %S for fine rejects). The total S is generally low although the materials are not barren of sulfur. All of the 87 samples have >0.1 %S (**Figure 11-9**).

Sulfide S: The sulfide sulfur content of coarse and fine reject samples was verified using the chromium reducible sulfur (S_{CR}) test. The S_{CR} content of the 87 samples ranged from 0.018 to 2.38 $\%S_{CR}$. Most samples (75 %) had >0.1 $\%S_{CR}$, which confirms that some of the of total sulfur is sulfide sulfur and the remainder is likely to be present as non-acid generating forms of sulfur, such as sulfate or organic sulfur (**Figure 11-10**).

MPA: Based on the S_{CR} content, the MPA that could be generated by the 87 samples of coarse rejects and fine rejects has been calculated. The MPA ranges from 0.55 to 72.9 kg H_2SO_4/t; and has a low median value of 3.6 kg H_2SO_4/t for coarse rejects and 10.5 kg H_2SO_4/t for fine rejects.

ANC: The ANC for the samples ranges from 11 to 172 kg H_2SO_4/t and has a median value of 57 kg H_2SO_4/t for coarse rejects and 70 kg H_2SO_4/t for fine rejects, which is considered low to moderate.

NAPP: The NAPP for the 87 coarse rejects and fine rejects samples has been calculated by subtracting the ANC from the MPA. The NAPP value for the coarse and fine reject samples ranges from -149 to 0 kg H_2SO_4/t (median -54.0 H_2SO_4/t for coarse rejects and -60.0 H_2SO_4/t for fine rejects) and is negative for all but one sample (**Figure 11-11**).

ANC:MPA Ratio: The ANC:MPA ratio for the 87 coarse and fine reject samples ranges from 1.0 to 129 and has a median value of 14 for coarse rejects and 7 for fine rejects. The majority of samples (94 %) have an ANC:MPA ratio of 3 or greater and are considered to have a negligible risk of AMD. From the remaining samples, 3 % have an ANC:MPA ratio between 2 and 3 (indicating low risk), and 3 % have an ANC:MPA ratio of less than 2 (indicating possible or increased risk) (**Figure 11-12**).

Geochemical Classification:

Table 4-15 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the 87 coarse and fine reject samples subjected to static geochemical testing. The results demonstrate that that 22 of the 87 samples (25 %) are classified as NAF (Barren) as they have a low sulfide sulfur content (≤ 0.1 %S). The majority of samples (62 out of 87, or 71 %) have marginally elevated sulfide content (compared to background concentrations) but also have more than sufficient ANC to be classified as NAF. Three (3) samples (or 3 %) are classified as Uncertain. The Uncertain samples are coarse reject (1 sample) collected April – June 2019 and fine reject (2 samples) collected April – June 2019 and 13 Oct 2020.

Overall, materials represented by the coarse and fine reject samples tested are expected to have a very low risk and increased factor of safety with respect to potential acid generation.

Table 4-15: Geochemical classification criteria for coarse rejects and fine rejects from PTM

Geochemical Classification	Sulfide Sulfur (%)	ANC: MPA Ratio	NAPP (kg H_2SO_4/t)	Number of Samples (n=87)	% Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	22	25 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	62	71 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	3	3 %
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

4.3.3 Multi-element testing

4.3.3.1 Multi-element concentration in solids

Multi-element analyses were completed on 18 selected individual coarse rejects and fine rejects samples. The multi-element results were compared to the median background concentration (median crustal abundance) of those elements in unmineralised soils (Bowen, 1979, CRC, 2000 and INAP, 2024). From this comparison, a GAI was calculated (**Table 4-8**).

The GAI results indicate that most of the metals and metalloids tested in the coarse and fine reject samples have GAI values less than 3 and are therefore not enriched compared to unmineralised soils (Bowen, 1979; CRC, 2000; INAP, 2024). The only minor exceptions are molybdenum (Mo), which has a GAI value of 3 in a fine rejects sample and sulfur (S), which has GAI values of 4 and 3 in two fine rejects samples.

4.3.3.2 Soluble water quality testing

Soluble multi-element test results are presented in **Table C4 (Attachment C)**.

RGS has compared the multi-element results in water extracts from 18 selected individual samples of coarse and fine reject from the PTM with Australian guideline values for freshwater aquatic ecosystems (95 % species protection level) and livestock drinking water (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as “maximum permissible levels” for site water storage or discharge.

Acidity in the water extracts from the samples ranges from <1 to 18 mg/L (as $CaCO_3$ equivalent) and is generally very low. The total alkalinity in the water extracts is variable and ranges from 62 to 8,030 mg $CaCO_3$/L. The majority of the alkalinity in the samples is in the form of bicarbonate (HCO_3), although some materials also contain carbonate. The net alkalinity values for the col reject and fine rejects samples are all positive, indicating the materials have excess acid buffering capacity in the unlikely event that any acidity is generated.

The concentrations of dissolved trace metals/metalloids tested in water extracts from the samples of mine materials are typically low and predominantly below the laboratory limit of reporting. Most dissolved metal/metalloid concentrations are below the applied water quality guideline criteria. The exceptions are aluminium (22 % of samples), arsenic (17 % of samples), selenium (6 % of samples), and zinc (6 % of samples) which can have concentrations marginally greater than the applied freshwater aquatic ecosystem water quality guideline values for 95% species protection. All of the metals/metalloid concentrations in the coarse and fine reject samples from PTM are well below the applied guideline values for livestock drinking water (ANZG, 2018).

4.3.4 Kinetic leach testing

In 2020, ES analytical completed a static and kinetic characterisation of a fine rejects sample (“PTM C1B”) provided by BHP MetCoal Holdings Pty Ltd. The sample was ~800 g and had been pulped to 0.075 mm. Once the kinetic containment vessel was hermetically sealed, oxygen and carbon dioxide concentration were semi-continuously measured (at one-hour intervals) over a period of 25 days.

The aim of this assessment was to understand the geochemical behaviour of the materials over time if subjected to subaerial deposition within mine spoil stockpiles. The static analytical program included total sulfur, ANC, NAPP, total carbon, total inorganic carbon, S_{CR}, NAG suite, NAG leachate chemistry, solids major and trace element chemistry, and QXRD. The selected fine rejects sample PTM C1B was slightly higher in total sulfur and ANC relative to other PTM fine rejects samples (**Table 4-16**).

Table 4-16: Comparison of static geochemistry results for PTM C1B kinetic testing sample

Parameter	PTM C1B	Median values from ABA testing
Total sulfur	1.28 %	0.52 %
Sulfide sulfur (S_{CR})	1.07 %	0.34 %
MPA	32.7 kg H_2SO_4/t	10.5 kg H_2SO_4/t
ANC	117 kg H_2SO_4/t	70 kg H_2SO_4/t
NAPP	-84.3 kg H_2SO_4/t	-60.0 kg H_2SO_4/t
ANC/MPA ratio	3.6	7

Kinetic geochemical analyses were performed to determine the oxygen consumption and pyrite oxidation rates (1.2 mmol/kg/day and 73 wt%pyr/yr, respectively), as well as the acidity generation rate (24 kg H_2SO_4/t/yr) (**Figure 4-9**).

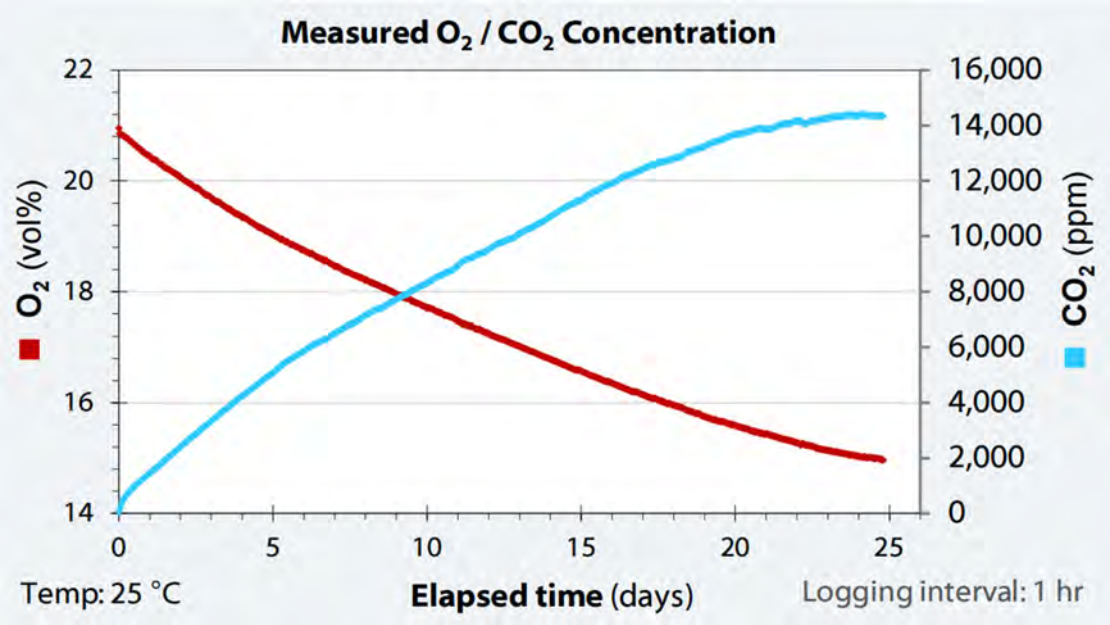

Figure 4-9: Kinetic oxygen consumption rates for PTM C1B fine rejects sample

The report found that the PTM C1B fine rejects sample was unlikely to generate acid and had a low risk for saline drainage. However, there was some potential for generating neutral metalliferous drainage over time based on slightly elevated concentrations of SO_4, Mn, Cu, Ni, and Zn.

4.3.5 Physical testing

The requirements of the PRCP (Section 3.6.2, pg. 33) describes the required geotechnical (physical) characterisation of fine rejects, however, this refers only to fine rejects that are stored within a fine rejects storage facility (TSF). At PTM, fine rejects are dewatered in sieves and then transported by truck for co-disposal within spoil dumps, in accordance with authorised EA conditions. This methodology is described further in **Section 5.2**. In effect, all fine rejects at PTM are treated as coal rejects, as there is no dedicated TSF. Geotechnical studies on fine rejects have been limited to date as they are not being placed within a TSF.

Golder (2020) investigated the geotechnical properties of fine rejects sample “S8_C3_MIDDLE_16/03/2020”, as part of a study of the fluidity of fine rejects prior to dewatering. The sample was chosen based on its yield

stress and being representative of a typical fine rejects sample in line with the average specific gravity, moisture content and slurry density of all fine reject samples.

The main findings of the geotechnical investigation program, were the following:

- The fine rejects can be classified as low to medium plasticity Silts and Clays
- The fine rejects are potentially susceptible to “classic” liquefaction if the moisture content of the soil is >85% of the Liquid Limit
- The degree of saturation for fine rejects is in the range of 79 to 100 % confirming the majority, but not all, fine rejects to be fully saturated
- The degree of saturation estimated for the adjacent spoil material varies from 20 to 75 %.

A summary of the fine reject sample properties is provided in **Table 4-17**. It should be noted that these properties reflect freshly placed fine rejects. Fine rejects that have dried, will have higher densities and greater solids concentrations and be less fluid in nature. Landloch (2024b) states that fine rejects may be used as a rehabilitation material, noting that they are predominantly NAF or NAF-Barren (**Figure 4-8**).

Table 4-17: Geotechnical properties of a typical freshly placed fine rejects sample

Property	Value
Average Dry Density (t/m³)	1.04
Fine rejects Solids Density (t/m³)	1.85
Degree of Saturation	1.00
Porosity	0.44
Void Ratio	0.77
Solids Concentration by Mass (%)	70.5
Solids Concentration by Volume (%)	56.4
Bulk Density (t/m³)	1.48

The Golder (2020) report found that overall dump stability was insensitive to the presence of fine rejects in the sieves, i.e., the dump exhibits generally similar factors of safety whether fine rejects are deposited in the sieves or if the dump was formed of homogenous spoil (typically the failure surfaces did not extend into the fine rejects sieves).

4.3.6 Mineralogy

Table 4-18 shows a results comparison for Quantitative X-Ray Diffraction (QXRD) for PTM coarse rejects and fine rejects. Major minerals include quartz (11.7 to 16.3 %), kaolinite (21.9 to 26.4 %), illite-smectite (16.8 to 17.1 %), and coal-amorphous (non-crystalline) material (39.3 to 40.6 %). Fine rejects contain higher concentrations of acid-producing minerals (e.g., pyrite and marcasite), as well as acid-neutralising minerals (e.g., calcite), compared to coarse rejects. The abundance of carbonate minerals has been calculated to have an overall negative net acid production (i.e., neutralising) for the coarse and fine reject materials.

Table 4-18: Selected XRD results for PTM coarse and fine rejects

Mineral Group	Sample ID	PTM_Coarse Reject_15-21Apr2021	PTM_Fine RejectsU/F_15-21Apr2021
Sulfide	*Pyrite*	0	0.6
	Marcasite	0	0.1
Sulfate	*Jarosite*	0	0
	Bassanite	0	0
Carbonate	*Calcite*	1	2.8
	Ankerite	0.2	0.3
Carbonate Silicate	*Siderite-Mn*	1.3	0.4
	Albite	0	0
	Kaolinite	21.9	26.4
Silicate Oxide	*Muscovite-illite*	0.6	0.8
	Illite-smectite (I-S)	17.1	16.8
	Montmorillonite	0	0
	Orthoclase	0	0
	Quartz	16.3	11.7
	Rutile	0.2	0.2
Oxide Other	*Anatase*	0.8	0.6
	Coal-amorphous	40.6	39.3

5 Management of mine materials

5.1 Spoil

Information presented on overburden and interburden (spoil) material in **Section 4.2** suggests that spoil is essentially barren of sulfur, is classified as NAF-Barren (90 %), or NAF (9 %) and has a high factor of safety with respect to any potential to generate AMD. This data is included in **Attachment B**.

The Late Permian spoil material in the Rangal Coal Measures, in particular, has excess ANC, which is readily available, to adequately buffer the negligible amount of acid that could theoretically be produced from this material. This material is classified as NAF-Barren but may also be considered to be acid consuming. The Permian interburden material covers a depth interval ranging from 8 to 44 m within the stratigraphic profile (**Figure 3-1**) and therefore a large volume of material mined from the open pit has readily available ANC to provide acid buffering. Hence, the Permian spoil materials provide a useful source of acid buffering material and this is further demonstrated in the kinetic leaching results for spoil shown in **Figure 4-7** and discussed in **Section 4.2.4**.

The concentration of total metals in most spoil is typically well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with rehabilitation and final land use. Surface runoff and seepage from spoil is predicted to be slightly alkaline and show relatively low levels of salinity following surface exposure (**Figure 4-3** and **Figure 4-4**), although slight increases in total sulfur and salinity are to be expected in close proximity to coal seams. The concentration of soluble trace metals and major ions in runoff and seepage from spoil is likely to be low, remain within applied water quality guideline criteria, and is unlikely to present any significant environmental risks for on-site or downstream water quality.

In common with most coal mines in the Northern Bowen Basin, some spoil materials are sodic and have a moderate to high dispersion potential. At the PTM, Permian overburden materials are considered the preferred materials for general applications such as rehabilitation, as they appear to be less prone to sodicity and dispersion than weathered sediments and clay spoil (Landloch, 2022) (**Section 4.2.5**).

Spoil management practices are documented in the BHP Coal Landform Design (BHP, 2017). The guideline ensures that final landforms are designed to manage closure landform risk and achieve closure objectives. Final landforms are further discussed in **Section 6**. Apart from the initial box cuts when PTM was first developed, all spoil dumps are in-pit and progressive backfilling occurs as the mining operation proceeds in a westerly direction. The Poitrel Coal Mine Closure Management Plan (CMP) includes an overburden sampling program within the existing landforms (BHP, 2019).

5.2 Coarse and Fine Rejects

The information on coarse rejects and fine rejects materials presented in **Section 4.3** confirms that most of the materials generated from the CHPP are likely to be NAF (71 %) or NAF-Barren (25 %) and have a high factor of safety with respect to any potential to generate AMD.

The concentration of total metals in coarse and fine reject materials is typically below applied guideline criteria for soils. Surface runoff and seepage from NAF materials left exposed to oxidising conditions is likely to be slightly alkaline, with low levels of salinity. The concentration of soluble trace metals and major ions in runoff and seepage from coarse rejects and fine rejects is also expected to be low. Continued geochemical testing was performed between 2017 to 2022 to verify the characteristics of coarse rejects and fine rejects produced by PTM. This data is included in **Attachment C**.

Coal processing of Run of mine (ROM) coal produced at PTM is transported to the Red Mountain Infrastructure (RMI) CHPP, which produces two waste products: i.e., coarse rejects and fine rejects.

Coarse rejects: (coarse screened coal waste) are produced from the spirals/spirals reject dewatering screen and Dense Medium Cyclone via a drain and rinse screen.

Fine Rejects: (thickened fine coal waste material) are produced from the CHPP thickener underflow and are then pumped to one of the following locations:

RMI is owned and operated by Stanmore and is located on the adjoining ML 70312. Coarse rejects and fine rejects are transported by truck back to PTM for co-disposal within spoil dumps in accordance with authorised EA conditions. RMI may process ROM coal originating from sources other than PTM from time to time. The

PTM EA consequently makes provision for the receipt and disposal of coarse rejects and fine rejects and other types of waste from sites including the RMI CHPP (EPML00819113), South Walker Creek Coal Mine (EPML00712313), Isaac Downs Coal Mine (EA0002817), Isaac Plains Coal Mine (EPML00932713), Millennium Coal Mine (EPML00819213), and Vulcan Coal Mine (EA0002912).

The processing of raw coal through the RMI CHPP results in separate coarse and fine rejects streams. Coarse and fine coal rejects are placed in designated reject disposal areas or co-disposed in mine waste spoil dumps. Coal reject disposal locations are broadly distributed within active low-wall spoil dumps.

According to Table D1 of the EA, coal rejects and sediment containing hydrocarbons are authorised to be disposed in spoil emplacements, as well as pits and voids. Fine rejects and water or sediment containing hydrocarbons can be temporarily stored in structures in the overburden for the purpose of dewatering/ evaporation prior to being disposed as coal rejects.

6 Post Mining Land Use and Final Landform

The Poitrel PRCP describes the closure objectives and commitments of PTM and how they will meet those over the full life cycle of the mine. The plan proposes backfilling the open-cut voids where possible with mine waste, placing potentially acid-forming, saline, or sodic materials towards the pit side of the low wall, and eventual encapsulation if necessary.

Existing measures for minimising and managing waste generated by the PTM are in place and will continue to be implemented, including co-disposal of rejects with spoil and temporary storage of fine rejects within overburden structures for drying prior to disposal as per rejects. The objectives of these practices are to minimise risk of adverse geochemical (oxidation and leaching) and geotechnical (landform instability) processes occurring, which have the potential to adversely affect the environment. Placement of coarse rejects and fine rejects within spoil is also controlled by final landform designs whereby disposal locations are planned so that neither material will be within 2m (depth) of reshaped and rehabilitated surfaces.

The rehabilitation strategy shown in **Table 6-1** is indicated as being geotechnically stable, with a Factor of Safety (FOS) ≥1.5. The proposed post mining land use is mixed:

- <15% cattle grazing land use; and
- ≥15% woodland and habitat land use

Table 6-1: Post mining land use details

Landform	Post Mining Land Use Details
Undisturbed area	• Cattle grazing • Woodland habitat • Watercourse • Water storage
Disturbed area (outside of spoil and pit area) – low gradient	• Cattle grazing • Woodland habitat • Watercourse • Water storage
Spoil area (15 % gradient)	• Woodland habitat Note: area based on draft landform and assumption of 15 % gradient
Low wall area (>25 % gradients)	• Woodland habitat Note: area based on draft landform and assumption of >25 % gradient
NUMA	As outlined in EA

7 Environmental issues, impacts and controls

The environmental issues, impacts and controls associated with mining waste materials at PTM are described in **Table 7-1**. The potential for AMD from mine materials is considered to be a minor risk and the following hierarchical of control strategies in order of priority can be categorised as:

- prevention of impact;
- minimisation of impact and/or likelihood through active or passive treatment impact; and
- interception and control of impact.

The control measures will depend on topography, mining method, material type, soil/rock types, mineralogy, and available neutralisation resources. Control measures are documented in **Table 7-1** and have been integrated into the management measures described in **Section 5**.

Table 7-1: Environmental Issues, Impacts and Controls

Potential Issue	Potential Impact	Control Measures
AMD	• Impact on surface water quality from spoil emplacement areas and stockpiles. • Impact on stock, irrigation and domestic groundwater quality/supplies. • Degradation of aquatic ecosystems. • Impact on recreation and aesthetics.	• Minimise exposure coarse and fine rejects material and progressive covering. • Development and communication of coarse and fine rejects disposal areas and methods. • Diversion of run-on water from coarse and fine reject disposal locations. • Minimisation of water pondage on dump surfaces and subsequent infiltration. • Placement of coarse and fine rejects material at least 2 m from final landform with Permian cover to minimise water movement through material and provide neutralising material. • Dewatering of fine rejects and placement in cells/sieves. • Appropriately designed and certified mine waste storage structures. • Disposal locations to be within the in-pit spoil and are internally draining to the mine pit. • Containment of mine affected water including leachate from coal reject disposal locations and coal stockpiles. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Rehabilitation of coal reject disposal areas and coal stockpiles. • Progressive characterisation of mining wastes, specifically coarse and fine rejects. • Tracking of coarse and fine reject disposal locations. • Monitoring of leachate from in-pit disposal locations and coal stockpiles. • Monitoring of groundwater resources, specifically aquifers suitable for human or stock consumption. • Monitoring of upstream reference and downstream impact points for water quality. • Adoption of emergency response plans, including consideration of downstream landholders.
Release of coarse and fine rejects from spoil storage areas	• Release of coarse and fine rejects. • Sediment load increased in drainage lines. • Water quality impact. • Impact of soil, plants and animals..	• Certified design and construction of waste storage facilities. • Routine inspections, monitoring and maintenance of facility and sediment dams.
Interaction of coarse and fine reject with rehabilitation	• Interaction of coarse and fine reject with rehabilitation.	• 2 m buffer maintained from coarse and fine reject locations to the final rehabilitation profile. • Rehabilitation monitoring.
Spoil run-off	• Surface water quality impacts from spoil run-off	• Progressive recontouring and rehabilitation of spoil dumps. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Installation and maintenance of drainage and sediment and erosion control structures to control and treat run-off from spoil piles.

8 Monitoring

Monitoring of water and solid materials forms an important part of the on-site management of mining waste materials and is completed in accordance with the EA, Water Management Plan and this MWCR.

The monitoring program is primarily aimed at managing coarse reject and fine reject materials within spoil dumps and potential impacts to ensure that management practices are appropriate or are modified accordingly. Monitoring is conducted by trained on site personnel or by specialist consultants as engaged by PTM.

Ongoing characterisation of coarse and fine rejects is completed in accordance with relevant site plans and procedures. Leachate from coarse and fine rejects placed at spoil disposal areas is included in the site water quality monitoring program.

On-going characterisation of the coal and mining waste materials (including overburden, interburden, floor, roof and partings) is completed on a project basis in accordance with relevant site plans and procedures.

The routine and project-based PTM monitoring program is described in **Table 8-1**. The monitoring program is revised as part of data and management plan reviews and as more site-specific data becomes available.

On a project basis, drill core/chip samples representing overburden, interburden, coal seam, coal seam roof, parting and floor materials from new areas of the site that are planned to be mined will be taken and subjected to geochemical screening tests according to this MWCR; and selected samples will be subjected to water extract water quality tests and kinetic tests, if required, as described in **Table 8-1**. Some input from an experienced geochemist will be required to assist with the sample selection and testing program and interpretation of results.

Drill core intervals will cover up to 0.5 m whereas drill chip intervals may cover up to 3 m intervals and be limited to a single lithology or material type, where possible, to assist in later interpretation of results. Drill core/chip samples will weigh approximately 1-2 kg and samples will be double bagged and clearly labelled with the sample name and date of collection. A list of all samples collected will be prepared and include the drill hole number, sample depth interval and any visual observations of key minerals (eg. pyrite, calcite). Drill logs will be geophysically corrected and provided to the geochemist interpreting the project based geochemical assessment program.

The drill core/chip samples described above will be stored in a cool dry place prior to being sent to an appropriate commercial laboratory for geochemical characterisation. Each sample batch will be accompanied by a completed laboratory Chain of Custody (COC) form, which identifies the samples and details the analyses required to be completed (**Table 8-1**).

8.1 Monitoring Records

Sampling and characterisation of coal and mining waste from the open pit (overburden, interburden, floor, partings and roof materials) and from coal processing (coarse rejects and fine rejects) is undertaken periodically as part of the monitoring program to assess the risk of AMD associated with any PAF materials. The aim the program is to quantify the characteristics of materials, assess potential impacts and confirm or modify management strategies associated with the material.

Additional monitoring to that described in **Table 8-1** includes routine ground water, regulated structures (TSF) inspections and rehabilitation monitoring.

Monitoring records for coal and mining waste materials are maintained by PTM and stored in the EDMS and include the following:

- Sample date and time;
- Sampler
- Sample location
- Sample source (coal or mine waste material)
- In-situ parameters pH, EC

Table 8-1: Routine and Project-Based PTM Coal, Mining Waste and Water Quality Monitoring Program

Frequency	Sample Source	Sample Point	Analysis	Comments
Quarterly	Processed coal seams	1. Fine rejects thickener underflow 2. Coarse rejects	pH, EC, total sulfur, ANC and Scr. 1:5 water extract water quality (dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4).	Frequency to be reviewed annually.
	ROM Coal	ROM Coal	pH, EC, total sulfur, ANC and Scr.	
Opportunistic	Leachate from coal reject	Leachate from coal reject disposal locations	pH, EC, dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4 (as per EA Table C3).	If possible. Locations to include in-pit cells and pit water.
Project Based	Overburden, interburden, floor, partings and roof of all seams	Overburden, interburden, floor, partings and roof from exploration drill core.	pH, EC, total sulfur and Scr, as required. 1:5 water extract water quality (dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4). Column leach testing as required.	One-off sampling for new project areas to focus on spatial distribution rather than strict timing.
As Required	All sample sources	Additional sampling will be undertaken on an as-needs basis.		

[#]ICPMS/CV FIMS – analytical methods required to achieve laboratory Limit of Reporting (LOR).

8.2 Saline and Sodic Potential

The EA and PRCP guideline requirements include characterisation programs to ensure that both geochemical and physical properties of mining waste materials are progressively characterised. The physical test parameters are typically focussed on rehabilitation. During disposal, spoil material is generally characterised to identify dispersive and non-dispersive spoil and saline drainage potential.

Saline drainage levels in surface runoff and seepage from spoil associated with sodium chloride (NaCl), sodium bi-carbonate ($NaHCO_3$) or sulfate (SO_4^{2-}) can be elevated and may not achieve with water quality targets and limit the ability to release water from site.

Soil and spoil dominated by NaCl or $NaHCO_3$ can be sodic (the clay minerals disperse making them erodible-when the clays settle, and they can have very low permeability) and this can reduce the ability to use the soil or spoil for rehabilitation.

PTM will ensure that a program for sampling and testing of soil and overburden at any new mining areas includes methods which allow identification and management of saline drainage potential and/or sodic potential.

8.3 Integrated Monitoring and Management

Other monitoring that may interact with mining waste management includes groundwater, regulated structures, rehabilitation monitoring and general inspections. Items considered include:

- Water quality – groundwater;
- Water quality – surface water;
- Seepage/leachate production and quality;
- Visual inspections;
- Soil geochemistry; and,
- Vegetation coverage and establishment.

All monitoring results are used to assist with continuous improvement of the mining waste management strategies.

8.4 MWCR Review

The PTM Environment Department is responsible for communicating the outcomes of coal and mine waste characterisation and review programs, to site personnel and contractors. Reviews will be undertaken by the PTM Environment Department and/or a suitably qualified specialist consultants on a three-yearly basis. If management practices are not effective, changes to the management will be made and implemented.

In addition to the PTM review process described above, additional reviews will occur on an ‘as needs’ basis if mining waste management issues arise. Reviews will include consideration of monitoring results. Any changes in operational practices will be incorporated into the documentation and communicated to responsible employees and contractors.

Suitable criteria to establish whether mining waste management practices are effective are as follows:

- no complaints in relation to coal and mine waste management;
- full compliance with the requirements of this MWCR;
- no uncontrolled release of contaminated leachate; and
- continual improvement in coal and mine waste management practices.

All matters relating to coal and mine waste are referred to and managed by the PTM Environment Department.

All relevant personnel employed at MCM will undergo training in relation to coal and mine waste management.

9 Certification

As described in **Section 1.5**, RGS certifies that this MWCR is feasible and would meet the intent of the EA conditions (i.e., the MWCR will enable PTM to continue to progressively characterise, mine and place the mined materials so that their potential to contribute to (or to mitigate) environmental harm can be determined. The Qualifications of the RGS personnel suitably qualified to certify this MWCR are provided below.

9.1 Suitably Qualified Persons – RGS Company Details

The core business of RGS is to undertake static and kinetic chemical and physical material characterisation studies and produce certified mine material, mine rehabilitation and mine closure plans that include sampling, analytical and monitoring programs.

RGS is an owner-operated leading environmental consulting company that has been operating successfully for the past seventeen years. We provide timely and cost-effective solutions to complex environmental management issues from exploration through the planning, operational and closure phases of small to large scale mining projects. RGS has gained an international reputation as a leading provider of environmental management services to the mining and mineral processing industry and takes pride in being flexible, practical and innovative. RGS is committed to delivering on time and within budget; technical excellence; consistent quality; and continual improvement of our service delivery and skills.

RGS personnel have provided services to more than 600 mining and mineral processing projects in Algeria, Argentina, Australia, Bangladesh, Brazil, China, Ghana, India, Indonesia, Laos, Malaysia, Mozambique, New Caledonia, New Zealand, Papua New Guinea, Philippines, Romania, Thailand, Turkey and Vietnam. RGS has worked on more than 100 coal mine projects in Queensland, New South Wales, Western Australia, Africa, New Zealand, Indonesia, Laos and Bangladesh. Our clients range from small to large mining companies including Anglo American, BHP Billiton, CS Energy, Evolution Mining, MMG, Rio Tinto, Stanwell Corporation, Vale and Glencore.

9.2 Suitably Qualified Persons – Relevant Experience

RGS Personnel

Alan Robertson has a PhD in Pure and Applied Chemistry and has over 30 years' experience completing geochemical studies for the mining and mineral processing industry. He has worked on projects for major mining companies (*e.g.,* Anglo American, BHP Billiton, Glencore and Vale) in Australia, Asia, Africa, Europe and South America for both coal and hard rock mines. Alan has expertise in mine waste characterisation, development of AMD management plans, and design of mine waste storage facilities from conception through to closure. Alan is regularly engaged directly by Regulators to provide independent environmental advice on mine closure and rehabilitation aspects of mining operations.

Matt Landers Matt has a PhD in Geochemistry and Soil mineralogy over 16 years' consulting experience in project management, development, implementation, and delivery of geochemical programs for mining and energy industries and holds current S11 and S1, S2, and S3 certifications required in Queensland. Matt specialises in the hydro-geochemical characterisation of mine waste and development of solutions to mine waste and water management for projects from concept through to closure. Matt has extensive experience in constructing water balance models using GoldSim and hydro-geochemical models (Geochemist's Workbench and PHREEQC) for the assessment of acid and metalliferous/ saline drainage, surface and groundwater quality assessments, waste storage facility seepage investigations, pit lake water quality and aquifer re-injection trials.

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11 Attachments

Attachment A: Soil quality sampling locations and data

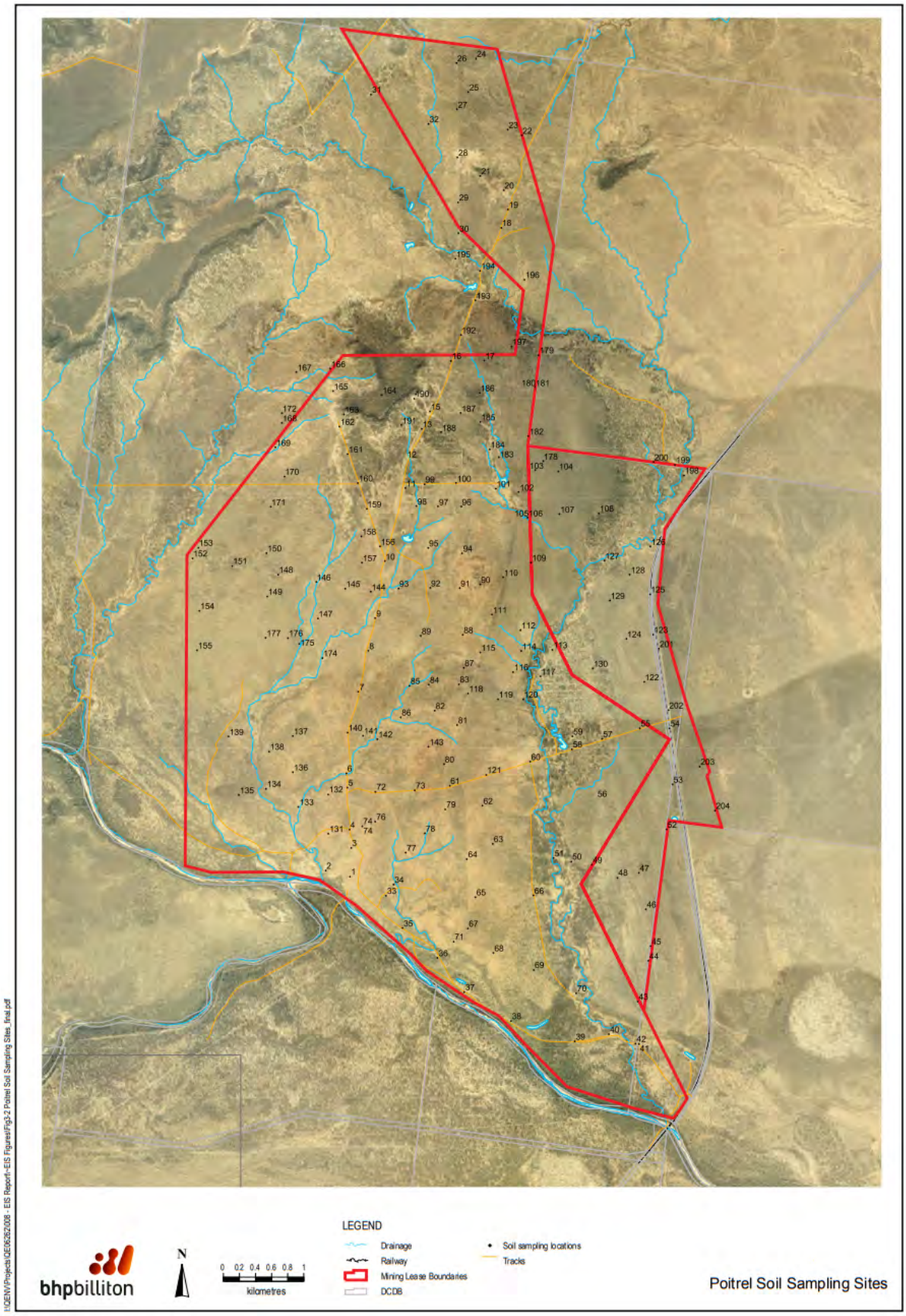

Figure 11-1: Pre-mining soil sampling locations (2005)

Table 11-1: Geochemical and physical soil data for Site 39 (Type: A1)

Chemical Analysis: Site 39

Analyte	0-10 cm	Comment	80-90 cm	Comment
NO3-N ppm	2.9	very low		
P (Olsen) ppm	10	low (adequate)		
K meq/100g	0.42	moderate - ok	0.15	very low
Mg meq/100g	0.99	ok	0.63	very low
Ca meq/100g	2.66	high	1.54	low
S ppm	3	very low		
Mn ppm	25.4	moderate		
B ppm	-0.1	very low		
Cu ppm	0.2	low		
Fe ppm	30	mod high		
Zn ppm	0.7	moderate		
OM %	0.7	low		
CEC meq/100g	4.51	very low	2.63	very low
Ca/Mg ratio	2.69	ok	2.44	ok
pH(H20)	6.6	neutral	7.8	slightly alkaline
EC dS/m	0.03	very low	0.03	very low
Al meq/100g	0.13	ok	0.10	ok
Cl ppm	10	very low		
Na meq/100g	0.31	very low	0.21	very low
ESP	6.9	Weak	8.0	moderate
R1 dispersion	0.84	Elevated but of little concern as soil is coarse sand. If >0.6, clay soils tend to lose aggregation, form crusts, surface sealing with increased runoff.		

Particle Size Analysis: Site 39

Coarse Sand%	Fine Sand%	Silt%	Clay %	Comments
51	41	3	5	A classic coarse sand. Highly permeable and loose structure.

Table 11-2: Geochemical and physical soil data for Site 41 (Type: A2)

Chemical Analysis: Site 41

Analyte	0-10 cm	Comment	50-60 cm	Comment
NO3-N ppm	3.7	very low		
P (Olsen) ppm	2	very low		
K meq/100g	0.28	adequate	1.11	
Mg meq/100g	1.40	low	9.74	
Ca meq/100g	3.75	moderate	27.72	
S ppm	2	low		
Mn ppm	8.9	moderate		
B ppm	-0.1	very low		
Cu ppm	0.3	low		
Fe ppm	27	moderate		
Zn ppm	0.3	low		
OM %	0.9	low		
CEC meq/100g	5.71	very low	42.43	good
Ca/Mg ratio	2.68	good	2.85	good
pH(CaCl2)	5.8	neutral		
pH(H20)	6.4	neutral	8.3	
EC dS/m	0.02	very low	**1.00**	**highly saline**
Al meq/100g	0.10	ok	0.21	ok
Cl ppm	9	very low		
Na meq/100g	0.18	very low	3.65	low - moderate
ESP	3	non dispersive	8.6	moderate
Dispersion R1	0.72	Ok as soil dominated by sands		

Particle Size Analysis 0-10cm: Site 41

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comment
18	65	8	11	Predominantly sand dominated by fine fraction which may compact into hard mass predisposing high runoff.

Table 11-3: Geochemical and physical soil data for Site 9 (Type: A3)

Chemical Analysis: Site 9

Analyte	0-10 cm	Comment	40-50 cm	Comment	80-90 cm	Comment
NO3-N ppm	59.4	high				
P (Olsen) ppm	2	very low				
K meq/100g	0.79	high	0.54	high	0.39	
Mg meq/100g	3.25	high	13.70	very high	3.15	high
Ca meq/100g	11.06	high	27.60	very high	9.55	high
S ppm	6	low				
Mn ppm	33.1	medium				
B ppm	0.2	low				
Cu ppm	1.4	low				
Fe ppm	30	high				
Zn ppm	0.6	adequate				
OM %	3.7	high				
CEC meq/100g	15.88	moderate	46.09	high	13.73	moderate
Ca/Mg ratio	3.40	ok	2.01	ok	3.03	ok
pH(H20)	6.2	neutral	7.3	neutral	9.1	
EC dS/m	0.16	low	0.43	non-saline	**0.68**	**saline**
Al meq/100g	0.36	non limiting	0.17	non limiting	0.12	non limiting
Cl ppm	54	very low				
Na meq/100g	0.42	very low	**4.08**	**moderate**	0.52	very low
ESP	4	ok	**8.85**	**moderate**	3.8	ok
R1 dispersion	0.46	ok				

Particle Size Analysis 0-10cm: Site 9

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comments
11	30	29	34	Soils with proportions of fine sand and silt exceeding 50% tend to exhibit more severe physical problems leading to sealing and coarse, hard structure.

Table 11-4: Geochemical and physical soil data for Site 1 (Type: B1)

Chemical Analysis: Site 1

Analyte	0-10 cm	Comment	40-50 cm	Comment	60-70 cm	Comment
NO3-N ppm	23.5	high				
P (Olsen) ppm	3	very low				
K meq/100g	1.39	low	0.88	very low	0.34	very low
Mg meq/100g	1.96	adequate	3.94	high	4.39	high
Ca meq/100g	11.00	high	14.81	high	12.73	high
S ppm	8	low				
Mn ppm	60.3	high				
B ppm	0.8	low				
Cu ppm	0.8	moderate				
Fe ppm	13	moderate				
Zn ppm	0.5	low				
OM %	1.9	ok				
CEC meq/100g	14.87	moderate	20.18	moderate	18.23	moderate
Ca/Mg ratio	5.61	good	3.76	good	2.90	good
pH(H20)	6.9	neutral	7.8	slight alkaline	7.4	slight alkaline
EC dS/m	0.09	very low	0.06	very low	0.03	very low
Al meq/100g	0.11	ok	0.17	ok	0.38	ok
Cl ppm	25	very low				
Na meq/100g	0.41		0.38		0.39	
ESP	2.8	good	1.9	good	2.1	good

Particle Size Analysis 0-10cm: Site 1

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comments
17	28	12	46	Overall, no problems are indicated. Fine sand content may facilitate some degree of sealing and hardsetting but not severe

Table 11-5: Geochemical and physical soil data for Site 90 (Type: B2)

Chemical Analysis: Site 90

Analyte	0-10 cm	Comment	30-40 cm	Comment
NO3-N ppm	116.2	Very high		
P (Olsen) ppm	19	adequate		
K meq/100g	3.01	high	0.92	moderate
Mg meq/100g	1.78	adequate	2.67	high
Ca meq/100g	6.62	high	9.31	high
S ppm	34	high		
Mn ppm	58.7	high		
B ppm	0.4	low		
Cu ppm	1.1	moderate		
Fe ppm	33	moderate		
Zn ppm	3.7	low		
OM %	2.8	ok		
CEC meq/100g	12.36	moderate - low	14.02	moderate
Ca/Mg ratio	3.72	good	3.49	good
pH(H20)	6.5	neutral	6.6	neutral
EC dS/m	0.42	non saline	0.11	non saline
Al meq/100g	0.44	ok	0.34	ok
Cl ppm	161	low		
Na meq/100g	0.51	low	0.78	low
ESP	4.1	low	5.6	ok
R1 dispersion	0.52	Slight tendency for sealing and crusting		

Particle Size Analysis 0-10cm: Site 90

Coarse Sand%	Fine Sand%	Silt%	Clay%	comment
12	54	10	26	Soils with proportions of fine sand and silt exceeding 50% in the presence of about 30% clay tend to exhibit sealing and coarse, hard structure.

Table 11-6: Geochemical and physical soil data for Site 18 (Type: B3)

Chemical Analysis: Site 18

Analyte	0-10 cm	Comment	40-50 cm	Comment	80-90 cm	Comment
NO3-N ppm	15.2	Moderate				
P (Olsen) ppm	6	low				
K meq/100g	1.03	ok	0.67	ok	0.66	ok
Mg meq/100g	5.60	ok	16.79	ok	9.66	ok
Ca meq/100g	22.15	ok	16.70	ok	13.60	ok
S ppm	6	low				
Mn ppm	41.9	high				
B ppm	0.8	adequate				
Cu ppm	1.6	moderate				
Fe ppm	28	moderate				
Zn ppm	1.2	ok				
OM %	4.9	good				
CEC meq/100g	30.02	good	38.77	good	28.05	good
Ca/Mg ratio	3.96	good	0.99	ok	1.41	ok
pH(H20)	7.6	slight alkaline	**9.0**	**high alkaline**	**9.0**	**high alkaline**
EC dS/m	0.12	low	**0.74**	**saline**	**1.13**	**highly saline**
Al meq/100g	0.30		0.20		0.04	
Cl ppm	22					
Na meq/100g	0.94		4.41		4.09	
ESP	3.1	low	**11.4**	**possible problem**	**14.6**	**sodic**
Dispersion R1	0.33	no problems indicated				

Particle Size Analysis 0-10cm: Site 18

Coarse Sand%	Fine Sand%	Silt%	Clay%	comments
12	28	20	44	Well balanced physical make-up overall. Slight tendency to crust.

Table 11-7: Geochemical and physical soil data for Site 24 (Type: B3v)

Chemical Analysis: Site 24

Analyte	0-10 cm	Comment	40-50 cm	Comment
NO3-N ppm	20.6	good		
P (Olsen) ppm	-1	very low		
K meq/100g	0.93	ok	0.15	low
Mg meq/100g	7.75	high	0.68	ok
Ca meq/100g	29.89	high	1.66	low
S ppm	9	low		
Mn ppm	21.9	moderate		
B ppm	2.3	moderate		
Cu ppm	1.1	moderate		
Fe ppm	17	ok		
Zn ppm	-0.1	v low		
OM %	2.4	ok		
CEC meq/100g	41.63	high	2.74	very low
Ca/Mg ratio	3.86	good	2.44	good
pH(H20)	8.4	alkaline	**9.0**	**highly alkaline**
EC dS/m	**0.54**	**almost 'saline'**	**0.77**	**saline**
Al meq/100g	0.26	ok	0.08	ok
Cl ppm	**698**	**becoming high**		
Na meq/100g	2.80	ok – non sodic	0.17	non sodic
ESP	6.7	ok	6.3	ok
Dispersion R1	0.45	ok		

Particle Size Analysis 0-10cm: Site 24

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comment
8	22	21	53	Tendency to form sandy crust.

Table 11-8: Geochemical and physical soil data for Site 178 (Type: B4)

Chemical Analysis: Site 178

Analyte	0-10 cm	Comment	40-50 cm	Comment	80-90 cm	Comment
NO3-N ppm	13.6	Adequate				
P (Olsen) ppm	1	very low				
K meq/100g	1.93	Ok	1.41	ok	1.31	ok
Mg meq/100g	7.80	Ok	8.79	ok	10.00	ok
Ca meq/100g	34.66	Ok	55.65	ok	50.66	ok
S ppm	7	Ok				
Mn ppm	52.2	Ok				
B ppm	0.9	Ok				
Cu ppm	2.6	Ok				
Fe ppm	34	Ok				
Zn ppm	0.2	very low				
OM %	4.5					
CEC meq/100g	45.18	High	67.21	high	64.29	high
Ca/Mg ratio	4.44	very good	6.33	very good	5.07	very good
pH(H20)	7.5	Neutral	8.6		8.9	
EC dS/m	0.11	Low	0.15	low	0.15	low
Al meq/100g	0.18	Ok	0.07	ok	0.16	ok
Cl ppm	31	very low				
Na meq/100g	0.61	Low	1.29	low	2.16	low
ESP	1.3	very low	1.9	very low	3.4	very low
Dispersion R1	0.29	Low				

Particle Size Analysis 0-10cm: Site 178

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comment
7	22	16	59	Good overall soil.

Table 11-9: Geochemical and physical soil data for Site 43 (Type: B5)

Chemical Analysis: Site 43

Analyte	0-10 cm	Comment	30-40 cm	Comment	80-90 cm	Comment
NO3-N ppm	20.4	good				
P (Olsen) ppm	2	low				
K meq/100g	1.74	ok	1.03	ok	1.10	ok
Mg meq/100g	5.80	ok	10.14	ok	10.91	ok
Ca meq/100g	27.31	ok	31.04	ok	22.85	ok
S ppm	9	ok				
Mn ppm	67.6	ok				
B ppm	2.3	ok				
Cu ppm	0.9	ok				
Fe ppm	26	ok				
Zn ppm	0.3	very low				
OM %	3.9	good				
CEC meq/100g	36.31	good	46.43	good	39.51	good
Ca/Mg ratio	4.71	good	3.06	good	2.09	good
pH(H20)	7.9	slight alk	**9.0**	**high alk**	8.6	mod alk
EC dS/m	0.15	low	**0.52**	**almost saline**	**1.19**	**highly saline**
Al meq/100g	0.45	ok	0.13	ok	0.13	ok
Cl ppm	14	low				
Na meq/100g	1.01	low	4.09	moderate	4.52	moderate
ESP	2.8	low	**9.0**	**slight sodic**	**11.4**	**mod sodic**
R1 dispersion	0.39	ok				

Particle Size Analysis: Site 43

Coarse Sand%	Fine Sand%	Silt%	Clay%	comment
12	30	16	46	Overall quite good range. Increasing fine sand may tend to coarser structure.

Table 11-10: Geochemical and physical soil data for Site 11 (Type: E1)

Chemical Analysis: Site 11

Analyte	0-10 cm	Comment	40-50 cm	Comment	70-80 cm	Comment
NO3-N ppm	15.1	moderate				
P (Olsen) ppm	5	low				
K meq/100g	0.78	ok	0.29	low	0.60	ok
Mg meq/100g	1.52	low	3.88	ok	13.72	high
Ca meq/100g	8.47	ok	6.80	ok	21.79	high
S ppm	5	low				
Mn ppm	31.2	ok				
B ppm	0.4	low				
Cu ppm	0.9	ok				
Fe ppm	32	ok				
Zn ppm	1.0	ok				
OM %	3.1	good				
CEC meq/100g	11.34	low	11.84	low	40.23	good
Ca/Mg ratio	5.57	good	1.75	ok	1.59	ok
pH(H20)	6.9	neutral	8.0	alk	7.9	alk
EC dS/m	0.09	low	0.08	low	0.06	low
Al meq/100g	0.26	ok	0.25	ok	0.12	ok
Cl ppm	26	low				
Na meq/100g	0.31	low	0.62		4.00	
ESP	2.7	ok	5.2	ok	**9.9**	**possible problem**
R1	0.77	ok as soil mainly sand				

Particle Size Analysis 0-10cm: Site 11

Coarse Sand%	Fine Sand%	Silt%	Clay%	comment
33	37	15	19	fine sand & silt (with 19% clay) predisposes hard setting and sealing

Table 11-11: Geochemical and physical soil data for Site 5 (Type: E3)

Chemical Analysis: Site 5

Analyte	0-10 cm	Comment	30-40 cm	Comment
NO3-N ppm	19.8	adequate		
P (Olsen) ppm	-1	extremely low		
K meq/100g	0.65	ok	0.66	ok
Mg meq/100g	3.23	ok	5.55	high
Ca meq/100g	15.32	ok	32.29	high
S ppm	5	low		
Mn ppm	26.2	moderate		
B ppm	0.8	low		
Cu ppm	0.8	moderate		
Fe ppm	14	moderate		
Zn ppm	-0.1	very low		
OM %	3.5	good		
CEC meq/100g	19.87	moderate	39.29	good
Ca/Mg ratio	4.74	good	5.82	good
pH(H20)	7.2	neutral	8.4	
EC dS/m	0.09	very low	0.09	very low
Al meq/100g	0.10	ok	0.05	ok
Cl ppm	26	very low		
Na meq/100g	0.57	very low	0.74	
ESP	2.9	non sodic	1.9	non sodic
Dispersion R1	0.28	no problems indicated		

Particle Size Analysis 0-10cm: Site 5

Coarse Sand%	Fine Sand%	Silt%	Clay%	Comments
24	39	12	28	Soils with proportions of fine sand and silt exceeding 50% in the presence of about 30% (as this soil is) tend to exhibit sealing and coarse, hard structure.

Figure 11-2: Topsoil stockpile sampling locations (2022)

Table 11-12: Laboratory analysis data for topsoil stockpiles (page 1 of 4)

	Lab No	220726-5		220726-9		220726-13		220726-17		220726-21		220726-25	
	Sample ID	st40a		st47		st48a		st48b		st40b		st6b	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		SCL		SCL		SL		CL		LMC	
Analyses	**Unit**												
pH - Water	pH units	8.48	*M.Alk*	7.21	*Neutral*	6.91	*Neutral*	8.45	*M.Alk*	8.22	*M.Alk*	8.42	*M.Alk*
Electrical Conductivity	dS/m	0.26	*M.Sal*	0.12	*L.Sal*	0.14	*L.Sal*	0.12	*L.Sal*	0.15	*L.Sal*	0.28	*M.Sal*
Chloride	mg/kg	59.4	*VL.Sal*	47.3	*VL.Sal*	58.2	*VL.Sal*	32.2	*VL.Sal*	53.1	*VL.Sal*	69.0	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	996.0	*L*	430.0	*VL*	471.0	*VL*	396.0	*VL*	974.0	*L*	1331.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	202.0	*	188.0	*	186.0	*	168.0	*	230.0	*	218.0	*
Phosphorus - Colwell extr	mg/kg	11.3	*L*	14.0	*L*	5.6	*L*	3.9	*L*	5.4	*L*	8.09	*L*
Potassium - Colwell ext	mg/kg	167.00	*L*	222.00	*M*	145.00	*L*	124.00	*L*	102.00	*VL*	106.00	*VL*
Sulphur - KCl	mg/kg	9.3	*M*	7.6	*L*	11.4	*M*	7.3	*L*	5.8	*L*	11.4	*M*
Organic Carbon	%	1.30	*M*	0.60	*L*	0.83	*L*	0.29	*EL*	1.40	*M*	1.36	*M*
Copper	mg/kg	1.08	*M*	0.66	*M*	0.66	*M*	0.34	*M*	1.06	*M*	1.26	*M*
Iron	mg/kg	8.48	*	14.10	*	12.00	*	5.46	*	7.64	*	5.32	*
Manganese	mg/kg	5.60	*M*	12.40	*M*	9.06	*M*	5.86	*M*	10.40	*M*	6.54	*M*
Zinc	mg/kg	0.32	*L*	0.34	*L*	2.32	*M*	0.20	*VL*	0.36	*L*	0.26	*VL*
Boron	mg/kg	0.96	*L*	0.40	*VL*	0.36	*VL*	0.20	*VL*	0.64	*L*	0.90	*L*
Cation Extraction Method	Rayment& Lyons	15C1	*	15A1	*	15A1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	19.3	*M*	8.0	*L*	5.8	*VL*	6.5	*L*	15.6	*M*	24.2	*M*
Ex Calcium Percent	%	68.38	*Normal*	69.34	*Normal*	72.43	*Normal*	78.34	*Normal*	70.25	*Normal*	75.23	*Normal*
Ex Magnesium Percent	%	25.32	*H*	23.20	*H*	19.81	*H*	15.05	*H*	24.18	*H*	20.01	*H*
Ex Potassium Percent	%	1.42	*Normal*	3.81	*Normal*	4.64	*Normal*	3.68	*Normal*	1.25	*Normal*	1.00	*L*
Ex Sodium Percent	%	4.82	*N.Sodic*	3.5	*N.Sodic*	2.9	*N.Sodic*	2.76	*N.Sodic*	4.25	*N.Sodic*	3.71	*N.Sodic*
Ex Aluminium Percent	%	0.06	*VL*	0.14	*VL*	0.19	*VL*	0.17	*VL*	0.07	*VL*	0.05	*VL*
Exchangeable Calcium	meq/100g	13.19	*H*	5.56	*M*	4.21	*L*	5.08	*M*	10.99	*H*	18.24	*H*
Exchangeable Magnesium	meq/100g	4.88	*H*	1.86	*M*	1.15	*M*	0.98	*L*	3.78	*H*	4.85	*H*
Exchangeable Potassium	meq/100g	0.27	*L*	0.31	*M*	0.27	*L*	0.24	*L*	0.20	*VL*	0.24	*L*
Exchangeable Sodium	meq/100g	0.93	*H*	0.28	*L*	0.17	*L*	0.18	*L*	0.67	*M*	0.90	*H*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*
Calcium/Magnesium Ratio	-	2.7	*Low Ca*	3.0	*Low Ca*	3.7	*Low Ca*	5.2	*Balanced*	2.9	*Low Ca*	3.8	*Low Ca*
Emerson Aggregate	Class	7.0	*Stable*	3b	*Slight Disp*	5.0	*Slaking*	3b	*Slight Disp*	7.0	*Stable*	7	*Stable*
Phosphorus Buffer Index	mg/kg	93.2	*	51.7	*	37.9	*	21.1	*	83.8	*	105	*

Table 11-13: Laboratory analysis data for topsoil stockpiles (page 2 of 4)

	Lab No	220726-29		220726-33		220726-37		220726-41		220726-44		220726-48	
	Sample ID	st6c		st11		st38		st27		st52		st20	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		MC		LMC		ZCL		MC		LMC	
Analyses	Unit												
pH - Water	pH units	8.45	M.Alk	8.37	M.Alk	8.11	M.Alk	7.26	Neutral	8.11	M.Alk	8.39	M.Alk
Electrical Conductivity	dS/m	0.15	L.Sal	0.17	L.Sal	0.25	M.Sal	0.21	M.Sal	0.15	L.Sal	0.22	L.Sal
Chloride	mg/kg	22.4	VL.Sal	23.4	VL.Sal	129.0	L.Sal	41.8	VL.Sal	32.0	VL.Sal	93.8	VL.Sal
Total Nitrogen - Kjeldahl	mg/kg	720.0	L	1008.0	L	889.0	L	1308.0	L	1384.0	L	999.0	L
Total Phosphorus - Nitric/Perchloric	mg/kg	179.0	*	172.0	*	189.0	*	227.0	*	208.0	*	210.0	*
Phosphorus - Colwell extr	mg/kg	6.06	L	6.69	L	4.93	L	8.34	L	8.21	L	7.75	L
Potassium - Colwell ext	mg/kg	83.70	VL	99.40	VL	87.40	VL	364.00	H	146.00	L	107.00	VL
Sulphur - KCl	mg/kg	5.7	L	7.3	L	8.9	M	12.4	H	7.6	L	9.8	M
Organic Carbon	%	0.76	L	1.27	M	1.09	M	1.58	M	1.82	H	1.19	M
Copper	mg/kg	0.9	M	1.08	M	0.8	M	0.67	M	0.7	M	1.02	M
Iron	mg/kg	6.94	*	7.92	*	8.14	*	12.30	*	5.82	*	4.80	*
Manganese	mg/kg	5.94	M	6.94	M	8.54	M	14.40	M	6.42	M	6.18	M
Zinc	mg/kg	2.22	M	0.22	VL	0.34	L	0.80	M	0.34	L	0.44	L
Boron	mg/kg	0.64	L	<0.20	FALSE	0.54	L	0.42	VL	<0.20	FALSE	1.04	M
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15A1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	16.0	M	24.6	M	14.0	M	11.7	L	18.7	M	17.9	M
Ex Calcium Percent	%	81.01	H	75.36	Normal	74.37	Normal	74.11	Normal	77.53	Normal	68.83	Normal
Ex Magnesium Percent	%	15.45	H	21.18	H	20.14	H	18.63	H	17.98	H	25.26	H
Ex Potassium Percent	%	1.13	Normal	0.87	L	1.34	Normal	5.86	H	1.64	Normal	1.15	Normal
Ex Sodium Percent	%	2.34	N.Sodic	2.54	N.Sodic	4.07	N.Sodic	1.3	N.Sodic	2.79	N.Sodic	4.69	N.Sodic
Ex Aluminium Percent	%	0.07	VL	0.05	VL	0.08	VL	0.09	VL	0.06	VL	0.06	VL
Exchangeable Calcium	meq/100g	12.94	H	18.56	H	10.40	H	8.69	M	14.52	H	12.31	H
Exchangeable Magnesium	meq/100g	2.47	M	5.22	H	2.82	M	2.18	M	3.37	H	4.52	H
Exchangeable Potassium	meq/100g	0.18	VL	0.21	L	0.19	VL	0.69	M	0.31	M	0.21	L
Exchangeable Sodium	meq/100g	0.37	M	0.63	M	0.57	M	0.15	L	0.52	M	0.84	H
Exchangeable Aluminium	meq/100g	0.01	H	0.01	H	0.01	H	0.01	H	0.01	H	0.01	H
Calcium/Magnesium Ratio	-	5.2	Balanced	3.6	Low Ca	3.7	Low Ca	4.0	Low Ca	4.3	Balanced	2.7	Low Ca
Emerson Aggregate	Class	7	Stable	7	Stable	7	Stable	7	Stable	7	Stable	5	Slaking
Phosphorus Buffer Index	mg/kg	88.9	*	126	*	64.7	*	55.9	*	88.1	*	78.9	*

Table 11-14: Laboratory analysis data for topsoil stockpiles (page 3 of 4)

	Lab No	220726-52		220726-56		220726-60		220726-64		220726-68		220726-72	
	Sample ID	st12		st.2		st.41		st43a		st43b		st1	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		CL		LMC		SCL		SCL		MC	
Analyses	**Unit**												
pH - Water	pH units	7.09	*Neutral*	7.6	*L.Alk*	7.58	*L.Alk*	8.4	*M.Alk*	8.05	*M.Alk*	7.68	*L.Alk*
Electrical Conductivity	dS/m	0.2	*L.Sal*	0.14	*L.Sal*	0.09	*VL.Sal*	0.17	*L.Sal*	0.13	*L.Sal*	0.12	*L.Sal*
Chloride	mg/kg	82.0	*VL.Sal*	68.3	*VL.Sal*	39.9	*VL.Sal*	59.4	*VL.Sal*	64.2	*VL.Sal*	35.3	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	795.0	*L*	991.0	*L*	270.0	*VL*	986.0	*L*	550.0	*L*	877.0	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	304.0	*	329.0	*	177.0	*	201.0	*	185.0	*	252.0	*
Phosphorus - Colwell extr	mg/kg	8.85	*L*	11.9	*L*	15.5	*L*	8.47	*L*	6.56	*L*	6.31	*L*
Potassium - Colwell ext	mg/kg	79.50	*VL*	113.00	*L*	120.00	*L*	104.00	*VL*	117.00	*L*	150.00	*L*
Sulphur - KCl	mg/kg	22.7	*VH*	14.7	*H*	7.5	*L*	12.3	*H*	9.9	*M*	12.1	*H*
Organic Carbon	%	1.04	*M*	1.1	*M*	0.57	*VL*	1.27	*M*	0.83	*L*	1	*M*
Copper	mg/kg	1.18	*M*	1.32	*M*	0.64	*M*	1.02	*M*	0.68	*M*	0.96	*M*
Iron	mg/kg	15.00	*	14.80	*	10.20	*	7.38	*	6.52	*	7.37	*
Manganese	mg/kg	12.40	*M*	14.20	*M*	16.20	*M*	8.38	*M*	8.24	*M*	16.80	*M*
Zinc	mg/kg	0.52	*L*	0.64	*L*	0.26	*VL*	0.34	*L*	0.34	*L*	0.46	*L*
Boron	mg/kg	0.56	*L*	0.66	*L*	0.58	*L*	0.64	*L*	0.74	*L*	0.54	*L*
Cation Extraction Method	Rayment& Lyons	15A1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	12.2	*M*	10.1	*L*	5.5	*VL*	15.9	*M*	10.5	*L*	13.6	*M*
Ex Calcium Percent	%	73.03	*Normal*	77.77	*Normal*	69.39	*Normal*	77.41	*Normal*	77.06	*Normal*	86.00	*H*
Ex Magnesium Percent	%	20.75	*H*	16.93	*H*	22.13	*H*	17.31	*H*	17.23	*H*	10.51	*Normal*
Ex Potassium Percent	%	1.90	*Normal*	2.06	*Normal*	3.92	*Normal*	1.45	*Normal*	2.18	*Normal*	2.22	*Normal*
Ex Sodium Percent	%	4.2	*N.Sodic*	3.13	*N.Sodic*	4.36	*N.Sodic*	3.75	*N.Sodic*	3.42	*N.Sodic*	1.20	*N.Sodic*
Ex Aluminium Percent	%	0.09	*VL*	0.11	*VL*	0.20	*VL*	0.07	*VL*	0.11	*VL*	0.08	*VL*
Exchangeable Calcium	meq/100g	8.95	*M*	7.89	*M*	3.82	*L*	12.30	*H*	8.13	*M*	11.73	*H*
Exchangeable Magnesium	meq/100g	2.54	*M*	1.72	*M*	1.22	*M*	2.75	*M*	1.82	*M*	1.43	*M*
Exchangeable Potassium	meq/100g	0.23	*L*	0.21	*L*	0.22	*L*	0.23	*L*	0.23	*L*	0.30	*M*
Exchangeable Sodium	meq/100g	0.52	*M*	0.32	*M*	0.24	*L*	0.60	*M*	0.36	*M*	0.16	*L*
Exchangeable Aluminium	meq/100g	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*	0.01	*H*
Calcium/Magnesium Ratio	-	3.5	*Low Ca*	4.6	*Balanced*	3.1	*Low Ca*	4.5	*Balanced*	4.5	*Balanced*	8.2	*Low Mg*
Emerson Aggregate	Class	7	*Stable*	7	*Stable*	3b	*Slight Disp*	7	*Stable*	7	*Stable*	4	*Slaking*
Phosphorus Buffer Index	mg/kg	51.4	*	64.9	*	51.5	*	89.2	*	59.6	*	71.8	*

Table 11-15: Laboratory analysis data for topsoil stockpiles (page 3 of 4)

	Lab No	220726-76		220726-80		220726-84		Mean		Min	Max
	Sample ID	st17a		st17b		st13					
	Sample Depth (m)	Composite		Composite		Composite					
	Field Texture	MC		LMC		MC					
Analyses	Unit										
pH - Water	pH units	8.45	M.Alk	8.49	M.Alk	7.85	L.Alk	8.0	M.Alk	6.9	8.5
Electrical Conductivity	dS/m	0.22	L.Sal	0.18	L.Sal	0.17	L.Sal	0.17	L.Sal	0.09	0.28
Chloride	mg/kg	85.9	VL.Sal	69.6	VL.Sal	38.1	VL.Sal	57	VL.Sal	22	129
Total Nitrogen - Kjeldahl	mg/kg	931.0	L	552.0	L	891.0	L	845	L	270	1384
Total Phosphorus - Nitric/Perchloric	mg/kg	192.0	*	192.0	*	224.0	*	211	*	168	329
Phosphorus - Colwell extr	mg/kg	3.93	L	3.68	L	14.3	L	8		4	16
Potassium - Colwell ext	mg/kg	81.90	VL	76.20	VL	104.00	VL	129		76	364
Sulphur - KCl	mg/kg	9.4	M	10.1	M	8.7	M	10.09	M	5.71	22.70
Organic Carbon	%	1.05	M	0.91	L	1.01	M	1.06	M	0.29	1.82
Copper	mg/kg	0.88	M	0.68	M	0.88	M	0.88	M	0.34	1.32
Iron	mg/kg	5.60	*	4.87	*	6.16	*	8	*	5	15
Manganese	mg/kg	5.38	M	4.54	M	8.24	M	9.17	M	4.54	16.80
Zinc	mg/kg	0.26	VL	0.22	VL	0.30	L	0.55	L	0.20	2.32
Boron	mg/kg	0.92	L	1.02	M	0.80	L	0.66	L	0.20	1.04
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	*	*	*	*
Cation Exchange Capacity	meq/100g	22.0	M	15.3	M	13.1	M	14.3	M	5.5	24.6
Ex Calcium Percent	%	69.80	Normal	70.59	Normal	76.70	Normal	74.4	Normal	68.4	86.0
Ex Magnesium Percent	%	24.05	H	23.99	H	18.89	H	19.9	H	10.5	25.3
Ex Potassium Percent	%	1.15	Normal	1.24	Normal	1.71	Normal	2.2	Normal	0.9	5.9
Ex Sodium Percent	%	4.94	N.Sodic	4.11	N.Sodic	2.62	N.Sodic	3.4	N.Sodic	1.2	4.9
Ex Aluminium Percent	%	0.05	VL	0.07	VL	0.08	VL	0.1	VL	0.0	0.2
Exchangeable Calcium	meq/100g	15.36	H	10.82	H	10.09	H	10.7	H	3.8	18.6
Exchangeable Magnesium	meq/100g	5.29	H	3.68	H	2.48	M	2.9	M	1.0	5.3
Exchangeable Potassium	meq/100g	0.25	L	0.19	VL	0.22	L	0.3	L	0.2	0.7
Exchangeable Sodium	meq/100g	1.09	H	0.63	M	0.34	M	0.5	M	0.2	1.1
Exchangeable Aluminium	meq/100g	0.01	H	0.01	H	0.01	H	0.0	H	0.0	0.0
Calcium/Magnesium Ratio	-	2.9	Low Ca	2.9	Low Ca	4.1	Balanced	4.0	Low Ca	2.7	8.2
Emerson Aggregate	Class	7	Stable	4	Slaking	4	Slaking	*	*	*	*
Phosphorus Buffer Index	mg/kg	84.9	*	80.9	*	79	*	*	*	*	*

Table 11-16: Summary of soil quality data for overburden and interburden (2022 drill holes)

#	Drillhole	Depth from	Depth to	Lithology	Exchangeable Ca	Exchangeable Mg	Exchangeable K	Exchangeable Na	CEC	ESP	Emerson	pH	EC	Ca/Mg ratio	Mg/K Ratio
Data from 2005 historical drill holes															
1	X8003_1	0	15	Weathered zone	25.1	8.3	1	4	38.3						
2	X8003_2	15	45	SS	22.9	6.3	0.8	2	31.9						
3	X8003_3	50.8	73.6	SS interburden	23.7	8.1	1.2	1.9	34.9						
4	X8005_1	0	20	Weathered zone	25.2	7.1	0.7	2.9	35.8						
5	X8005_2	20	42	SS	23.2	6	1	2.5	32.6						
6	X8005_3	42	55.3	ST	23	5	0.8	3	31.8						
7	X8005_4	67	81	SS interburden	22.1	6.6	1.1	4.3	34						
8	X8009_1	0	19.5	Weathered zone	24.4	7.2	0.6	3.5	35.7						
9	X8009_2	19.5	52.9	SS	21.1	5.8	1	3.6	31.6						
10	X8009_3	58.4	72	SS interburden	18.5	6.6	1.1	4.5	30.7						
11	X8011_1	0	17	Weathered zone	19.4	9.3	0.8	3	32.4						
12	X8011_2	17	23	ST	18.6	6.2	1.4	1.8	27.9						
13	X8011_3	23	24	SS	24	5.7	1	1.9	1.9						
14	X8011_4	24	34	ST	20.6	6.8	1.8	2.4	2.4						
15	X8011_5	34	38	SS	21.7	3.8	0.7	1.5	1.5						
16	X8011_6	38	46	ST	21.6	6	1.2	2.5	2.5						
17	X8011_7	46	48	SS	23.6	2.6	0.7	1.3	1.3						
18	X8011_8	48	54.1	ST	22.7	3.5	1	1.7	1.7						
19	X8011_9	60.1	74.5	ST/SS Interburden	25.3	7.2	1.2	4.3	4.3						
20	X8012_1	1	14	Weathered zone	21.9	8.3	1.2	4.6	4.6						
21	X8012_2	14	17	SS	21.3	3.4	0.7	1.5	1.5						
22	X8012_3	17	22	ST	22	6.4	1.4	2.9	2.9						
23	X8012_4	22	45.8	SS, XS at base	22.3	5.1	0.9	2	2						
24	X8012_5	53.8	76.8	ST Interburden	18.2	8.5	1.2	3.2	3.2						
25	X8013_1	1	17.5	Weathered zone	25	6.3	0.6	2.6	2.6						
26	X8013_2	17.5	22.5	SS, ST at base	24	5.6	1.3	1.4	1.4						
27	X8013_3	35	38.7	SS/ST Interburden	19.8	7.8	1.1	2.6	31.3						
28	X8014_1	1.5	12.5	Weathered zone	21.4	8.1	0.9	3.4	33.8						
29	X8014_2	12.5	55.7	ST/SS/ST	22.5	6.8	1.2	1.6	32						
30	X8014_3	61.2	73	CY/ST/CY Interburden	18.3	8.7	1.3	3	31.2						
31	X8017_1	0.5	18	Weathered zone	21.2	7.5	0.7	4.6	33.9						
32	X8017_2	18	46.3	SS/ST/CY	23.9	4.6	0.9	2.2	31.5						
33	X8017_3	57.2	71.8	CY Interburden	16.7	7.4	1.2	3.9	29.1						
34	X8017_4	71.8	71.9	XT Interburden	25.4	6.8	1.2	3.4	36.8						
35	X8020_1	1	15.5	Weathered zone	7.8	12.5	1	4.8	26						
36	X8020_2	15.5	20.5	CY	3	6.8	1	3.1	13.8						
37	X8020_3	29.9	39	CY Interburden	8.4	7.9	1.1	4	21.3						
38	X8020_4	39	41.6	YC Interburden	5.9	8.4	1.4	5	20.7						
39	X8024_1	0.5	22	Weathered zone	7	11.7	1.3	6.3	26.3						
40	X8024_2	22	36	CY	22.1	8	1.3	3.8	35.2						
41	X8024_3	36	47.5	SS	22.4	3.6	0.6	1.6	28.3						
42	X8024_4	55.8	69.5	CY/YC Interburden	14.6	8.8	0.9	4.3	28.7						
43	X8025_1	0.5	19	Weathered zone	22.5	7.6	0.6	3.3	34						
44	X8025_2	19	25.4	CY/SS/ST	3.7	7.1	1.3	1.7	13.7						
45	X8025_3	32.5	33	CY Interburden	5	8.4	2.7	4.6	20.6						
46	X8025_4	33	40	ST Interburden	21.1	7.7	1.1	3.4	33.4						
47	X8025_5	40	40.3	YC Interburden	13.5	8.3	1.8	4.3	27.8						
48	X8026_1	0.5	19	Weathered zone	23.5	8.1	1	4.2	36.7						
49	X8026_2	19	24	CY	19.7	8.2	1.6	2.4	31.9						
50	X8026_3	24	36.1	SS/ST	22.8	4.4	0.9	1.5	29.6						
51	X8026_4	43.7	48	CY Interburden	6.1	6.6	1.2	3.5	17.4						
52	X8026_5	48	50	ST Interburden	23.7	5.7	0.9	1.9	32.2						
53	X8026_6	50	52.5	YC/SS Interburden	6.9	7.4	1.6	2.5	18.3						
54	X8026_7	52.5	54	CY/XT Interburden	22.2	6.5	1.4	2.4	32.5						
55	X8026_8	54	60	YC/ST Interburden	11	7.7	1	3.8	23.5						
56	X8026_9	60	60.7	SS interburden	21.3	5	1	2.9	30.3						
57	X3030_1	0.5	17	Weathered zone	27.3	6.2	1	3	37.5						

58	X3030_2	17	27	ST/SS	23.1	3.6	0.7	0.8	28.2						
59	X3030_3	27	27.7	CY	21	3.9	0.6	0.5	26						
60	X3030_4	34.6	37	CY Interburden	9.4	5	0.6	1.3	16.4						
61	X3030_5	37	41	SS Interburden	21.2	7.8	1.1	1.6	31.8						
62	X3030_6	41	45.5	CY Interburden	20.7	8.1	1.8	2.1	32.6						
63	X3038_1	0.5	16	Weathered zone	22.1	8.5	1	3.8	35.3						
64	X3038_2	16	24	ST	17.9	5.8	1.4	2.1	27.2						
65	X3038_3	24	58.1	SS/ST/YC/XT	21.4	3.8	1.4	3.4	29.9						
66	X3038_4	62.5	73	SS interburden	10.3	4.3	1.7	6	22.3						
67	X3038_5	73	79.4	CY/YC Interburden	16	4.1	1.2	5.9	27.2						
68	X8040_1	0.5	31	Weathered zone	24.7	6.5	0.6	5	36.8						
69	X8040_2	31	37.5	CY	23.6	5.3	1.3	3.5	33.7						
70	X8040_3	43.1	56.3	CY Interburden	18.4	2.3	0.8	1.2	22.6						
71	X8041_1	0.5	13	Weathered zone	13	5.4	0.5	5	23.9						
72	X8041_2	13	25	CY/SS/ST	18.3	2.7	0.8	1.8	23.6						
73	X8041_3	25	35.5	ST/SS	17.5	3.3	1	1.8	23.6						
74	X8041_4	50	54	YC Interburden	3.8	4	0.8	1.4	9.9						
75	X8041_5	54	69	SS/ST Interburden	9.9	5.7	0.9	2.9	19.4						
76	X8041_6	69	74.2	CY Interburden	10.5	5	1.3	2.3	19.1						
77	X8044_1	0.5	11	Weathered zone	16.3	5.2	0.5	2.3	24.3						
78	X8044_2	11	18.9	ST/SS/CY	14.1	2.9	0.6	0.8	18.3						
79	X8044_3	27.2	32	SS interburden	18.3	8	1.4	1.5	29.2						
80	X8044_4	32	34.2	YC Interburden	6.2	6.2	1.4	1.2	15						
81	X8045_1	1	10.2	Weathered zone	18.1	3.6	1	3.1	25.8						
82	X8045_2	10.2	21.2	SS, YC at base	18.4	3.8	0.9	0.7	23.8						
83	X8045_3	29.6	31	CY Interburden	3.3	5.1	0.6	1.4	10.4						
84	X8045_4	31	38.5	SS interburden	5.8	6.2	0.7	1.4	14.2						
85	X8048_1	0.5	16.5	Weathered zone	14	6.9	0.9	4.5	26.2						
86	X8048_2	16.5	57.6	SS/ST	12.2	4.9	1.1	3.4	21.7						
87	X8048_3	63.6	72.8	SS/CY Interburden	6	7.5	0.9	4.7	19.2						
88	X8049_1	1	18.5	Weathered zone	12.9	8.5	0.6	3.4	25.4						
89	X8049_2	18.5	35.4	SS/ST	13.7	4	0.6	1.2	19.5						
90	X8049_3	45	51	CY Interburden	9.8	9.5	1.3	3.7	24.3						
91	X8050_1	0.5	11	Weathered zone	16.9	5.1	0.7	3.8	26.5						
92	X8050_2	11	29	SS/ST	11.6	2.8	0.6	1.2	16.1						
93	X8050_3	36.2	52.3	CY/SS/ST Interburden	8.3	5.6	0.8	4.7	19.4						

Table 11-17: Summary of soil quality data for overburden and interburden (2022 drill holes)

#	Drillhole	Depth from	Depth to	Lithology	Exchangeable Ca	Exchangeable Mg	Exchangeable K	Exchangeable Na	CEC	ESP	Emerson	pH	EC	Ca/Mg ratio	Mg/K Ratio
Data from 2022 drill holes															
1	171773	20.54	21.2	ST	1.5	5.2	0.4	4.7	11.8	39.5	2	9.3	284	0.3	13.0
2	171773	23.54	24.44	CS	0.8	4	0.4	3.7	8.9	41.3	2	9.4	360	0.2	10.0
3	171773	28.19	28.47	SSFM	1.1	2.7	0.2	2.2	6.2	35	2	9.6	280	0.4	13.5
4	171773	33.18	34.35	ST	2	2.8	0.3	3.2	8.3	38.3	2	9.8	238	0.7	9.3
5	171773	39.42	40.3	ST	4	4.3	0.5	4.1	12.8	31.6	2	9.7	265	0.9	8.6
6	171773	50.69	51.22	ST	2.1	2.3	0.4	2.2	6.9	31.1	2	9.7	235	0.9	5.8
7	171773	54.2	54.91	SSMM	2	1.4	<0.2	1	4.6	22.4	2	9.6	192	1.4	
8	171773	64.66	65.22	SSFF	2.2	2	0.3	1.7	6.2	27.2	2	9.7	223	1.1	6.7
9	171773	75.2	76.48	SSFF	1.9	1.6	0.2	1.4	5	27	3	9.5	217	1.2	8.0
10	171773	78.29	78.36	ST	1.4	1.1	<0.2	1.4	3.9	35.7	3	9.3	209	1.3	
11	171773	83.91	84.27	XM	1	1.2	0.2	1.9	4.3	44.6	3	9.7	223	0.8	6.0
12	171773	87.26	88.8	SSFM	2.6	1.8	0.2	2.6	7.2	35.2	3	9.9	318	1.4	9.0
13	171773	101.2	101.93	SSFF	3.2	1.6	0.3	3.9	9	43.2	2	9.5	364	2.0	5.3
14	171773	103.5	103.8	XM	3.6	1.5	0.4	5.4	11	49.5	2	9.4	238	2.4	3.8
15	171773	108.2	108.78	MS	3.7	1.3	0.5	6.8	12.3	55.2	2	9.9	156	2.8	2.6
16	171773	109.4	109.43	MS	2.8	0.9	0.3	5.7	9.8	58.3	2	9.4	125	3.1	3.0
17	171870	17.29	17.35	SSFM	1.3	2.7	0.2	2.1	6.4	33.4	2	9	384	0.5	13.5
18	171870	22.66	22.68	CL	1.8	2.9	0.3	2.4	7.4	32.1	2	9.2	369	0.6	9.7
19	171870	30.87	31.1	ST	2	1.8	0.2	2	6.1	32.7	2	9.1	333	1.1	9.0
20	171870	41.99	42.22	SSFF	1.9	1.3	<0.2	1.5	4.9	29.9	2	9.2	280	1.5	
21	171870	45.35	48.23	ST	2.5	1.5	0.2	2	6.3	31.8	2	9.1	270	1.7	7.5
22	171870	57.26	58.92	ST	2.8	1.5	0.2	2	6.6	30.8	2	9.2	312	1.9	7.5
23	171870	67.32	69.13	ST	2	1.2	0.2	1.4	4.8	29.3	2	9.1	292	1.7	6.0
24	171870	76.2	76.31	CS	3.6	2.1	0.3	1.8	7.8	22.6	2	5.2	380	1.7	7.0
25	171870	77.04	77.11	MS	2.8	1.5	0.2	2.1	6.8	31.3	2	5	297	1.9	7.5
26	171870	79.08	79.84	SSFM	2.4	1.2	0.2	2	5.8	35.4	2	8.5	311	2.0	6.0
27	171870	85.51	85.95	SSCC	2.4	1.1	0.2	2.1	5.8	36.2	2	9.4	375	2.2	5.5
28	171870	91.77	92.07	MS	3.2	1.4	0.3	3.1	7.9	38.8	2	9.2	431	2.3	4.7
29	171870	94.3	94.43	ST	2.3	0.8	0.3	3.8	7.1	52.9	2	9	341	2.9	2.7
30	171870	96.06	96.2	CS	2.6	0.9	0.3	3.5	7.2	48	2	9.3	502	2.9	3.0
31	171876	23.42	23.69	SSMC	2.6	3	<0.2	1.7	7.5	23.2	3	9.2	234	0.9	
32	171876	24.11	24.72	SSMM	2	1.8	<0.2	1.2	5.1	24.6	3	9.2	223	1.1	
33	171876	26.9	27.08	CS	3.8	7.8	0.3	4.2	16.1	25.8	2	9.1	402	0.5	26.0
34	171876	27.12	27.35	CS	4	7.8	0.4	4.7	16.9	27.7	2	9	422	0.5	19.5
35	171876	33.89	34.8	ST	3.5	4.3	0.5	3.4	11.6	29.5	2	9.2	177	0.8	8.6
36	171876	39.2	40.35	ST	3.4	3.5	0.5	4	11.5	34.6	2	9.4	137	1.0	7.0
37	171876	45.24	45.85	SSFF	3.6	3	0.4	3.5	10.4	33.2	2	9.5	294	1.2	7.5
38	171876	51.87	53.93	SSFM	2.5	1.4	0.2	1.6	5.8	27.8	2	9.5	238	1.8	7.0
39	171876	58.39	58.69	SSVV	5	2.9	0.4	4.3	12.6	34.1	2	9.2	178	1.7	7.3
40	171876	63.83	65.45	ST	3.5	2	0.3	2.8	8.6	32.4	2	9.5	267	1.8	6.7
41	171876	69.2	70.43	SSFF	3.5	1.8	0.3	2.4	8	30.5	2	9.4	243	1.9	6.0
42	171876	76.75	77	MS	3.4	1.4	<0.2	3	8	38.1	3	8.9	279	2.4	
43	171876	81.81	82.04	MS	4.4	1.4	0.4	5	11.3	44.3	2	8.9	118	3.1	3.5
44	171876	85.67	86.87	SSMC	5.2	1.6	0.3	4.9	12	40.7	3	9.7	380	3.3	5.3
45	171876	89.69	90.29	SSMC	3.6	1.6	0.3	2.7	8.2	33.3	3	9.5	331	2.3	5.3
46	171876	93.3	94.46	ST	4.7	1.4	0.4	5.1	11.7	44.1	2	9.6	305	3.4	3.5
47	171876	100.1	100.35	MS	4.9	1.8	0.6	10.4	17.6	58.7	2	9.8	411	2.7	3.0

Min	**0.8**	**0.8**	**0.2**	**0.5**	**1.3**	**22.4**	**2**	**5**	**118**	**0.2**	**2.6**
Max	**27.3**	**12.5**	**2.7**	**10.4**	**38.3**	**58.7**	**3**	**9.9**	**502**	**3.4**	**26.0**
Median	**12.55**	**5.05**	**0.8**	**2.9**	**17.95**	**33.4**	**2**	**9.4**	**280**	**1.7**	**7.0**

*Statistics include both 2005 and 2022 soil quality data

Attachment B: Spoil geochemical data

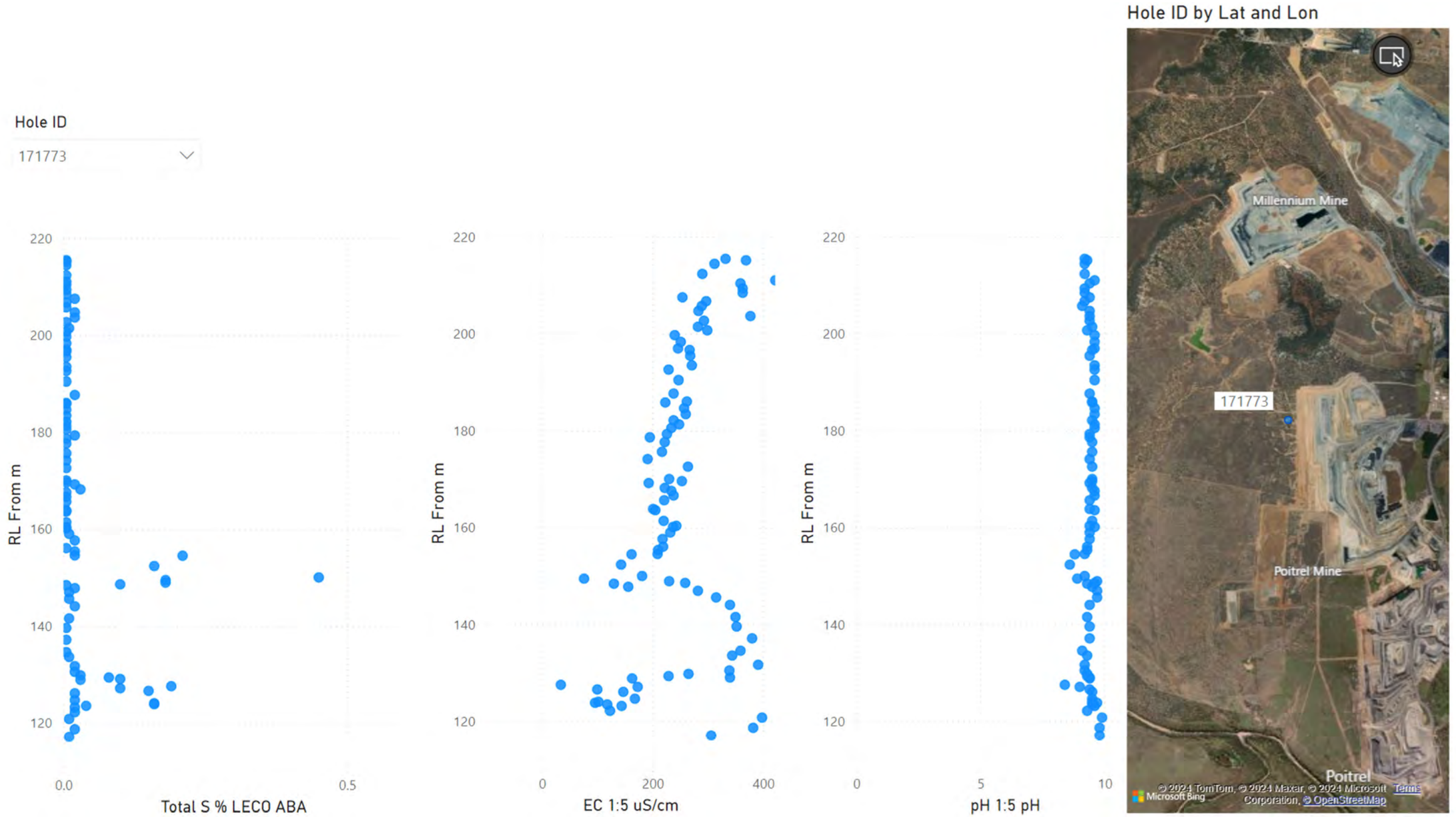

Figure 11-3: Total S, EC, and pH results for overburden and interburden from drill hole 171773

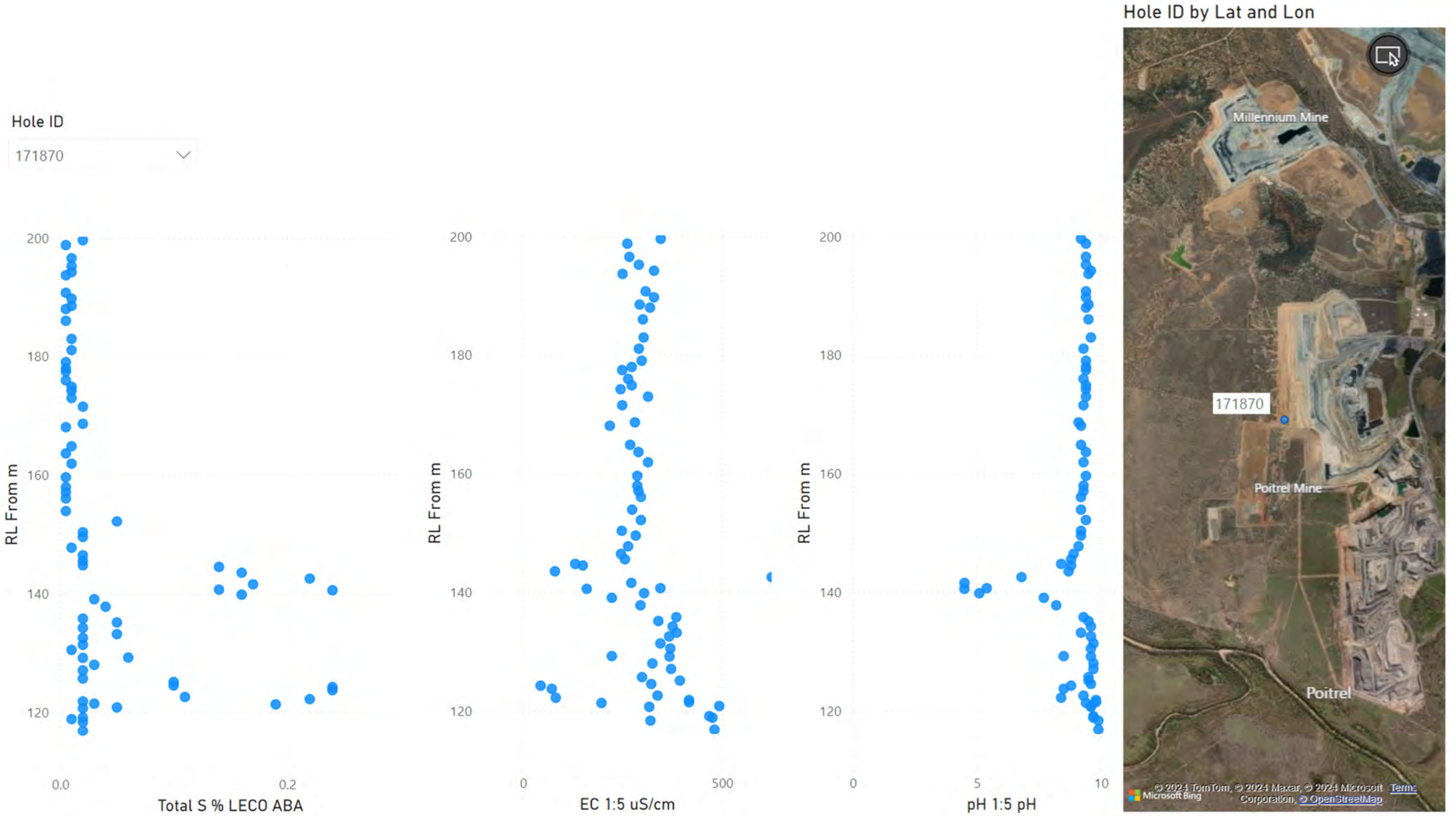

Figure 11-4: Total S, EC, and pH results for overburden and interburden from drill hole 171870

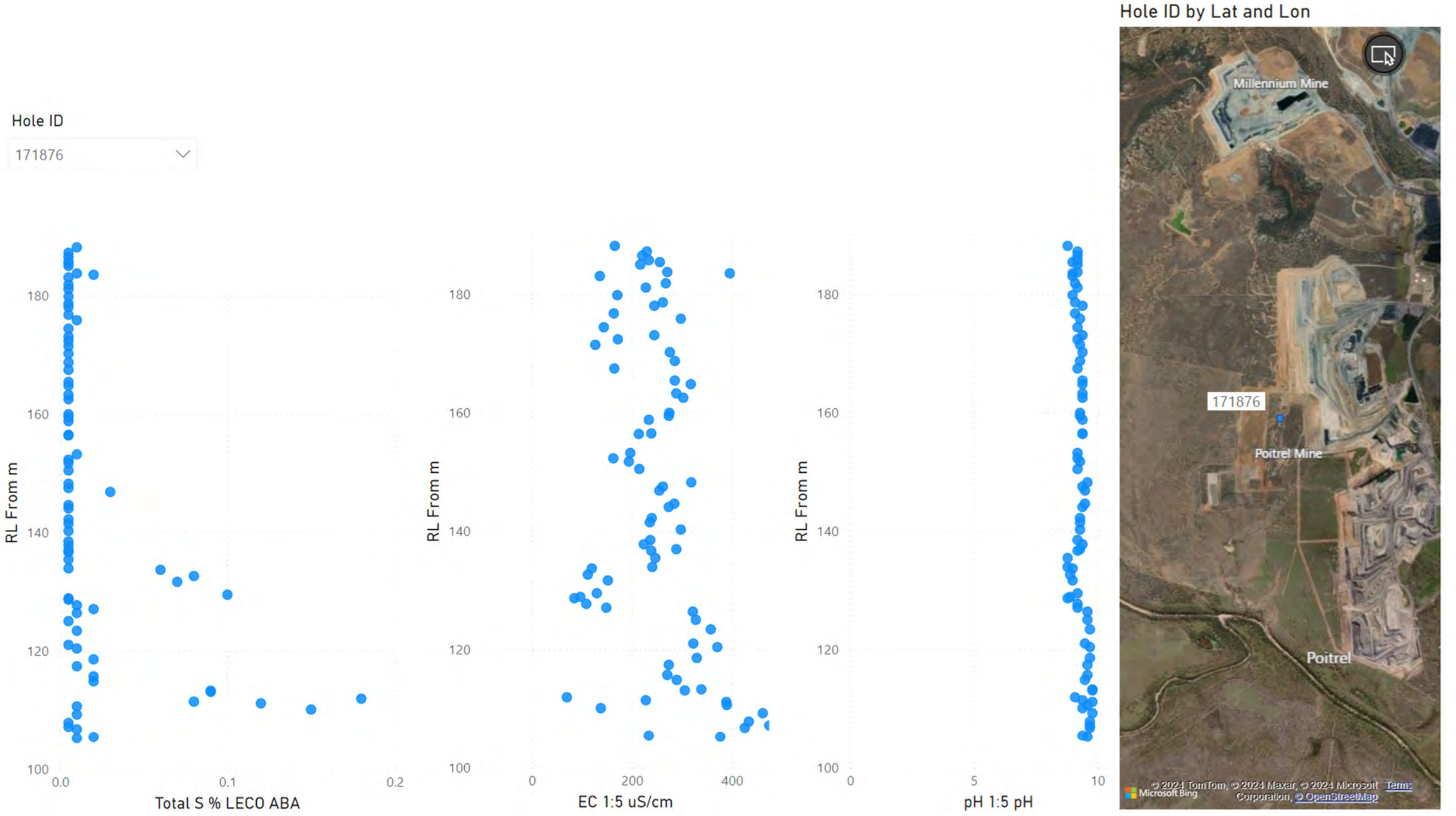

Figure 11-5: Total S, EC, and pH results for overburden and interburden from drill hole 171876

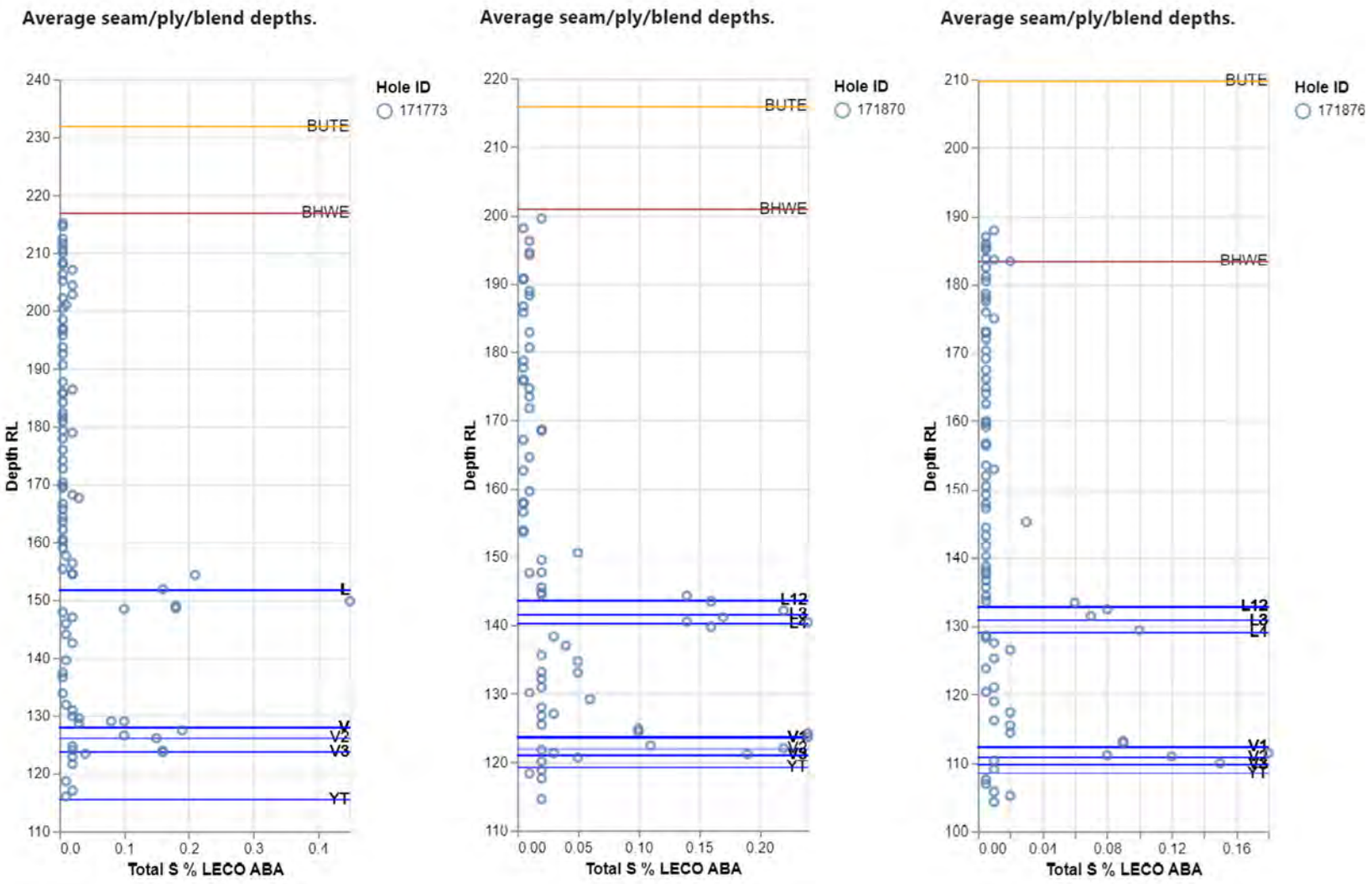

Figure 11-6: Total S concentrations in each drill hole relative to coal seams

Table B1: Acid Base Account Results for Spoil from the Stanmore Project

Sample No.	Date	Drill Hole ID	Client Sample ID	Sample Lithology	Lithology Code	From (m)	To (m)	Interval (m)	Depth (m)	pH (1:5)	EC (1:5) (µS/cm)	Total S (%)	Scr (%)	ANC[2]	MPA[2]	NAPP[2]	ANC:MPA Ratio	Sample Classification[3]
1	23/09/2020	171773	WC171773-01	Sandstone, fine	SSFF	17.4	17.7	0.3	0.3	9.20	332	<0.01		64.1	0.2	-63.9	418.6	Non-Acid Forming (Barren)
2	23/09/2020	171773	WC171773-02	Siltstone	ST	17.7	18.2	0.5	0.5	9.30	369	<0.01		37.9	0.2	-37.7	247.5	Non-Acid Forming (Barren)
3	23/09/2020	171773	WC171773-03	Siltstone; common sandstone bands throughout	ST	18.5	20.4	1.9	1.9	9.20	312	<0.01		18.8	0.2	-18.6	122.8	Non-Acid Forming (Barren)
4	23/09/2020	171773	WC171773-04	Siltstone; rare sandstone laminae near base of unit	ST	20.5	21.2	0.7	0.7	9.20	290	<0.01		21.3	0.2	-21.1	139.1	Non-Acid Forming (Barren)
5	23/09/2020	171773	WC171773-05	Claystone	CS	21.9	22.2	0.3	0.3	9.60	422	<0.01		27.4	0.2	-27.2	178.9	Non-Acid Forming (Barren)
6	23/09/2020	171773	WC171773-06	Sandstone, fine	SSFF	22.5	22.8	0.3	0.3	9.40	359	<0.01		324.0	0.2	-323.8	2115.9	Non-Acid Forming (Barren)
7	23/09/2020	171773	WC171773-07	Claystone	CS	23.5	24.4	0.9	0.9	9.20	363	<0.01		20.2	0.2	-20.0	131.9	Non-Acid Forming (Barren)
8	23/09/2020	171773	WC171773-08	Siltstone	ST	24.4	24.8	0.3	0.3	9.20	363	<0.01		21.1	0.2	-20.9	137.8	Non-Acid Forming (Barren)
9	23/09/2020	171773	WC171773-09	Sandstone, fine-medium	SSFM	25.4	25.8	0.4	0.4	9.40	254	0.02		103.0	0.6	-102.4	168.2	Non-Acid Forming (Barren)
10	23/09/2020	171773	WC171773-10	Siltstone	ST	26.2	26.5	0.3	0.3	9.20	297	<0.01		24.2	0.2	-24.0	158.0	Non-Acid Forming (Barren)
11	23/09/2020	171773	WC171773-11	Siltstone	ST	27.2	27.7	0.5	0.5	9.10	289	<0.01		21.4	0.2	-21.2	139.8	Non-Acid Forming (Barren)
12	23/09/2020	171773	WC171773-12	Sandstone, fine-medium; minor siltstone laminae	SSFM	28.2	28.5	0.3	0.3	9.40	283	0.02		69.2	0.6	-68.6	113.0	Non-Acid Forming (Barren)
13	23/09/2020	171773	WC171773-13	Siltstone; minor sandstone laminae near middle of unit	ST	29.3	30.0	0.8	0.8	9.40	377	0.02		23.1	0.6	-22.5	37.7	Non-Acid Forming (Barren)
14	23/09/2020	171773	WC171773-14	Sandstone, fine; minor siltstone laminae	SSFF	30.2	30.7	0.5	0.5	9.40	293	<0.01		92.7	0.2	-92.5	605.4	Non-Acid Forming (Barren)
15	23/09/2020	171773	WC171773-15	Siltstone; minor sandstone bands	ST	31.5	31.8	0.4	0.4	9.50	282	0.01		25.0	0.3	-24.7	81.6	Non-Acid Forming (Barren)
16	23/09/2020	171773	WC171773-16	Sandstone, medium-coarse	SSMC	32.2	32.4	0.2	0.2	9.30	299	<0.01		26.6	0.2	-26.4	173.7	Non-Acid Forming (Barren)
17	23/09/2020	171773	WC171773-17	Siltstone	ST	33.2	34.4	1.2	1.2	9.60	240	<0.01		156.0	0.2	-155.8	1018.8	Non-Acid Forming (Barren)
18	23/09/2020	171773	WC171773-18	Siltstone; rare sandstone laminae	ST	34.6	35.9	1.4	1.4	9.60	251	<0.01		23.1	0.2	-22.9	150.9	Non-Acid Forming (Barren)
19	23/09/2020	171773	WC171773-19	Sandstone, fine	SSFF	35.9	36.2	0.3	0.3	9.60	246	<0.01		339.0	0.2	-338.8	2213.9	Non-Acid Forming (Barren)
20	23/09/2020	171773	WC171773-20	Siltstone	ST	36.2	37.1	0.8	0.8	9.50	267	<0.01		25.7	0.2	-25.5	167.8	Non-Acid Forming (Barren)
21	23/09/2020	171773	WC171773-21	Siltstone; minor sandstone bands	ST	37.4	39.2	1.7	1.7	9.40	268	<0.01		24.3	0.2	-24.1	158.7	Non-Acid Forming (Barren)
22	23/09/2020	171773	WC171773-22	Siltstone; minor sandstone bands	ST	39.4	40.3	0.9	0.9	9.60	271	<0.01		21.1	0.2	-20.9	137.8	Non-Acid Forming (Barren)
23	23/09/2020	171773	WC171773-23	Sandstone, very fine	SSVV	40.3	42.2	1.9	1.9	9.60	229	<0.01		26.8	0.2	-26.6	175.0	Non-Acid Forming (Barren)
24	23/09/2020	171773	WC171773-24	Sandstone, fine; abundant siltstone bands throughout	SSFF	42.4	45.2	2.7	2.7	9.60	247	<0.01		38.8	0.2	-38.6	253.4	Non-Acid Forming (Barren)
25	23/09/2020	171773	WC171773-25	Sandstone, fine; abundant siltstone bands throughout	SSFF	45.2	46.4	1.3	1.3	9.40	238	0.02		50.4	0.6	-49.8	82.3	Non-Acid Forming (Barren)
26	23/09/2020	171773	WC171773-26	Sandstone, very fine	SSVV	46.8	47.0	0.2	0.2	9.50	262	<0.01		49.8	0.2	-49.6	325.2	Non-Acid Forming (Barren)
27	23/09/2020	171773	WC171773-27	Siderite	SD	47.0	47.2	0.2	0.2	9.50	223	<0.01		423.0	0.2	-422.8	2762.4	Non-Acid Forming (Barren)
28	23/09/2020	171773	WC171773-28	Siltstone	ST	48.2	48.7	0.5	0.5	9.60	257	<0.01		26.4	0.2	-26.2	172.4	Non-Acid Forming (Barren)
29	23/09/2020	171773	WC171773-29	Siltstone; common sandstone bands near base of unit	ST	49.4	50.5	1.1	1.1	9.60	260	<0.01		28.2	0.2	-28.0	184.2	Non-Acid Forming (Barren)
30	23/09/2020	171773	WC171773-30	Siltstone	ST	50.7	51.2	0.5	0.5	9.50	238	<0.01		30.3	0.2	-30.1	197.9	Non-Acid Forming (Barren)
31	23/09/2020	171773	WC171773-31	Sandstone, very fine; common siltstone laminae through	SSVV	51.5	52.0	0.4	0.4	9.60	248	<0.01		28.4	0.2	-28.2	185.5	Non-Acid Forming (Barren)
32	23/09/2020	171773	WC171773-32	Sandstone, fine; minor siltstone laminae throughout	SSFF	52.3	53.5	1.3	1.3	9.60	234	<0.01		119.0	0.2	-118.8	777.1	Non-Acid Forming (Barren)
33	23/09/2020	171773	WC171773-33	Siltstone; common sandstone laminae throughout	ST	53.5	53.9	0.4	0.4	9.40	226	0.02		25.4	0.6	-24.8	41.5	Non-Acid Forming (Barren)
34	23/09/2020	171773	WC171773-34	Sandstone, medium	SSMM	54.2	54.9	0.7	0.7	9.40	195	<0.01		466.0	0.2	-465.8	3043.3	Non-Acid Forming (Barren)
35	23/09/2020	171773	WC171773-35	Sandstone, medium-coarse; rare siltstone laminae	SSMC	55.2	56.9	1.7	1.7	9.50	222	<0.01		48.3	0.2	-48.1	315.4	Non-Acid Forming (Barren)
36	23/09/2020	171773	WC171773-36	Sandstone, medium-coarse; rare siltstone clasts near ba	SSMC	57.2	58.7	1.5	1.5	9.50	217	<0.01		73.3	0.2	-73.1	478.7	Non-Acid Forming (Barren)
37	23/09/2020	171773	WC171773-37	Sandstone, medium-coarse; rare siltstone clasts near ba	SSMC	58.7	60.1	1.4	1.4	9.40	191	<0.01		144.0	0.2	-143.8	940.4	Non-Acid Forming (Barren)
38	23/09/2020	171773	WC171773-38	Siltstone; minor sandstone bands throughout	ST	60.3	62.5	2.3	2.3	9.50	264	<0.01		28.2	0.2	-28.0	184.2	Non-Acid Forming (Barren)
39	23/09/2020	171773	WC171773-39	Siltstone	ST	62.8	63.2	0.4	0.4	9.50	230	<0.01		27.8	0.2	-27.6	181.6	Non-Acid Forming (Barren)
40	23/09/2020	171773	WC171773-40	Calcite	CA	63.3	63.4	0.1	0.1	9.50	253	<0.01		139.0	0.2	-138.8	907.8	Non-Acid Forming (Barren)
41	23/09/2020	171773	WC171773-41	Siltstone; calcite rare nodules	ST	63.6	64.7	1.0	1.0	9.40	193	0.02		22.0	0.6	-21.4	35.9	Non-Acid Forming (Barren)
42	23/09/2020	171773	WC171773-42	Sandstone, fine; siltstone bands throughout; calcite com	SSFF	64.7	65.2	0.6	0.6	9.50	222	0.03		67.8	0.9	-66.9	73.8	Non-Acid Forming (Barren)
43	23/09/2020	171773	WC171773-43	Sandstone, fine; siltstone bands throughout; siderite con	SSFF	65.3	66.2	1.0	1.0	9.60	234	<0.01		67.6	0.2	-67.4	441.5	Non-Acid Forming (Barren)
44	23/09/2020	171773	WC171773-44	Sandstone, fine; siltstone bands throughout; siderite con	SSFF	66.2	67.1	0.9	0.9	9.60	238	<0.01		28.3	0.2	-28.1	184.8	Non-Acid Forming (Barren)
45	23/09/2020	171773	WC171773-45	Sandstone, fine; siltstone bands throughout; calcite com	SSFF	67.2	68.5	1.3	1.3	9.40	221	<0.01		36.8	0.2	-36.6	240.3	Non-Acid Forming (Barren)
46	23/09/2020	171773	WC171773-46	Siltstone; mudstone throughout	ST	69.0	69.3	0.3	0.3	9.40	201	<0.01		23.5	0.2	-23.3	153.5	Non-Acid Forming (Barren)
47	23/09/2020	171773	WC171773-47	Sandstone, fine; siltstone bands throughout; calcite spor	SSFF	69.3	70.7	1.4	1.4	9.60	205	<0.01		124.0	0.2	-123.8	809.8	Non-Acid Forming (Barren)
48	23/09/2020	171773	WC171773-48	Siltstone; siderite common nodules	ST	71.5	72.3	0.8	0.8	9.50	220	<0.01		36.6	0.2	-36.4	239.0	Non-Acid Forming (Barren)
49	23/09/2020	171773	WC171773-49	Siderite; siltstone bands near base of unit	SD	72.5	72.7	0.2	0.2	9.40	243	<0.01		168.0	0.2	-167.8	1097.1	Non-Acid Forming (Barren)
50	23/09/2020	171773	WC171773-50	Sandstone, fine; siltstone bands throughout; siderite spo	SSFF	72.7	73.8	1.1	1.1	9.60	237	<0.01		40.1	0.2	-39.9	261.9	Non-Acid Forming (Barren)
51	23/09/2020	171773	WC171773-51	Sandstone, fine; siltstone bands throughout; calcite spor	SSFF	73.9	75.2	1.4	1.4	9.40	232	0.01		110.0	0.3	-109.7	359.2	Non-Acid Forming (Barren)
52	23/09/2020	171773	WC171773-52	Sandstone, fine; siltstone bands throughout; calcite spor	SSFF	75.2	76.5	1.3	1.3	9.40	218	0.02		68.5	0.6	-67.9	111.8	Non-Acid Forming (Barren)
53	23/09/2020	171773	WC171773-53	Siltstone; mudstone throughout	ST	76.8	77.5	0.7	0.7	9.30	219	<0.01		18.3	0.2	-18.1	119.5	Non-Acid Forming (Barren)
54	23/09/2020	171773	WC171773-54	Sandstone, fine; siltstone bands throughout; calcite spor	SSFF	77.5	78.3	0.8	0.8	9.30	210	0.02		54.2	0.6	-53.6	88.5	Non-Acid Forming (Barren)
55	23/09/2020	171773	WC171773-55	Siltstone; mudstone throughout	ST	78.3	78.4	0.1	0.1	9.20	209	0.02		17.6	0.6	-17.0	28.7	Non-Acid Forming (Barren)
56	23/09/2020	171773	WC171773-56	Coal, dull <1% bright	CODD	78.4	78.5	0.1	0.1	8.80	162	0.21	0.084	172.0	2.6	-169.4	66.9	Non-Acid Forming

Table B1: Acid Base Account Results for Spoil from the Stanmore Project

Sample No.	Date	Drill Hole ID	Client Sample ID	Sample Lithology	Lithology Code	From (m)	To (m)	Interval (m)	Depth (m)	pH (1:5)	EC (1:5) (µS/cm)	Total S (%)	Scr (%)	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
57	23/09/2020	171773	WC171773-57	Coal, 10-40% bright	CODB	80.5	81.0	0.5	0.5	8.60	143	0.16	0.127	19.8	3.9	-15.9	5.1	Non-Acid Forming
58	23/09/2020	171773	WC171773-58	Mudstone; carbonaceous in part near top of unit	MS	82.8	83.0	0.2	0.2	9.20	181	0.45	0.501	10.7	15.3	4.6	0.7	Uncertain
59	23/09/2020	171773	WC171773-59	Coal, 10-40% bright	CODB	83.4	83.9	0.5	0.5	8.90	76	0.18	0.020	17.2	0.6	-16.6	28.1	Non-Acid Forming
60	23/09/2020	171773	WC171773-60	Carbonaceous Mudstone; coaly lenses throughout	XM	83.9	84.3	0.4	0.4	9.70	230	0.18	0.047	14.0	1.4	-12.6	9.7	Non-Acid Forming
61	23/09/2020	171773	WC171773-61	Carbonaceous Mudstone	XM	84.3	84.4	0.1	0.1	9.60	259	0.10	0.078	13.2	2.4	-10.8	5.5	Non-Acid Forming (Barren)
62	23/09/2020	171773	WC171773-62	Mudstone	MS	84.4	85.0	0.5	0.5	9.30	130	<0.01		12.8	0.2	-12.6	83.6	Non-Acid Forming (Barren)
63	23/09/2020	171773	WC171773-63	Sandstone, fine; siltstone bands throughout	SSFF	85.1	85.8	0.8	0.8	9.50	156	0.02		15.2	0.6	-14.6	24.8	Non-Acid Forming (Barren)
64	23/09/2020	171773	WC171773-64	Sandstone, fine-medium; siltstone wisps throughout	SSFM	85.9	86.9	1.0	1.0	9.70	282	0.01		84.0	0.3	-83.7	274.3	Non-Acid Forming (Barren)
65	23/09/2020	171773	WC171773-65	Sandstone, fine-medium	SSFM	87.3	88.8	1.5	1.5	9.70	315	0.01		91.6	0.3	-91.3	299.1	Non-Acid Forming (Barren)
66	23/09/2020	171773	WC171773-66	Sandstone, fine-medium	SSFM	88.8	90.3	1.5	1.5	9.40	340	0.02		148.0	0.6	-147.4	241.6	Non-Acid Forming (Barren)
67	23/09/2020	171773	WC171773-67	Sandstone, fine-medium	SSFM	91.3	93.3	2.0	2.0	9.30	350	0.01		53.9	0.3	-53.6	176.0	Non-Acid Forming (Barren)
68	23/09/2020	171773	WC171773-68	Sandstone, fine-medium; rare carbonaceous wisps	SSFM	93.3	95.4	2.2	2.2	9.40	352	<0.01		112.0	0.2	-111.8	731.4	Non-Acid Forming (Barren)
69	23/09/2020	171773	WC171773-69	Sandstone, fine-medium; siltstone bands	SSFM	95.7	96.2	0.5	0.5	9.40	380	<0.01		204.0	0.2	-203.8	1332.2	Non-Acid Forming (Barren)
70	23/09/2020	171773	WC171773-70	Sandstone, fine-medium; calcite abundant cement	SSFM	98.3	99.0	0.7	0.7	9.10	359	<0.01		446.0	0.2	-445.8	2912.7	Non-Acid Forming (Barren)
71	23/09/2020	171773	WC171773-71	Sandstone, fine; siltstone bands throughout	SSFF	99.3	101.0	1.7	1.7	9.30	344	0.01		44.3	0.3	-44.0	144.7	Non-Acid Forming (Barren)
72	23/09/2020	171773	WC171773-72	Sandstone, fine; siltstone bands throughout	SSFF	101.2	101.9	0.8	0.8	9.20	391	0.02		165.0	0.6	-164.4	269.4	Non-Acid Forming (Barren)
73	23/09/2020	171773	WC171773-73	Siltstone; mudstone laminae	ST	102.3	103.0	0.6	0.6	9.20	339	0.02		30.9	0.6	-30.3	50.4	Non-Acid Forming (Barren)
74	23/09/2020	171773	WC171773-74	Mudstone; siltstone in part near top of unit	MS	103.1	103.3	0.2	0.2	9.30	265	0.03		26.0	0.9	-25.1	28.3	Non-Acid Forming (Barren)
75	23/09/2020	171773	WC171773-75	Carbonaceous Mudstone	XM	103.5	103.8	0.3	0.3	9.30	229	0.08	0.064	21.0	2.0	-19.0	10.7	Non-Acid Forming (Barren)
76	23/09/2020	171773	WC171773-76	Coal, <10% bright	CODM	103.8	103.8	0.0	0.0	9.40	340	0.10	0.061	27.1	1.9	-25.2	14.5	Non-Acid Forming (Barren)
77	23/09/2020	171773	WC171773-77	Tuff; carbonaceous near top of unit near base of unit	TF	104.0	104.2	0.2	0.2	9.40	163	0.03		15.9	0.9	-15.0	17.3	Non-Acid Forming (Barren)
78	23/09/2020	171773	WC171773-78	Coal, 10-40% bright	CODB	105.3	105.4	0.1	0.1	8.40	34	0.19	0.009	14.0	0.3	-13.7	50.8	Non-Acid Forming
79	23/09/2020	171773	WC171773-79	Mudstone; clayey bands near base of unit	MS	105.7	106.3	0.5	0.5	9.00	173	0.10	0.089	14.5	2.7	-11.8	5.3	Non-Acid Forming (Barren)
80	23/09/2020	171773	WC171773-80	Coal, 10-40% bright	CODB	106.3	106.8	0.5	0.5	9.40	100	0.15	0.006	15.6	0.2	-15.4	84.9	Non-Acid Forming
81	23/09/2020	171773	WC171773-81	Mudstone; common clayey bands	MS	106.8	108.1	1.4	1.4	9.50	147	0.02		16.8	0.6	-16.2	27.4	Non-Acid Forming (Barren)
82	23/09/2020	171773	WC171773-82	Mudstone; carbonaceous in part near base of unit	MS	108.2	108.8	0.6	0.6	9.50	168	0.02		18.4	0.6	-17.8	30.0	Non-Acid Forming (Barren)
83	23/09/2020	171773	WC171773-83	Coal, <10% bright	CODM	108.8	108.9	0.1	0.1	9.50	102	0.16	0.015	11.6	0.5	-11.1	25.3	Non-Acid Forming
84	23/09/2020	171773	WC171773-84	Carbonaceous Mudstone; coaly lenses throughout	XM	109.0	109.2	0.1	0.1	9.70	96	0.16	0.012	12.5	0.4	-12.1	34.0	Non-Acid Forming
85	23/09/2020	171773	WC171773-85	Mudstone	MS	109.4	109.4	0.1	0.1	9.50	118	0.04		14.7	1.2	-13.5	12.0	Non-Acid Forming (Barren)
86	23/09/2020	171773	WC171773-86	Mudstone	MS	109.7	110.0	0.3	0.3	9.60	144	0.02		16.6	0.6	-16.0	27.1	Non-Acid Forming (Barren)
87	23/09/2020	171773	WC171773-87	Siltstone; mudstone throughout	ST	110.7	111.2	0.5	0.5	9.30	123	0.02		17.8	0.6	-17.2	29.1	Non-Acid Forming (Barren)
88	23/09/2020	171773	WC171773-88	Sandstone, fine-medium; siltstone bands throughout; ca	SSFM	112.1	114.2	2.1	2.1	9.90	398	0.01		25.2	0.3	-24.9	82.3	Non-Acid Forming (Barren)
89	23/09/2020	171773	WC171773-89	Sandstone, fine-medium; siltstone wisps throughout; cal	SSFM	114.2	115.8	1.6	1.6	9.80	382	0.02		63.7	0.6	-63.1	104.0	Non-Acid Forming (Barren)
90	23/09/2020	171773	WC171773-90	Sandstone, fine-medium; siltstone wisps throughout; cal	SSFM	115.8	116.8	1.0	1.0	9.80	306	0.01		58.7	0.3	-58.4	191.7	Non-Acid Forming (Barren)
91	05/07/2020	171870	171870_WC01	Sandstone, fine-medium	SSFM	17.3	17.4	0.1	0.1	9.20	346	0.02		42.9	0.6	-42.3	70.0	Non-Acid Forming (Barren)
92	05/07/2020	171870	171870_WC02	Siltstone; minor sandstone laminae	ST	18.1	18.8	0.7	0.7	9.40	262	<0.01		18.2	0.2	-18.0	118.9	Non-Acid Forming (Barren)
93	05/07/2020	171870	171870_WC03	Sandstone, fine; common siltstone laminae	SSFF	20.3	20.6	0.3	0.3	9.40	267	0.01		19.1	0.3	-18.8	62.4	Non-Acid Forming (Barren)
94	05/07/2020	171870	171870_WC04	Sandstone, fine; common siltstone laminae near base of	SSFF	21.7	22.3	0.7	0.7	9.40	291	0.01		21.7	0.3	-21.4	70.9	Non-Acid Forming (Barren)
95	05/07/2020	171870	171870_WC05	Clay	CL	22.7	22.7	0.0	0.0	9.60	329	0.01		21.4	0.3	-21.1	69.9	Non-Acid Forming (Barren)
96	05/07/2020	171870	171870_WC06	Siltstone; rare sandstone laminae	ST	23.2	26.1	2.9	2.9	9.50	250	<0.01		18.4	0.2	-18.2	120.2	Non-Acid Forming (Barren)
97	05/07/2020	171870	171870_WC07	Sandstone, fine	SSFF	26.1	26.2	0.1	0.1	9.40	308	<0.01		26.6	0.2	-26.4	173.7	Non-Acid Forming (Barren)
98	05/07/2020	171870	171870_WC08	Sandstone, very fine	SSVV	27.1	28.0	0.8	0.8	9.40	329	0.01		58.0	0.3	-57.7	189.4	Non-Acid Forming (Barren)
99	05/07/2020	171870	171870_WC09	Siltstone	ST	28.4	28.6	0.2	0.2	9.50	293	0.01		21.1	0.3	-20.8	68.9	Non-Acid Forming (Barren)
100	05/07/2020	171870	171870_WC10	Sandstone, very fine	SSVV	28.9	30.2	1.3	1.3	9.40	319	<0.01		45.8	0.2	-45.6	299.1	Non-Acid Forming (Barren)
101	05/07/2020	171870	171870_WC11	Siltstone	ST	30.9	31.1	0.2	0.2	9.50	301	<0.01		23.9	0.2	-23.7	156.1	Non-Acid Forming (Barren)
102	05/07/2020	171870	171870_WC12	Sandstone, medium	SSMM	33.9	34.0	0.1	0.1	9.60	303	0.01		32.5	0.3	-32.2	106.1	Non-Acid Forming (Barren)
103	05/07/2020	171870	171870_WC13	Siltstone; minor sandstone laminae near top of unit	ST	35.8	36.2	0.4	0.4	9.30	291	0.01		21.7	0.3	-21.4	70.9	Non-Acid Forming (Barren)
104	05/07/2020	171870	171870_WC14	Sandstone, fine-medium; rare siltstone laminae	SSFM	37.8	38.2	0.3	0.3	9.40	298	<0.01		53.0	0.2	-52.8	346.1	Non-Acid Forming (Barren)
105	05/07/2020	171870	171870_WC15	Sandstone, very fine; common siltstone laminae near mi	SSVV	38.9	39.2	0.3	0.3	9.40	273	<0.01		38.5	0.2	-38.3	251.4	Non-Acid Forming (Barren)
106	05/07/2020	171870	171870_WC16	Siltstone; common sandstone laminae throughout	ST	39.4	40.9	1.5	1.5	9.40	249	<0.01		19.6	0.2	-19.4	128.0	Non-Acid Forming (Barren)
107	05/07/2020	171870	171870_WC17	Sandstone, fine; common siltstone laminae	SSFF	40.9	41.1	0.2	0.2	9.30	264	<0.01		119.0	0.2	-118.8	777.1	Non-Acid Forming (Barren)
108	05/07/2020	171870	171870_WC18	Sandstone, fine	SSFF	42.0	42.2	0.2	0.2	9.40	273	0.01		21.2	0.3	-20.9	69.2	Non-Acid Forming (Barren)
109	05/07/2020	171870	171870_WC19	Siltstone; minor sandstone laminae	ST	42.7	43.4	0.8	0.8	9.40	245	0.01		20.5	0.3	-20.2	66.9	Non-Acid Forming (Barren)
110	05/07/2020	171870	171870_WC20	Sandstone, very fine; common siltstone laminae	SSVV	43.9	45.1	1.2	1.2	9.40	314	0.01		35.1	0.3	-34.8	114.6	Non-Acid Forming (Barren)
111	05/07/2020	171870	171870_WC21	Siltstone; minor sandstone laminae near base of unit	ST	45.4	48.2	2.9	2.9	9.30	249	0.02		19.5	0.6	-18.9	31.8	Non-Acid Forming (Barren)
112	05/07/2020	171870	171870_WC22	Siltstone; minor sandstone laminae	ST	48.2	48.4	0.2	0.2	9.10	281	0.02		28.7	0.6	-28.1	46.9	Non-Acid Forming (Barren)

Table B1: Acid Base Account Results for Spoil from the Stanmore Project

Sample No.	Date	Drill Hole ID	Client Sample ID	Sample Lithology	Lithology Code	From (m)	To (m)	Interval (m)	Depth (m)	pH (1:5)	EC (1:5) (µS/cm)	Total S (%)	Scr (%)	ANC[2]	MPA[2]	NAPP[2]	ANC:MPA Ratio	Sample Classification[3]
113	05/07/2020	171870	171870_WC23	Sandstone, medium	SSMM	48.8	49.7	0.9	0.9	9.20	218	<0.01		163.0	0.2	-162.8	1064.5	Non-Acid Forming (Barren)
114	05/07/2020	171870	171870_WC24	Siltstone	ST	52.0	52.3	0.2	0.2	9.20	269	0.01		69.7	0.3	-69.4	227.6	Non-Acid Forming (Barren)
115	05/07/2020	171870	171870_WC25	Siltstone	ST	53.2	54.2	1.0	1.0	9.40	290	<0.01		39.5	0.2	-39.3	258.0	Non-Acid Forming (Barren)
116	05/07/2020	171870	171870_WC26	Siltstone; sideritic near middle of unit; calcite rare in veir	ST	55.0	57.3	2.3	2.3	9.30	314	0.01		45.7	0.3	-45.4	149.2	Non-Acid Forming (Barren)
117	05/07/2020	171870	171870_WC27	Siltstone; minor sandstone bands	ST	57.3	58.9	1.7	1.7	9.40	287	<0.01		45.7	0.2	-45.5	298.4	Non-Acid Forming (Barren)
118	05/07/2020	171870	171870_WC28	Sandstone, very fine	SSVV	58.9	59.0	0.1	0.1	9.30	287	<0.01		141.0	0.2	-140.8	920.8	Non-Acid Forming (Barren)
119	05/07/2020	171870	171870_WC29	Sandstone, very fine; common siltstone laminae through	SSVV	59.8	60.3	0.5	0.5	9.30	290	<0.01		53.9	0.2	-53.7	352.0	Non-Acid Forming (Barren)
120	05/07/2020	171870	171870_WC30	Siltstone; common sandstone bands throughout	ST	60.8	63.0	2.1	2.1	9.20	296	<0.01		39.4	0.2	-39.2	257.3	Non-Acid Forming (Barren)
121	05/07/2020	171870	171870_WC31	Sandstone, fine; minor siltstone laminae	SSFF	63.0	63.2	0.3	0.3	9.20	274	<0.01		74.7	0.2	-74.5	487.8	Non-Acid Forming (Barren)
122	05/07/2020	171870	171870_WC32	Siltstone; common sandstone bands near top of unit	ST	64.7	66.3	1.6	1.6	9.40	296	0.05		24.8	1.5	-23.3	16.2	Non-Acid Forming (Barren)
123	05/07/2020	171870	171870_WC33	Sandstone, fine; common siltstone laminae near middle	SSFF	66.5	67.3	0.8	0.8	9.20	248	0.02		184.0	0.6	-183.4	300.4	Non-Acid Forming (Barren)
124	05/07/2020	171870	171870_WC34	Siltstone; common sandstone laminae throughout; calcit	ST	67.3	69.1	1.8	1.8	9.20	283	0.02		52.8	0.6	-52.2	86.2	Non-Acid Forming (Barren)
125	05/07/2020	171870	171870_WC35	Sandstone, fine	SSFF	69.1	69.2	0.1	0.1	9.10	264	0.01		72.2	0.3	-71.9	235.8	Non-Acid Forming (Barren)
126	05/07/2020	171870	171870_WC36	Siltstone; minor sandstone laminae near base of unit	ST	70.4	71.3	0.9	0.9	8.90	246	0.02		11.0	0.6	-10.4	18.0	Non-Acid Forming (Barren)
127	05/07/2020	171870	171870_WC37	Sandstone, fine; common siltstone laminae throughout	SSFF	71.3	72.1	0.8	0.8	8.80	256	0.02		14.5	0.6	-13.9	23.7	Non-Acid Forming (Barren)
128	05/07/2020	171870	171870_WC38	Carbonaceous Mudstone	XM	72.1	72.4	0.3	0.3	8.40	131	0.02		7.1	0.6	-6.5	11.6	Non-Acid Forming (Barren)
129	05/07/2020	171870	171870_WC39	Coal, dull, conchoidal; calcite common in veins	CODC	72.4	72.5	0.2	0.2	8.80	150	0.14	0.013	117.0	0.4	-116.6	293.9	Non-Acid Forming
130	05/07/2020	171870	171870_WC40	Coal, <10% bright	CODM	73.4	73.4	0.0	0.0	8.70	80	0.16	0.016	20.3	0.5	-19.8	41.4	Non-Acid Forming
131	05/07/2020	171870	171870_WC41	Coal, 10-40% bright	CODB	74.3	74.7	0.4	0.4	6.80	625	0.22	0.018	26.4	0.6	-25.8	47.9	Non-Acid Forming
132	05/07/2020	171870	171870_WC42	Coal, 10-40% bright	CODB	75.3	75.7	0.4	0.4	4.50	272	0.17	0.021	1.8	0.6	-1.2	2.8	Uncertain
133	05/07/2020	171870	171870_WC43	Claystone	CS	76.2	76.3	0.1	0.1	5.40	345	0.14	0.016	9.9	0.5	-9.4	20.2	Non-Acid Forming
134	05/07/2020	171870	171870_WC44	Coal, <10% bright	CODM	76.3	76.4	0.1	0.1	4.50	160	0.24	0.015	9.0	0.5	-8.5	19.6	Non-Acid Forming
135	05/07/2020	171870	171870_WC45	Mudstone	MS	77.0	77.1	0.1	0.1	5.10	304	0.16	0.018	3.0	0.6	-2.4	5.4	Non-Acid Forming
136	05/07/2020	171870	171870_WC46	Siltstone	ST	77.8	78.5	0.7	0.7	7.70	223	0.03		9.2	0.9	-8.3	10.0	Non-Acid Forming (Barren)
137	05/07/2020	171870	171870_WC47	Sandstone, fine-medium; common siltstone laminae nea	SSFM	79.1	79.8	0.8	0.8	8.20	295	0.04		17.5	1.2	-16.3	14.3	Non-Acid Forming (Barren)
138	05/07/2020	171870	171870_WC48	Sandstone, fine-medium	SSFM	81.1	81.3	0.2	0.2	9.30	385	0.02		107.0	0.6	-106.4	174.7	Non-Acid Forming (Barren)
139	05/07/2020	171870	171870_WC49	Siltstone; common sandstone laminae near top of unit	ST	81.7	82.1	0.4	0.4	9.50	340	0.05		21.9	1.5	-20.4	14.3	Non-Acid Forming (Barren)
140	05/07/2020	171870	171870_WC50	Sandstone, medium-coarse	SSMC	82.7	83.7	1.1	1.1	9.60	376	0.02		118.0	0.6	-117.4	192.7	Non-Acid Forming (Barren)
141	05/07/2020	171870	171870_WC51	Sandstone, fine-medium; abundant siltstone laminae thr	SSFM	83.7	83.8	0.1	0.1	9.20	386	0.05		43.5	1.5	-42.0	28.4	Non-Acid Forming (Barren)
142	05/07/2020	171870	171870_WC52	Sandstone, medium-coarse	SSMC	84.3	84.7	0.4	0.4	9.60	367	0.02		44.8	0.6	-44.2	73.1	Non-Acid Forming (Barren)
143	05/07/2020	171870	171870_WC53	Sandstone, coarse	SSCC	85.5	86.0	0.4	0.4	9.70	345	0.02		39.1	0.6	-38.5	63.8	Non-Acid Forming (Barren)
144	05/07/2020	171870	171870_WC54	Sandstone, medium-coarse	SSMC	86.4	86.8	0.4	0.4	9.60	370	0.01		172.0	0.3	-171.7	561.6	Non-Acid Forming (Barren)
145	05/07/2020	171870	171870_WC55	Coal, fibrous; siderite common fragments	COFB	87.7	87.7	0.0	0.0	8.50	223	0.06		492.0	1.8	-490.2	267.8	Non-Acid Forming (Barren)
146	05/07/2020	171870	171870_WC56	Sandstone, medium-coarse; common siltstone clasts ne	SSMC	87.7	88.9	1.2	1.2	9.60	368	0.02		222.0	0.6	-221.4	362.4	Non-Acid Forming (Barren)
147	05/07/2020	171870	171870_WC57	Siltstone; minor sandstone laminae near base of unit	ST	88.9	89.8	0.9	0.9	9.70	325	0.03		25.1	0.9	-24.2	27.3	Non-Acid Forming (Barren)
148	05/07/2020	171870	171870_WC58	Sandstone, fine; common siltstone laminae throughout	SSFF	89.8	90.1	0.3	0.3	9.70	372	0.02		116.0	0.6	-115.4	189.4	Non-Acid Forming (Barren)
149	05/07/2020	171870	171870_WC59	Siltstone	ST	91.2	91.4	0.2	0.2	9.50	299	0.02		22.5	0.6	-21.9	36.7	Non-Acid Forming (Barren)
150	05/07/2020	171870	171870_WC60	Mudstone	MS	91.8	92.1	0.3	0.3	9.50	394	0.10		23.6	3.1	-20.5	7.7	Non-Acid Forming (Barren)
151	05/07/2020	171870	171870_WC61	Coal, dull, conchoidal	CODC	92.4	92.4	0.0	0.0	9.60	322	0.10		14.4	3.1	-11.3	4.7	Non-Acid Forming
152	05/07/2020	171870	171870_WC62	Coal, dull, conchoidal	CODC	92.6	92.7	0.0	0.0	8.80	44	0.24	0.021	31.7	0.6	-31.1	49.3	Non-Acid Forming
153	05/07/2020	171870	171870_WC63	Coal, <10% bright	CODM	93.2	93.2	0.0	0.0	8.50	72	0.24	0.021	17.0	0.6	-16.4	26.4	Non-Acid Forming
154	05/07/2020	171870	171870_WC64	Siltstone	ST	94.3	94.4	0.1	0.1	9.30	338	0.11	0.067	8.9	2.1	-6.8	4.3	Non-Acid Forming
155	05/07/2020	171870	171870_WC65	Coal, dull <1% bright	CODD	94.7	94.9	0.2	0.2	8.40	82	0.22	0.020	2.7	0.6	-2.1	4.4	Uncertain
156	05/07/2020	171870	171870_WC66	Claystone	CS	95.1	95.1	0.0	0.0	9.80	417	0.02		6.7	0.6	-6.1	10.9	Non-Acid Forming (Barren)
157	05/07/2020	171870	171870_WC67	Claystone	CS	95.4	95.6	0.1	0.1	9.80	417	0.03		8.4	0.9	-7.5	9.1	Non-Acid Forming (Barren)
158	05/07/2020	171870	171870_WC68	Coal, <10% bright	CODM	95.6	95.7	0.2	0.2	9.40	197	0.19	0.025	71.3	0.8	-70.5	93.1	Non-Acid Forming
159	05/07/2020	171870	171870_WC69	Claystone	CS	96.1	96.2	0.1	0.1	9.60	493	0.05		54.4	1.5	-52.9	35.5	Non-Acid Forming (Barren)
160	05/07/2020	171870	171870_WC70	Claystone; tuffaceous	CS	96.2	96.8	0.6	0.6	9.60	317	0.02		8.9	0.6	-8.3	14.5	Non-Acid Forming (Barren)
161	05/07/2020	171870	171870_WC71	Siltstone	ST	97.8	98.0	0.3	0.3	9.70	468	0.02		24.9	0.6	-24.3	40.7	Non-Acid Forming (Barren)
162	05/07/2020	171870	171870_WC72	Sandstone, fine	SSFF	98.0	98.5	0.5	0.5	9.70	476	0.01		21.8	0.3	-21.5	71.2	Non-Acid Forming (Barren)
163	05/07/2020	171870	171870_WC73	Sandstone, fine-medium; common siltstone laminae nea	SSFM	98.5	99.3	0.7	0.7	9.90	320	0.02		39.8	0.6	-39.2	65.0	Non-Acid Forming (Barren)
164	05/07/2020	171870	171870_WC74	Sandstone, medium-coarse	SSMC	100.1	102.3	2.2	2.2	9.90	481	0.02		91.6	0.6	-91.0	149.6	Non-Acid Forming (Barren)
165	23/09/2020	171876	WC171876-01	Siltstone	ST	22.5	22.8	0.3	0.3	8.80	166	0.01		10.6	0.3	-10.3	34.6	Non-Acid Forming (Barren)
166	23/09/2020	171876	WC171876-02	Sandstone, medium-coarse	SSMC	23.4	23.7	0.3	0.3	9.20	230	<0.01		209.0	0.2	-208.8	1364.9	Non-Acid Forming (Barren)
167	23/09/2020	171876	WC171876-03	Sandstone, medium	SSMM	24.1	24.7	0.6	0.6	9.20	221	<0.01		106.0	0.2	-105.8	692.2	Non-Acid Forming (Barren)
168	23/09/2020	171876	WC171876-04	Sandstone, medium	SSMM	24.9	25.2	0.3	0.3	9.20	234	<0.01		37.4	0.2	-37.2	244.2	Non-Acid Forming (Barren)

Table B1: Acid Base Account Results for Spoil from the Stanmore Project

Sample No.	Date	Drill Hole ID	Client Sample ID	Sample Lithology	Lithology Code	From (m)	To (m)	Interval (m)	Depth (m)	pH (1:5)	EC (1:5) (µS/cm)	Total S (%)	Scr (%)	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
169	23/09/2020	171876	WC171876-05	Sandstone, medium	SSMM	25.2	25.6	0.4	0.4	9.00	256	<0.01		80.3	0.2	-80.1	524.4	Non-Acid Forming (Barren)
170	23/09/2020	171876	WC171876-06	Sandstone, medium-coarse	SSMC	25.6	26.9	1.3	1.3	9.20	217	<0.01		72.0	0.2	-71.8	470.2	Non-Acid Forming (Barren)
171	23/09/2020	171876	WC171876-07	Claystone	CS	26.9	27.1	0.2	0.2	9.20	271	0.01		7.5	0.3	-7.2	24.5	Non-Acid Forming (Barren)
172	23/09/2020	171876	WC171876-08	Claystone	CS	27.1	27.4	0.2	0.2	9.00	396	0.02		14.0	0.6	-13.4	22.9	Non-Acid Forming (Barren)
173	23/09/2020	171876	WC171876-09	Sandstone, very fine	SSVV	27.6	28.2	0.6	0.6	9.00	136	<0.01		13.9	0.2	-13.7	90.8	Non-Acid Forming (Barren)
174	23/09/2020	171876	WC171876-10	Sandstone, fine-medium	SSFM	28.8	29.5	0.7	0.7	9.10	268	<0.01		34.5	0.2	-34.3	225.3	Non-Acid Forming (Barren)
175	23/09/2020	171876	WC171876-11	Sandstone, medium	SSMM	29.5	30.2	0.7	0.7	9.20	228	<0.01		71.6	0.2	-71.4	467.6	Non-Acid Forming (Barren)
176	23/09/2020	171876	WC171876-12	Siltstone	ST	30.8	32.0	1.2	1.2	9.00	171	<0.01		14.8	0.2	-14.6	96.7	Non-Acid Forming (Barren)
177	23/09/2020	171876	WC171876-13	Sandstone, fine-medium; minor siltstone laminae	SSFM	32.0	32.6	0.6	0.6	9.10	262	<0.01		36.7	0.2	-36.5	239.7	Non-Acid Forming (Barren)
178	23/09/2020	171876	WC171876-14	Sandstone, fine-medium; minor siltstone laminae	SSFM	32.6	33.2	0.6	0.6	9.40	245	<0.01		130.0	0.2	-129.8	849.0	Non-Acid Forming (Barren)
179	23/09/2020	171876	WC171876-15	Siltstone; minor sandstone bands near middle of unit	ST	33.9	34.8	0.9	0.9	9.10	164	<0.01		12.2	0.2	-12.0	79.7	Non-Acid Forming (Barren)
180	23/09/2020	171876	WC171876-16	Siltstone; minor sandstone bands near middle of unit	ST	34.8	35.7	0.9	0.9	9.30	298	0.01		18.9	0.3	-18.6	61.7	Non-Acid Forming (Barren)
181	23/09/2020	171876	WC171876-17	Siltstone; minor sandstone laminae	ST	36.2	37.6	1.4	1.4	9.20	144	<0.01		21.8	0.2	-21.6	142.4	Non-Acid Forming (Barren)
182	23/09/2020	171876	WC171876-18	Sandstone, fine-medium	SSFM	37.6	37.8	0.2	0.2	9.40	245	<0.01		67.2	0.2	-67.0	438.9	Non-Acid Forming (Barren)
183	23/09/2020	171876	WC171876-19	Siltstone	ST	38.3	38.7	0.4	0.4	9.20	172	<0.01		20.4	0.2	-20.2	133.2	Non-Acid Forming (Barren)
184	23/09/2020	171876	WC171876-20	Siltstone; minor sandstone laminae near middle of unit; s	ST	39.2	40.4	1.2	1.2	9.30	127	<0.01		11.0	0.2	-10.8	71.8	Non-Acid Forming (Barren)
185	23/09/2020	171876	WC171876-21	Siltstone; minor sandstone laminae near base of unit	ST	40.5	41.5	1.1	1.1	9.40	276	<0.01		57.5	0.2	-57.3	375.5	Non-Acid Forming (Barren)
186	23/09/2020	171876	WC171876-22	Siltstone; rare sandstone bands	ST	41.9	43.2	1.3	1.3	9.30	286	<0.01		20.4	0.2	-20.2	133.2	Non-Acid Forming (Barren)
187	23/09/2020	171876	WC171876-23	Siltstone; rare sandstone bands	ST	43.2	44.5	1.3	1.3	9.20	165	<0.01		17.6	0.2	-17.4	114.9	Non-Acid Forming (Barren)
188	23/09/2020	171876	WC171876-24	Sandstone, fine; common siltstone laminae throughout	SSFF	45.2	45.9	0.6	0.6	9.40	286	<0.01		26.8	0.2	-26.6	175.0	Non-Acid Forming (Barren)
189	23/09/2020	171876	WC171876-25	Siltstone; common sandstone laminae near base of unit	ST	45.9	46.6	0.8	0.8	9.40	318	<0.01		31.5	0.2	-31.3	205.7	Non-Acid Forming (Barren)
190	23/09/2020	171876	WC171876-26	Sandstone, fine; abundant siltstone laminae throughout	SSFF	47.4	48.2	0.7	0.7	9.40	289	<0.01		14.2	0.2	-14.0	92.7	Non-Acid Forming (Barren)
191	23/09/2020	171876	WC171876-27	Siltstone; rare sandstone bands	ST	48.2	50.7	2.6	2.6	9.40	303	<0.01		44.4	0.2	-44.2	290.0	Non-Acid Forming (Barren)
192	23/09/2020	171876	WC171876-28	Sandstone, fine; common siltstone laminae	SSFF	50.7	50.9	0.2	0.2	9.30	275	<0.01		26.4	0.2	-26.2	172.4	Non-Acid Forming (Barren)
193	23/09/2020	171876	WC171876-29	Siltstone; common sandstone laminae near top of unit	ST	51.2	51.5	0.3	0.3	9.30	274	<0.01		15.1	0.2	-14.9	98.6	Non-Acid Forming (Barren)
194	23/09/2020	171876	WC171876-30	Sandstone, fine-medium; rare siltstone laminae	SSFM	51.9	53.9	2.1	2.1	9.40	234	<0.01		96.2	0.2	-96.0	628.2	Non-Acid Forming (Barren)
195	23/09/2020	171876	WC171876-31	Sandstone, medium	SSMM	54.2	54.3	0.1		9.40	239	<0.01		100.0	0.2	-99.8	653.1	Non-Acid Forming (Barren)
196	23/09/2020	171876	WC171876-32	Sandstone, medium	SSMM	54.3	57.2	2.9		9.40	214	<0.01		91.7	0.2	-91.5	598.9	Non-Acid Forming (Barren)
197	23/09/2020	171876	WC171876-33	Sandstone, very fine; common siltstone laminae	SSVV	57.5	57.7	0.2		9.20	197	0.01		21.1	0.3	-20.8	68.9	Non-Acid Forming (Barren)
198	23/09/2020	171876	WC171876-34	Sandstone, very fine; common siltstone laminae	SSVV	58.4	58.7	0.3		9.20	163	<0.01		15.3	0.2	-15.1	99.9	Non-Acid Forming (Barren)
199	23/09/2020	171876	WC171876-35	Siltstone; rare sandstone bands	ST	58.9	60.2	1.3		9.30	194	<0.01		17.2	0.2	-17.0	112.3	Non-Acid Forming (Barren)
200	23/09/2020	171876	WC171876-36	Siltstone	ST	60.2	61.4	1.2		9.20	215	<0.01		16.9	0.2	-16.7	110.4	Non-Acid Forming (Barren)

Notes:

1. Current pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; NAPP = Net Acid Producing Potential; NAG = Net Acid Generation.
3. Sample classification criteria detail provided in report text.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used .

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171773_21-21.2m	PTM_171773_23.6-23.8m	PTM_171773_28.2-28.4m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone; rare sandstone laminae near base of unit	Claystone	Sandstone, fine-medium; minor siltstone laminae
pH	0.1	-	9.20	9.20	9.40
Electrical Conductivity	1	-	290	363	283
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,700	2,800	25,100
Magnesium (Mg)	50	-	8,500	8,000	5,600
Potassium (K)	50	-	16,600	21,800	6,700
Sodium (Na)	50	-	2,510	1,740	5,330
Aluminium (Al)	50	-	103,000	97,600	85,700
Iron (Fe)	50	-	45,000	39,700	28,400
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	3	18
Barium (Ba)	10	-	174	229	185
Beryllium (Be)	1	90	2	2	1
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	36	59	47
Cobalt (Co)	5	300	18	12	19
Chromium (Cr)	0.1	300	44.90	48.30	41.20
Caesium (Cs)	5	-	8	11	3
Copper (Cu)	2	17,000	45	46	36
Gallium (Ga)	2	-	25	24	17
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	5	4	4
Mercury (Hg)	5	80	0	<0.005	0
Indium (In)	0.1	-	0.08	0.07	0.06
Lanthanum (La)	0.1	-	14.40	28.60	21.20
Lithium (Li)	5	-	51	37	40
Manganese (Mn)	5	19,000	294	286	1,010
Molybdenum (Mo)		-	0.2	0.3	1.0
Niobium (Nb)		-	10.1	10.65	7.94
Nickel (Ni)		1,200	29.50	26.00	24.40
Phosphorus (P)		-	690.00	430.00	440.00
Lead (Pb)		600	28.6	27.1	20.2
Rubidium (Rb)		-	69.40	133.50	28.40
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	100	100	400
Antimony (Sb)		-	0.7	0.8	1.0
Scandium (Sc)		-	19.1	19.1	16.7
Selenium (Se)		700	0.1	0.1	0.2
Tin (Sn)		-	2.58	2.83	1.88
Strontium (Sr)		-	97.2	103.0	137.0
Tantalum (Ta)		-	0.73	0.79	0.56
Tellerium (Te)		-	0.06	0.06	0.04
Thorium (Th)		-	8.28	12.60	8.61
Titanium (Ti)		-	5290.0	4920.0	4840.0
Thallium (Tl)		-	0.6	0.8	0.3
Uranium (U)		-	3.05	3.01	2.44
Vanadium (V)		-	137.50	131.5	118
Tungsten (W)		-	1.89	1.995	1.575
Yttrium (Y)		-	21.90	25.00	22.60
Zinc (Zn)		30,000	104.5	83.9	68.4
Zirconium (Zn)		-	169.0	159.0	140.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	23/09/2020	23/09/2020	23/09/2020
		Client ID →	PTM_171773_33.5-33.7m	PTM_171773_39.5-39.7m	PTM_171773_51-51.2m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone	Siltstone; minor sandstone bands	Siltstone
pH	0.1	-	9.60	9.60	9.50
Electrical Conductivity	1	-	240	271	238
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	58,500	2,700	6,300
Magnesium (Mg)	50	-	3,800	7,700	10,700
Potassium (K)	50	-	7,400	22,500	15,600
Sodium (Na)	50	-	3,930	1,780	3,060
Aluminium (Al)	50	-	61,200	103,000	85,200
Iron (Fe)	50	-	19,000	33,000	60,400
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	27	2	3
Barium (Ba)	10	-	125	267	257
Beryllium (Be)	1	90	1	2	2
Bismith (Bi)	1	-	0	1	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	42	40	59
Cobalt (Co)	5	300	18	12	20
Chromium (Cr)	0.1	300	53.60	43.30	48.40
Caesium (Cs)	5	-	3	14	7
Copper (Cu)	2	17,000	20	43	43
Gallium (Ga)	2	-	13	27	21
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	3	4	4
Mercury (Hg)	5	80	0	<0.005	<0.005
Indium (In)	0.1	-	0.05	0.08	0.07
Lanthanum (La)	0.1	-	18.55	18.25	27.20
Lithium (Li)	5	-	27	39	28
Manganese (Mn)	5	19,000	2,320	173	879
Molybdenum (Mo)		-	0.3	0.2	0.2
Niobium (Nb)		-	6.72	9.4	9.2
Nickel (Ni)		1,200	24.60	28.50	31.80
Phosphorus (P)		-	460.00	240.00	920.00
Lead (Pb)		600	37.3	21.0	16.4
Rubidium (Rb)		-	30.50	125.00	90.90
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	100	100	100
Antimony (Sb)		-	0.6	0.8	0.7
Scandium (Sc)		-	12.9	19.5	19.1
Selenium (Se)		700	0.1	0.1	0.1
Tin (Sn)		-	1.76	2.51	2.31
Strontium (Sr)		-	155.0	132.5	131.0
Tantalum (Ta)		-	0.48	0.67	0.66
Tellerium (Te)		-	0.03	0.04	0.05
Thorium (Th)		-	5.79	10.25	10.20
Titanium (Ti)		-	4390.0	4950.0	4380.0
Thallium (Tl)		-	0.2	0.9	0.6
Uranium (U)		-	1.81	2.41	2.73
Vanadium (V)		-	118.5	125.50	116.00
Tungsten (W)		-	1.41	1.845	1.84
Yttrium (Y)		-	22.00	18.00	31.40
Zinc (Zn)		30,000	46.3	77.8	108
Zirconium (Zn)		-	99.4	161.5	143.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171773_54.71-54.91m	PTM_171773_65-65.2m	PTM_171773_76.28-76.48m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, medium	Sandstone, fine; siltstone bands throughout; calcite common cement	Sandstone, fine; siltstone bands throughout; calcite sporadic cement
pH	0.1	-	9.40	9.50	9.40
Electrical Conductivity	1	-	195	222	218
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	179,500	24,900	25,400
Magnesium (Mg)	50	-	4,400	10,900	6,400
Potassium (K)	50	-	1,000	12,000	8,200
Sodium (Na)	50	-	380	3,470	3,180
Aluminium (Al)	50	-	8,100	79,500	84,600
Iron (Fe)	50	-	23,400	60,900	57,700
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	5	25	19
Barium (Ba)	10	-	111	241	810
Beryllium (Be)	1	90	1	2	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	31	53	54
Cobalt (Co)	5	300	9	27	20
Chromium (Cr)	0.1	300	10.85	50.00	79.00
Caesium (Cs)	5	-	1	5	3
Copper (Cu)	2	17,000	13	35	30
Gallium (Ga)	2	-	3	18	21
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	4	5
Mercury (Hg)	5	80	<0.004	0	0
Indium (In)	0.1	-	0.03	0.06	0.07
Lanthanum (La)	0.1	-	12.95	25.90	25.50
Lithium (Li)	5	-	12	27	34
Manganese (Mn)	5	19,000	2,870	1,410	973
Molybdenum (Mo)		-	0.1	0.8	1.3
Niobium (Nb)		-	0.01	7.73	9.69
Nickel (Ni)		1,200	9.50	30.00	28.50
Phosphorus (P)		-	1310.00	630.00	800.00
Lead (Pb)		600	18.7	36.8	21.3
Rubidium (Rb)		-	6.06	71.40	43.40
Rhenium (Re)		-	<0.0002	0.0004	<0.0004
Sulfur (S)		-	300	400	300
Antimony (Sb)		-	0.3	1.3	0.9
Scandium (Sc)		-	9.9	17.7	17.8
Selenium (Se)		700	0.0	0.2	0.1
Tin (Sn)		-	0.31	2.24	2.24
Strontium (Sr)		-	585.0	169.0	189.0
Tantalum (Ta)		-	<0.005	0.57	0.67
Tellerium (Te)		-	0.01	0.03	0.04
Thorium (Th)		-	3.83	9.32	11.40
Titanium (Ti)		-	40.0	4330.0	6090.0
Thallium (Tl)		-	0.0	0.4	0.3
Uranium (U)		-	0.59	2.68	2.91
Vanadium (V)		-	28.50	114.00	148.50
Tungsten (W)		-	0.009	1.52	1.88
Yttrium (Y)		-	32.20	26.30	27.50
Zinc (Zn)		30,000	29.4	111.5	100.5
Zirconium (Zn)		-	5.1	129.0	177.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	23/09/2020	23/09/2020	23/09/2020
		Client ID →	PTM_171773_78.29-78.36m	PTM_171773_80.49-81.37m	PTM_171773_82.84-83.03m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone; mudstone throughout	Coal, 10-40% bright	Mudstone; carbonaceous in part near top of unit
pH	0.1	-	9.20	8.60	9.20
Electrical Conductivity	1	-	209	143	181
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	4,500	5,600	1,000
Magnesium (Mg)	50	-	1,400	1,000	400
Potassium (K)	50	-	600	100	1,200
Sodium (Na)	50	-	440	200	450
Aluminium (Al)	50	-	7,300	4,600	3,400
Iron (Fe)	50	-	4,700	5,600	3,900
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	10	0	5
Barium (Ba)	10	-	73	20	201
Beryllium (Be)	1	90	1	0	1
Bismith (Bi)	1	-	1	0	1
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	24	3	2
Cobalt (Co)	5	300	8	1	2
Chromium (Cr)	0.1	300	9.63	2.43	1.53
Caesium (Cs)	5	-	2	0	4
Copper (Cu)	2	17,000	56	21	59
Gallium (Ga)	2	-	2	1	1
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.08	0.03	0.03
Lanthanum (La)	0.1	-	9.68	0.88	1.06
Lithium (Li)	5	-	9	15	2
Manganese (Mn)	5	19,000	160	38	6
Molybdenum (Mo)		-	0.8	0.2	1.4
Niobium (Nb)		-	0.05	0.013	0.028
Nickel (Ni)		1,200	10.05	1.05	5.06
Phosphorus (P)		-	150.00	1220.00	10.00
Lead (Pb)		600	21.7	3.7	19.8
Rubidium (Rb)		-	4.73	0.40	8.85
Rhenium (Re)		-	<0.0002	0.0007	0.0007
Sulfur (S)		-	200	1900	6000
Antimony (Sb)		-	0.4	0.1	0.2
Scandium (Sc)		-	6.1	2.3	2.3
Selenium (Se)		700	0.8	0.4	0.7
Tin (Sn)		-	0.88	0.24	0.30
Strontium (Sr)		-	58.4	43.5	77.9
Tantalum (Ta)		-	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.12	0.04	0.09
Thorium (Th)		-	4.73	1.19	1.02
Titanium (Ti)		-	30.0	10.0	10.0
Thallium (Tl)		-	0.0	<0.001	0.0
Uranium (U)		-	0.47	0.20	0.28
Vanadium (V)		-	21.10	10.70	5.90
Tungsten (W)		-	0.001	0.005	0.012
Yttrium (Y)		-	5.64	16.90	1.38
Zinc (Zn)		30,000	36	12.2	17.7
Zirconium (Zn)		-	6.2	2.1	6.2

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171773_83.91-84.19m	PTM_171773_87.5-87.7m	PTM_171773_101.7-101.93m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Carbonaceous Mudstone; coaly lenses throughout	Sandstone, fine-medium	Sandstone, fine; siltstone bands throughout
pH	0.1	-	9.70	9.70	9.20
Electrical Conductivity	1	-	230	315	391
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	1,800	27,900	46,000
Magnesium (Mg)	50	-	500	12,400	14,700
Potassium (K)	50	-	1,100	14,200	16,100
Sodium (Na)	50	-	460	12,100	6,340
Aluminium (Al)	50	-	2,600	71,700	76,400
Iron (Fe)	50	-	520	37,100	52,200
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	5	18	29
Barium (Ba)	10	-	1,070	244	378
Beryllium (Be)	1	90	1	1	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	3	40	46
Cobalt (Co)	5	300	3	16	14
Chromium (Cr)	0.1	300	1.10	48.10	52.40
Caesium (Cs)	5	-	6	3	6
Copper (Cu)	2	17,000	46	19	37
Gallium (Ga)	2	-	0	16	17
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	3	3
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.03	0.04	0.05
Lanthanum (La)	0.1	-	1.39	18.85	22.70
Lithium (Li)	5	-	1	17	24
Manganese (Mn)	5	19,000	15	791	1,080
Molybdenum (Mo)		-	0.4	0.6	0.8
Niobium (Nb)		-	0.031	6.04	6.87
Nickel (Ni)		1,200	4.00	23.60	28.60
Phosphorus (P)		-	10.00	670.00	850.00
Lead (Pb)		600	12.1	10.4	13.0
Rubidium (Rb)		-	11.35	60.20	72.90
Rhenium (Re)		-	0.0011	<0.0004	0.0004
Sulfur (S)		-	1100	200	200
Antimony (Sb)		-	0.1	0.6	0.6
Scandium (Sc)		-	2.6	15.2	13.8
Selenium (Se)		700	0.2	0.0	0.2
Tin (Sn)		-	0.24	1.45	1.68
Strontium (Sr)		-	120.5	337.0	397.0
Tantalum (Ta)		-	<0.005	0.41	0.47
Tellerium (Te)		-	0.05	0.02	0.03
Thorium (Th)		-	1.11	6.02	7.09
Titanium (Ti)		-	10.0	4120.0	4070.0
Thallium (Tl)		-	0.0	0.4	0.4
Uranium (U)		-	0.24	1.51	1.90
Vanadium (V)		-	5.20	114.00	104.50
Tungsten (W)		-	0.007	0.933	1.24
Yttrium (Y)		-	1.87	19.80	21.20
Zinc (Zn)		30,000	41.4	60.8	74.4
Zirconium (Zn)		-	5.0	97.5	114.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171773_103.5-103.8m	PTM_171773_103.98-104.18m	PTM_171773_105.8-106m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Carbonaceous Mudstone	Tuff; carbonaceous near top of unit near base of unit	Mudstone; clayey bands near base of unit
pH	0.1	-	9.30	9.40	9.00
Electrical Conductivity	1	-	229	163	173
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	3,300	2,500	2,000
Magnesium (Mg)	50	-	4,900	2,500	2,600
Potassium (K)	50	-	2,600	2,100	2,100
Sodium (Na)	50	-	1,330	1,480	1,230
Aluminium (Al)	50	-	13,900	10,300	10,900
Iron (Fe)	50	-	29,000	7,600	12,700
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	12	0	16
Barium (Ba)	10	-	277	319	290
Beryllium (Be)	1	90	1	1	1
Bismith (Bi)	1	-	0	0	1
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	15	4	5
Cobalt (Co)	5	300	31	2	45
Chromium (Cr)	0.1	300	11.60	7.54	9.44
Caesium (Cs)	5	-	4	5	4
Copper (Cu)	2	17,000	52	46	64
Gallium (Ga)	2	-	4	3	3
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.06	0.06	0.08
Lanthanum (La)	0.1	-	5.92	1.51	2.16
Lithium (Li)	5	-	16	12	13
Manganese (Mn)	5	19,000	651	54	198
Molybdenum (Mo)		-	3.3	0.3	5.6
Niobium (Nb)		-	0.007	0.006	0.009
Nickel (Ni)		1,200	38.40	5.49	53.00
Phosphorus (P)		-	600.00	20.00	30.00
Lead (Pb)		600	20.6	21.2	32.0
Rubidium (Rb)		-	12.95	11.55	11.40
Rhenium (Re)		-	0.0004	<0.0002	0.0005
Sulfur (S)		-	800	200	1200
Antimony (Sb)		-	0.9	0.1	1.9
Scandium (Sc)		-	5.2	3.6	5.1
Selenium (Se)		700	0.5	0.4	1.1
Tin (Sn)		-	0.63	0.57	0.79
Strontium (Sr)		-	244.0	275.0	225.0
Tantalum (Ta)		-	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.10	0.06	0.11
Thorium (Th)		-	3.08	1.89	2.08
Titanium (Ti)		-	10.0	10.0	10.0
Thallium (Tl)		-	0.0	0.0	0.0
Uranium (U)		-	0.39	0.42	0.45
Vanadium (V)		-	32.50	15.40	23.60
Tungsten (W)		-	0.009	0.001	0.006
Yttrium (Y)		-	8.67	2.94	5.14
Zinc (Zn)		30,000	98.9	71.9	104.5
Zirconium (Zn)		-	2.9	3.0	4.8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171773_108.5-108.7m	PTM_171773_109.02-109.16m	PTM_171773_109.35-109.43m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Mudstone; carbonaceous in part near base of unit	Carbonaceous Mudstone; coaly lenses throughout	Mudstone
pH	0.1	-	9.50	9.70	9.50
Electrical Conductivity	1	-	168	96	118
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,100	1,000	2,400
Magnesium (Mg)	50	-	7,900	400	1,900
Potassium (K)	50	-	26,900	1,000	1,800
Sodium (Na)	50	-	5,660	630	1,540
Aluminium (Al)	50	-	103,000	2,900	9,900
Iron (Fe)	50	-	28,800	630	5,800
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	1	5
Barium (Ba)	10	-	590	146	380
Beryllium (Be)	1	90	2	1	1
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	61	3	5
Cobalt (Co)	5	300	9	3	2
Chromium (Cr)	0.1	300	37.30	1.43	6.40
Caesium (Cs)	5	-	19	5	7
Copper (Cu)	2	17,000	53	31	41
Gallium (Ga)	2	-	26	0	3
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	5	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.08	0.02	0.05
Lanthanum (La)	0.1	-	27.20	1.47	2.09
Lithium (Li)	5	-	34	2	15
Manganese (Mn)	5	19,000	299	26	41
Molybdenum (Mo)		-	0.4	0.1	0.2
Niobium (Nb)		-	9.44	0.039	0.012
Nickel (Ni)		1,200	23.40	3.26	12.20
Phosphorus (P)		-	360.00	10.00	30.00
Lead (Pb)		600	26.4	12.3	15.8
Rubidium (Rb)		-	143.50	7.88	12.35
Rhenium (Re)		-	<0.0004	0.0006	0.0004
Sulfur (S)		-	300	200	100
Antimony (Sb)		-	0.6	0.0	0.0
Scandium (Sc)		-	18.4	1.8	4.6
Selenium (Se)		700	0.5	0.3	0.2
Tin (Sn)		-	2.67	0.30	0.80
Strontium (Sr)		-	421.0	112.5	292.0
Tantalum (Ta)		-	0.69	<0.005	<0.005
Tellerium (Te)		-	0.10	0.04	0.05
Thorium (Th)		-	11.65	1.03	2.13
Titanium (Ti)		-	4310.0	10.0	10.0
Thallium (Tl)		-	0.9	0.0	0.0
Uranium (U)		-	2.90	0.24	0.42
Vanadium (V)		-	140.50	6.70	18.10
Tungsten (W)		-	1.93	0.009	0.002
Yttrium (Y)		-	25.60	1.43	3.46
Zinc (Zn)		30,000	101	10.5	28.9
Zirconium (Zn)		-	167.5	4.7	3.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	05/07/2020	05/07/2020	05/07/2020
		Client ID →	PTM_171870_17.29-18.1m	PTM_171870_22.66-23.2m	PTM_171870_30.87-33.92m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, fine-medium	Clay	Siltstone
pH	0.1	-	9.20	9.60	9.50
Electrical Conductivity	1	-	346	329	301
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	15,000	5,500	7,700
Magnesium (Mg)	50	-	7,200	7,800	8,100
Potassium (K)	50	-	17,600	19,500	14,800
Sodium (Na)	50	-	2,410	2,390	3,660
Aluminium (Al)	50	-	94,500	103,500	108,500
Iron (Fe)	50	-	39,800	45,300	47,800
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	3	2
Barium (Ba)	10	-	510	245	255
Beryllium (Be)	1	90	2	2	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	60	64	61
Cobalt (Co)	5	300	16	15	18
Chromium (Cr)	0.1	300	64.80	56.30	52.60
Caesium (Cs)	5	-	7	13	8
Copper (Cu)	2	17,000	86	45	60
Gallium (Ga)	2	-	21	24	21
Germanium (Ge)	5	-	<0.05	<0.05	<0.05
Hafnium (Hf)	5	-	4	4	4
Mercury (Hg)	5	80	0	<0.005	<0.005
Indium (In)	0.1	-	0.07	0.07	0.07
Lanthanum (La)	0.1	-	28.90	31.20	29.70
Lithium (Li)	5	-	31	31	41
Manganese (Mn)	5	19,000	769	2,110	775
Molybdenum (Mo)		-	0.4	0.4	0.3
Niobium (Nb)		-	8.83	8.65	8.82
Nickel (Ni)		1,200	37.30	27.10	31.20
Phosphorus (P)		-	370.00	390.00	550.00
Lead (Pb)		600	19.6	28.0	20.2
Rubidium (Rb)		-	101.50	131.00	91.30
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	200	100	100
Antimony (Sb)		-	0.7	0.7	0.7
Scandium (Sc)		-	17.7	19.0	18.5
Selenium (Se)		700	0.1	0.0	0.1
Tin (Sn)		-	4.89	2.83	2.76
Strontium (Sr)		-	113.0	134.0	141.5
Tantalum (Ta)		-	0.69	0.66	0.67
Tellerium (Te)		-	0.04	0.04	0.05
Thorium (Th)		-	10.45	10.55	10.75
Titanium (Ti)		-	4860.0	5310.0	5610.0
Thallium (Tl)		-	0.6	0.8	0.5
Uranium (U)		-	2.64	2.63	2.71
Vanadium (V)		-	122.00	127.00	132.00
Tungsten (W)		-	4.13	3.17	2.27
Yttrium (Y)		-	22.00	25.50	25.90
Zinc (Zn)		30,000	89	92.8	100.5
Zirconium (Zn)		-	141.5	144.5	154.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	05/07/2020	05/07/2020	05/07/2020
		Client ID →	PTM_171870_41.99-42.65m	PTM_171870_45.35-48.23m	PTM_171870_57.26-58.92m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, fine	Siltstone; minor sandstone laminae near base of unit	Siltstone; minor sandstone bands
pH	0.1	-	9.40	9.30	9.40
Electrical Conductivity	1	-	273	249	287
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	5,900	5,300	14,900
Magnesium (Mg)	50	-	7,900	9,300	8,900
Potassium (K)	50	-	13,200	19,300	16,400
Sodium (Na)	50	-	4,110	4,340	4,630
Aluminium (Al)	50	-	100,500	97,700	107,500
Iron (Fe)	50	-	45,600	49,500	42,900
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	8	3
Barium (Ba)	10	-	248	308	308
Beryllium (Be)	1	90	2	2	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	55	64	66
Cobalt (Co)	5	300	19	18	17
Chromium (Cr)	0.1	300	57.40	57.90	57.40
Caesium (Cs)	5	-	7	8	7
Copper (Cu)	2	17,000	51	51	55
Gallium (Ga)	2	-	22	21	24
Germanium (Ge)	5	-	<0.05	<0.05	<0.05
Hafnium (Hf)	5	-	4	4	5
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.07	0.07	0.07
Lanthanum (La)	0.1	-	26.50	31.70	32.60
Lithium (Li)	5	-	35	27	34
Manganese (Mn)	5	19,000	793	700	741
Molybdenum (Mo)		-	0.4	0.8	0.3
Niobium (Nb)		-	7.9	9.69	10.05
Nickel (Ni)		1,200	30.60	36.20	32.40
Phosphorus (P)		-	530.00	850.00	810.00
Lead (Pb)		600	20.0	27.6	22.3
Rubidium (Rb)		-	82.50	112.00	98.50
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	100	200	100
Antimony (Sb)		-	0.9	1.2	1.0
Scandium (Sc)		-	18.5	19.0	19.7
Selenium (Se)		700	0.1	0.1	0.1
Tin (Sn)		-	3.04	3.05	2.97
Strontium (Sr)		-	136.0	143.5	184.5
Tantalum (Ta)		-	0.60	0.73	0.73
Tellerium (Te)		-	0.05	0.05	0.06
Thorium (Th)		-	11.05	10.85	12.15
Titanium (Ti)		-	5150.0	5190.0	5930.0
Thallium (Tl)		-	0.5	0.6	0.6
Uranium (U)		-	2.87	2.63	3.18
Vanadium (V)		-	123.00	125.00	128.50
Tungsten (W)		-	4.65	2.39	2.31
Yttrium (Y)		-	22.60	28.40	27.30
Zinc (Zn)		30,000	97.6	102.5	100.5
Zirconium (Zn)		-	134.0	150.5	164.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	05/07/2020	05/07/2020	05/07/2020
		Client ID →	PTM_171870_67.32-69.13m	PTM_171870_75.3-76.2m	PTM_171870_76.2-76.31m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone; common sandstone laminae throughout; calcite rare in veins	Coal, 10-40% bright	Claystone
pH	0.1	-	9.20	4.50	5.40
Electrical Conductivity	1	-	283	272	345
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	17,600	1,300	3,900
Magnesium (Mg)	50	-	6,900	500	800
Potassium (K)	50	-	13,500	600	2,000
Sodium (Na)	50	-	2,870	300	800
Aluminium (Al)	50	-	103,500	2,300	5,700
Iron (Fe)	50	-	42,900	2,270	4,500
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	14	0	1
Barium (Ba)	10	-	277	29	141
Beryllium (Be)	1	90	2	0	1
Bismith (Bi)	1	-	0	0	1
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	66	3	11
Cobalt (Co)	5	300	18	1	3
Chromium (Cr)	0.1	300	61.90	2.58	5.55
Caesium (Cs)	5	-	6	2	6
Copper (Cu)	2	17,000	57	33	73
Gallium (Ga)	2	-	23	1	2
Germanium (Ge)	5	-	<0.05	0	0
Hafnium (Hf)	5	-	5	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.07	0.03	0.05
Lanthanum (La)	0.1	-	31.90	1.25	4.24
Lithium (Li)	5	-	35	4	6
Manganese (Mn)	5	19,000	846	29	41
Molybdenum (Mo)		-	0.5	0.4	0.7
Niobium (Nb)		-	9.67	0.024	0.044
Nickel (Ni)		1,200	34.00	1.49	6.20
Phosphorus (P)		-	840.00	300.00	1120.00
Lead (Pb)		600	22.6	7.9	29.0
Rubidium (Rb)		-	76.10	4.75	13.80
Rhenium (Re)		-	<0.0004	0.0003	0.0009
Sulfur (S)		-	200	300	500
Antimony (Sb)		-	0.8	0.1	0.4
Scandium (Sc)		-	19.5	1.7	3.4
Selenium (Se)		700	0.1	0.7	1.2
Tin (Sn)		-	3.23	0.33	0.50
Strontium (Sr)		-	171.0	35.5	139.0
Tantalum (Ta)		-	0.73	<0.005	<0.005
Tellerium (Te)		-	0.06	0.04	0.10
Thorium (Th)		-	11.30	1.65	5.98
Titanium (Ti)		-	5620.0	10.0	20.0
Thallium (Tl)		-	0.5	0.0	0.0
Uranium (U)		-	2.83	0.31	0.50
Vanadium (V)		-	125.00	7.10	12.20
Tungsten (W)		-	2.55	0.007	0.01
Yttrium (Y)		-	28.60	3.51	6.96
Zinc (Zn)		30,000	98.2	5.7	12.3
Zirconium (Zn)		-	162.5	3.5	10.9

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

			Sampling Date →	05/07/2020	05/07/2020	05/07/2020
			Client ID →	PTM_171870_76.31-77.04m	PTM_171870_77.04-77.82m	PTM_171870_79.08-81.08m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C		Coal, <10% bright	Mudstone	Sandstone, fine-medium; common siltstone laminae near middle of unit
pH	0.1	-		4.50	5.10	8.20
Electrical Conductivity	1	-		160	304	295
Major Cations		-		All units mg/kg		
Calcium (Ca)	50	-		3,100	1,200	4,800
Magnesium (Mg)	50	-		300	600	5,500
Potassium (K)	50	-		300	1,600	17,700
Sodium (Na)	50	-		240	680	7,300
Aluminium (Al)	50	-		3,000	3,300	106,500
Iron (Fe)	50	-		1,170	3,000	15,000
Minor and Trace Elements		-		All units mg/kg		
Silver (Ag)	5	-		0	0	0
Arsenic (As)	50	300		1	3	24
Barium (Ba)	10	-		24	121	389
Beryllium (Be)	1	90		0	1	2
Bismith (Bi)	1	-		0	0	0
Cadmium (Cd)	2	90		0	0	0
Cerium (Ce)	2	-		8	3	76
Cobalt (Co)	5	300		2	4	22
Chromium (Cr)	0.1	300		2.54	3.97	71.20
Caesium (Cs)	5	-		1	4	7
Copper (Cu)	2	17,000		28	55	59
Gallium (Ga)	2	-		0	1	24
Germanium (Ge)	5	-		0	0	<0.05
Hafnium (Hf)	5	-		0	0	4
Mercury (Hg)	5	80		0	0	0
Indium (In)	0.1	-		0.01	0.03	0.06
Lanthanum (La)	0.1	-		3.27	1.34	35.00
Lithium (Li)	5	-		5	2	26
Manganese (Mn)	5	19,000		10	61	178
Molybdenum (Mo)		-		0.3	0.6	1.7
Niobium (Nb)		-		0.036	0.055	8.79
Nickel (Ni)		1,200		2.90	8.01	47.10
Phosphorus (P)		-		1210.00	10.00	680.00
Lead (Pb)		600		5.8	18.2	20.2
Rubidium (Rb)		-		2.51	10.35	85.70
Rhenium (Re)		-		0.0004	0.0011	0.0005
Sulfur (S)		-		300	500	500
Antimony (Sb)		-		0.1	0.2	1.1
Scandium (Sc)		-		1.7	2.7	20.7
Selenium (Se)		700		0.4	0.3	0.2
Tin (Sn)		-		0.19	0.35	2.87
Strontium (Sr)		-		62.2	96.1	298.0
Tantalum (Ta)		-		<0.005	<0.005	0.64
Tellerium (Te)		-		0.03	0.07	0.06
Thorium (Th)		-		1.81	1.01	9.15
Titanium (Ti)		-		10.0	20.0	5850.0
Thallium (Tl)		-		0.0	0.0	0.5
Uranium (U)		-		0.40	0.29	2.45
Vanadium (V)		-		11.00	6.90	166.50
Tungsten (W)		-		0.012	0.015	3.87
Yttrium (Y)		-		4.67	1.18	28.90
Zinc (Zn)		30,000		9.4	31.1	129
Zirconium (Zn)		-		2.8	8.7	145.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	05/07/2020	05/07/2020	05/07/2020
		Client ID →	PTM_171870_85.51-86.36m	PTM_171870_91.77-92.35m	PTM_171870_93.16-94.3m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, coarse	Mudstone	Coal, <10% bright
pH	0.1	-	9.70	9.50	8.50
Electrical Conductivity	1	-	345	394	72
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	11,300	5,600	9,000
Magnesium (Mg)	50	-	7,100	3,800	3,600
Potassium (K)	50	-	19,100	2,500	200
Sodium (Na)	50	-	10,500	1,280	250
Aluminium (Al)	50	-	84,800	8,900	2,100
Iron (Fe)	50	-	16,200	31,100	23,000
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	24	18	0
Barium (Ba)	10	-	379	264	22
Beryllium (Be)	1	90	1	1	0
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	49	14	6
Cobalt (Co)	5	300	17	31	1
Chromium (Cr)	0.1	300	87.90	7.86	2.53
Caesium (Cs)	5	-	6	3	0
Copper (Cu)	2	17,000	60	50	18
Gallium (Ga)	2	-	18	3	1
Germanium (Ge)	5	-	<0.05	0	0
Hafnium (Hf)	5	-	3	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.05	0.06	0.01
Lanthanum (La)	0.1	-	23.80	5.28	2.11
Lithium (Li)	5	-	12	8	3
Manganese (Mn)	5	19,000	253	766	374
Molybdenum (Mo)		-	1.5	2.6	0.2
Niobium (Nb)		-	6.98	0.006	0.034
Nickel (Ni)		1,200	45.90	40.70	1.55
Phosphorus (P)		-	650.00	430.00	140.00
Lead (Pb)		600	16.2	21.5	3.5
Rubidium (Rb)		-	83.30	11.70	1.10
Rhenium (Re)		-	0.0005	0.0006	0.0004
Sulfur (S)		-	300	700	300
Antimony (Sb)		-	0.8	0.7	0.1
Scandium (Sc)		-	16.2	4.7	1.4
Selenium (Se)		700	0.1	0.6	0.2
Tin (Sn)		-	3.47	0.62	0.35
Strontium (Sr)		-	317.0	222.0	43.6
Tantalum (Ta)		-	0.51	<0.005	<0.005
Tellerium (Te)		-	0.04	0.10	0.01
Thorium (Th)		-	7.24	2.55	1.02
Titanium (Ti)		-	4760.0	10.0	10.0
Thallium (Tl)		-	0.5	0.0	<0.001
Uranium (U)		-	1.88	0.36	0.14
Vanadium (V)		-	152.50	22.00	5.40
Tungsten (W)		-	8.35	0.011	0.056
Yttrium (Y)		-	22.50	7.73	2.51
Zinc (Zn)		30,000	87	83.2	9.7
Zirconium (Zn)		-	110.5	2.3	2.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

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Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		05/07/2020	05/07/2020	05/07/2020
	Client ID →		PTM_171870_94.3-94.67m	PTM_171870_94.67-95.05m	PTM_171870_95.55-96.06m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone	Coal, dull <1% bright	Coal, <10% bright
pH	0.1	-	9.30	8.40	9.40
Electrical Conductivity	1	-	338	82	197
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,300	600	36,400
Magnesium (Mg)	50	-	1,400	500	7,000
Potassium (K)	50	-	2,500	400	700
Sodium (Na)	50	-	1,590	190	570
Aluminium (Al)	50	-	6,400	1,900	2,800
Iron (Fe)	50	-	17,300	3,400	10,400
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	12	0	2
Barium (Ba)	10	-	295	38	82
Beryllium (Be)	1	90	1	0	0
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	6	14	15
Cobalt (Co)	5	300	25	2	5
Chromium (Cr)	0.1	300	4.42	3.75	4.45
Caesium (Cs)	5	-	4	1	1
Copper (Cu)	2	17,000	65	25	21
Gallium (Ga)	2	-	2	0	0
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.06	0.02	0.03
Lanthanum (La)	0.1	-	2.37	4.70	5.22
Lithium (Li)	5	-	5	2	3
Manganese (Mn)	5	19,000	255	41	274
Molybdenum (Mo)		-	8.6	0.1	0.6
Niobium (Nb)		-	0.007	0.025	0.041
Nickel (Ni)		1,200	30.20	3.20	6.56
Phosphorus (P)		-	100.00	30.00	50.00
Lead (Pb)		600	26.3	5.6	13.3
Rubidium (Rb)		-	12.35	2.18	3.41
Rhenium (Re)		-	0.0005	0.0003	0.0004
Sulfur (S)		-	900	200	200
Antimony (Sb)		-	0.6	0.0	0.1
Scandium (Sc)		-	4.6	1.6	2.8
Selenium (Se)		700	0.9	0.2	0.4
Tin (Sn)		-	0.64	0.35	0.63
Strontium (Sr)		-	249.0	32.8	243.0
Tantalum (Ta)		-	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.10	0.02	0.04
Thorium (Th)		-	2.28	2.00	2.43
Titanium (Ti)		-	<5	10.0	10.0
Thallium (Tl)		-	0.0	<0.001	<0.001
Uranium (U)		-	0.48	0.38	0.41
Vanadium (V)		-	14.50	12.20	12.70
Tungsten (W)		-	0.008	0.022	0.016
Yttrium (Y)		-	6.99	4.95	5.12
Zinc (Zn)		30,000	95.6	47	25.2
Zirconium (Zn)		-	3.4	2.7	3.8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		05/07/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171870_96.06-96.2m	PTM_171876_23.42-23.69m	PTM_171876_24.3-24.5m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Claystone	Sandstone, medium-coarse	Sandstone, medium
pH	0.1	-	9.60	9.20	9.20
Electrical Conductivity	1	-	493	230	221
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	13,900	79,000	40,200
Magnesium (Mg)	50	-	5,700	4,500	5,000
Potassium (K)	50	-	2,000	7,100	6,300
Sodium (Na)	50	-	1,720	3,910	4,730
Aluminium (Al)	50	-	9,800	61,900	56,600
Iron (Fe)	50	-	14,300	31,800	37,600
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	0	3	3
Barium (Ba)	10	-	293	133	164
Beryllium (Be)	1	90	1	1	1
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	7	40	45
Cobalt (Co)	5	300	2	13	16
Chromium (Cr)	0.1	300	5.86	57.00	69.80
Caesium (Cs)	5	-	3	3	3
Copper (Cu)	2	17,000	113	23	18
Gallium (Ga)	2	-	3	13	13
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	3	3
Mercury (Hg)	5	80	0	<0.005	<0.005
Indium (In)	0.1	-	0.08	0.04	0.04
Lanthanum (La)	0.1	-	2.22	18.20	20.10
Lithium (Li)	5	-	12	22	17
Manganese (Mn)	5	19,000	249	3,580	1,880
Molybdenum (Mo)		-	1.4	0.4	0.4
Niobium (Nb)		-	0.005	5.95	5.92
Nickel (Ni)		1,200	7.45	27.00	25.30
Phosphorus (P)		-	120.00	820.00	570.00
Lead (Pb)		600	30.0	17.0	14.1
Rubidium (Rb)		-	9.00	41.20	36.50
Rhenium (Re)		-	0.0006	<0.0004	<0.0004
Sulfur (S)		-	200	50	100
Antimony (Sb)		-	0.1	0.5	0.6
Scandium (Sc)		-	5.0	12.0	11.8
Selenium (Se)		700	0.4	0.1	0.1
Tin (Sn)		-	1.35	1.60	1.60
Strontium (Sr)		-	319.0	161.5	121.5
Tantalum (Ta)		-	<0.005	0.43	0.42
Tellerium (Te)		-	0.05	0.03	0.03
Thorium (Th)		-	4.33	6.00	6.28
Titanium (Ti)		-	10.0	3530.0	3470.0
Thallium (Tl)		-	0.0	0.2	0.2
Uranium (U)		-	0.75	1.51	1.70
Vanadium (V)		-	23.20	109.50	104.50
Tungsten (W)		-	0.002	1.2	1.21
Yttrium (Y)		-	4.67	19.00	17.95
Zinc (Zn)		30,000	45.9	51.4	58.2
Zirconium (Zn)		-	3.3	96.2	94.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_26.9-27.08m	PTM_171876_27.12-27.35m	PTM_171876_34-34.2m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Claystone	Claystone	Siltstone; minor sandstone bands near middle of unit
pH	0.1	-	9.20	9.00	9.10
Electrical Conductivity	1	-	271	396	164
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	1,800	3,400	1,500
Magnesium (Mg)	50	-	5,900	6,600	8,300
Potassium (K)	50	-	24,800	25,400	17,700
Sodium (Na)	50	-	1,280	1,250	3,520
Aluminium (Al)	50	-	88,600	92,400	91,800
Iron (Fe)	50	-	30,900	39,900	48,100
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	4	4	2
Barium (Ba)	10	-	590	640	180
Beryllium (Be)	1	90	3	3	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	37	41	53
Cobalt (Co)	5	300	10	12	20
Chromium (Cr)	0.1	300	47.40	49.00	59.40
Caesium (Cs)	5	-	16	15	7
Copper (Cu)	2	17,000	44	40	71
Gallium (Ga)	2	-	26	24	22
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	5	4	4
Mercury (Hg)	5	80	<0.005	<0.005	<0.005
Indium (In)	0.1	-	0.07	0.07	0.06
Lanthanum (La)	0.1	-	17.80	17.75	26.60
Lithium (Li)	5	-	23	26	27
Manganese (Mn)	5	19,000	88	165	285
Molybdenum (Mo)		-	0.3	0.3	0.2
Niobium (Nb)		-	10.8	9.89	8.91
Nickel (Ni)		1,200	20.50	23.80	34.20
Phosphorus (P)		-	150.00	270.00	270.00
Lead (Pb)		600	13.5	21.4	13.1
Rubidium (Rb)		-	158.50	143.50	104.50
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	200	200	100
Antimony (Sb)		-	0.9	0.9	0.7
Scandium (Sc)		-	18.8	17.9	19.0
Selenium (Se)		700	0.1	0.0	0.0
Tin (Sn)		-	2.63	2.56	2.35
Strontium (Sr)		-	100.5	118.0	110.0
Tantalum (Ta)		-	0.77	0.71	0.65
Tellerium (Te)		-	0.04	0.04	0.04
Thorium (Th)		-	10.50	8.97	9.58
Titanium (Ti)		-	5310.0	4950.0	4790.0
Thallium (Tl)		-	1.0	1.0	0.6
Uranium (U)		-	2.12	2.40	2.43
Vanadium (V)		-	129.00	123.50	112.00
Tungsten (W)		-	2.03	2.04	1.52
Yttrium (Y)		-	16.75	21.10	20.50
Zinc (Zn)		30,000	58.3	70.8	98.2
Zirconium (Zn)		-	170.5	157.5	144.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_39.8-40m	PTM_171876_45.3-45.5m	PTM_171876_52-52.2m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Siltstone; minor sandstone laminae near middle of unit; siderite rare	Sandstone, fine; common siltstone laminae throughout	Sandstone, fine-medium; rare siltstone laminae
pH	0.1	-	9.30	9.40	9.40
Electrical Conductivity	1	-	127	286	234
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	1,200	7,700	36,700
Magnesium (Mg)	50	-	6,700	8,500	5,800
Potassium (K)	50	-	23,600	12,000	8,700
Sodium (Na)	50	-	2,350	4,810	5,220
Aluminium (Al)	50	-	98,400	99,500	69,700
Iron (Fe)	50	-	25,900	42,100	32,600
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	2	22
Barium (Ba)	10	-	286	199	151
Beryllium (Be)	1	90	2	2	1
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	55	53	41
Cobalt (Co)	5	300	9	17	17
Chromium (Cr)	0.1	300	53.90	49.50	57.30
Caesium (Cs)	5	-	12	6	3
Copper (Cu)	2	17,000	39	45	23
Gallium (Ga)	2	-	23	23	15
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	5	4	3
Mercury (Hg)	5	80	<0.005	0	0
Indium (In)	0.1	-	0.08	0.08	0.04
Lanthanum (La)	0.1	-	26.70	25.20	18.65
Lithium (Li)	5	-	31	44	21
Manganese (Mn)	5	19,000	79	537	951
Molybdenum (Mo)		-	0.3	0.3	0.7
Niobium (Nb)		-	11.5	9.33	7.29
Nickel (Ni)		1,200	27.50	27.60	27.40
Phosphorus (P)		-	180.00	630.00	580.00
Lead (Pb)		600	16.6	19.8	19.1
Rubidium (Rb)		-	142.00	68.20	40.60
Rhenium (Re)		-	<0.0004	<0.0004	<0.0004
Sulfur (S)		-	100	100	100
Antimony (Sb)		-	0.9	0.7	1.7
Scandium (Sc)		-	18.4	19.2	14.1
Selenium (Se)		700	0.1	0.1	0.2
Tin (Sn)		-	3.07	2.31	1.85
Strontium (Sr)		-	123.5	131.0	176.5
Tantalum (Ta)		-	0.84	0.67	0.53
Tellerium (Te)		-	0.06	0.05	0.03
Thorium (Th)		-	12.20	11.65	7.97
Titanium (Ti)		-	5210.0	5540.0	4390.0
Thallium (Tl)		-	0.8	0.4	0.3
Uranium (U)		-	2.80	2.39	1.85
Vanadium (V)		-	146.50	128.50	107.50
Tungsten (W)		-	2.11	1.86	1.4
Yttrium (Y)		-	20.30	22.00	21.40
Zinc (Zn)		30,000	62.9	103	67.3
Zirconium (Zn)		-	164.0	156.0	115.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	23/09/2020	23/09/2020	23/09/2020
		Client ID →	PTM_171876_58.4-58.6m	PTM_171876_64-64.2m	PTM_171876_69.2-69.4m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, very fine; common siltstone laminae	Siltstone; abundant sandstone bands throughout	Sandstone, fine; common siltstone bands throughout
pH	0.1	-	9.20	9.50	9.30
Electrical Conductivity	1	-	163	255	236
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,800	23,200	49,000
Magnesium (Mg)	50	-	7,900	12,400	11,000
Potassium (K)	50	-	17,200	12,000	7,200
Sodium (Na)	50	-	3,560	3,450	3,760
Aluminium (Al)	50	-	111,500	73,800	70,600
Iron (Fe)	50	-	36,300	99,800	97,700
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	3	11	5
Barium (Ba)	10	-	279	247	233
Beryllium (Be)	1	90	2	3	2
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	44	64	52
Cobalt (Co)	5	300	16	27	30
Chromium (Cr)	0.1	300	41.20	48.70	54.30
Caesium (Cs)	5	-	8	5	3
Copper (Cu)	2	17,000	52	36	24
Gallium (Ga)	2	-	26	17	16
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	5	3	3
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.07	0.06	0.05
Lanthanum (La)	0.1	-	21.00	29.10	24.70
Lithium (Li)	5	-	48	23	28
Manganese (Mn)	5	19,000	333	3,090	2,310
Molybdenum (Mo)		-	0.3	0.4	0.5
Niobium (Nb)		-	9.26	7.4	7.55
Nickel (Ni)		1,200	24.90	30.00	28.80
Phosphorus (P)		-	670.00	1850.00	1850.00
Lead (Pb)		600	14.3	28.5	25.8
Rubidium (Rb)		-	87.40	70.30	41.00
Rhenium (Re)		-	<0.0004	0.0004	<0.0004
Sulfur (S)		-	100	300	100
Antimony (Sb)		-	0.8	0.7	0.5
Scandium (Sc)		-	19.8	19.7	20.2
Selenium (Se)		700	0.1	0.2	0.1
Tin (Sn)		-	2.41	1.75	1.64
Strontium (Sr)		-	160.0	170.5	226.0
Tantalum (Ta)		-	0.66	0.54	0.51
Tellerium (Te)		-	0.09	0.04	0.03
Thorium (Th)		-	11.00	9.04	8.86
Titanium (Ti)		-	5410.0	4130.0	4550.0
Thallium (Tl)		-	0.7	0.4	0.2
Uranium (U)		-	2.76	2.43	2.35
Vanadium (V)		-	138.00	115.00	120.00
Tungsten (W)		-	1.885	1.47	1.4
Yttrium (Y)		-	21.10	39.90	40.90
Zinc (Zn)		30,000	96.5	136	119
Zirconium (Zn)		-	165.0	131.5	138.0

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	23/09/2020	23/09/2020	23/09/2020
		Client ID →	PTM_171876_76.8-77m	PTM_171876_78-78.4m	PTM_171876_81.81-82.04m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Mudstone	Coal, 10-40% bright	Mudstone
pH	0.1	-	8.80	8.90	8.90
Electrical Conductivity	1	-	241	112	97
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,200	3,800	1,300
Magnesium (Mg)	50	-	2,000	700	3,300
Potassium (K)	50	-	6,000	100	21,900
Sodium (Na)	50	-	1,060	250	1,520
Aluminium (Al)	50	-	147,500	2,400	115,000
Iron (Fe)	50	-	7,300	4,400	6,700
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	6	0	3
Barium (Ba)	10	-	238	13	480
Beryllium (Be)	1	90	3	0	2
Bismith (Bi)	1	-	1	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	20	2	38
Cobalt (Co)	5	300	7	1	1
Chromium (Cr)	0.1	300	47.50	3.14	33.90
Caesium (Cs)	5	-	5	0	16
Copper (Cu)	2	17,000	53	22	64
Gallium (Ga)	2	-	38	1	30
Germanium (Ge)	5	-	<0.05	0	0
Hafnium (Hf)	5	-	8	0	4
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.12	0.02	0.08
Lanthanum (La)	0.1	-	8.18	1.05	21.20
Lithium (Li)	5	-	168	4	34
Manganese (Mn)	5	19,000	57	41	30
Molybdenum (Mo)		-	4.1	0.3	0.5
Niobium (Nb)		-	19.7	0.02	10.1
Nickel (Ni)		1,200	26.50	1.08	9.66
Phosphorus (P)		-	210.00	150.00	130.00
Lead (Pb)		600	31.4	6.6	16.1
Rubidium (Rb)		-	32.00	0.42	125.00
Rhenium (Re)		-	<0.0004	0.0004	<0.0004
Sulfur (S)		-	100	200	300
Antimony (Sb)		-	1.1	0.1	0.6
Scandium (Sc)		-	19.4	2.0	14.3
Selenium (Se)		700	0.5	0.7	0.4
Tin (Sn)		-	5.63	0.22	3.02
Strontium (Sr)		-	118.0	31.3	260.0
Tantalum (Ta)		-	1.47	<0.005	0.80
Tellerium (Te)		-	0.13	0.04	0.11
Thorium (Th)		-	20.40	0.64	11.95
Titanium (Ti)		-	7930.0	10.0	5390.0
Thallium (Tl)		-	0.4	<0.001	0.8
Uranium (U)		-	5.13	0.16	2.62
Vanadium (V)		-	124.00	12.20	97.20
Tungsten (W)		-	3.31	0.007	1.87
Yttrium (Y)		-	16.75	2.90	13.10
Zinc (Zn)		30,000	77.4	10	23.5
Zirconium (Zn)		-	277.0	2.5	151.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_86-86.2m	PTM_171876_90-90.2m	PTM_171876_94-94.2m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Sandstone, medium-coarse	Sandstone, medium-coarse; siderite sporadic disseminated	Siltstone; minor sandstone laminae throughout
pH	0.1	-	9.60	9.50	9.60
Electrical Conductivity	1	-	328	323	274
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	17,700	115,500	6,800
Magnesium (Mg)	50	-	9,200	21,900	8,500
Potassium (K)	50	-	17,100	2,000	20,300
Sodium (Na)	50	-	9,740	750	5,520
Aluminium (Al)	50	-	78,200	7,100	80,500
Iron (Fe)	50	-	22,600	70,200	61,100
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	16	20	15
Barium (Ba)	10	-	398	198	470
Beryllium (Be)	1	90	1	1	2
Bismith (Bi)	1	-	0	0	0
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	43	15	53
Cobalt (Co)	5	300	13	17	13
Chromium (Cr)	0.1	300	58.40	10.45	45.40
Caesium (Cs)	5	-	3	1	8
Copper (Cu)	2	17,000	23	9	50
Gallium (Ga)	2	-	18	2	19
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	3	0	3
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.05	0.02	0.06
Lanthanum (La)	0.1	-	20.50	5.83	25.50
Lithium (Li)	5	-	14	8	19
Manganese (Mn)	5	19,000	434	1,830	1,390
Molybdenum (Mo)		-	0.6	0.5	0.6
Niobium (Nb)		-	6.98	0.005	7.07
Nickel (Ni)		1,200	22.10	20.90	27.50
Phosphorus (P)		-	770.00	860.00	980.00
Lead (Pb)		600	13.2	6.8	15.7
Rubidium (Rb)		-	68.70	7.34	97.90
Rhenium (Re)		-	<0.0004	<0.0002	0.0005
Sulfur (S)		-	200	50	300
Antimony (Sb)		-	0.6	0.1	0.5
Scandium (Sc)		-	14.2	5.7	16.3
Selenium (Se)		700	0.0	0.0	0.2
Tin (Sn)		-	1.57	0.19	1.74
Strontium (Sr)		-	328.0	639.0	298.0
Tantalum (Ta)		-	0.47	<0.005	0.51
Tellerium (Te)		-	0.02	0.01	0.06
Thorium (Th)		-	6.77	2.58	8.23
Titanium (Ti)		-	5030.0	10.0	4030.0
Thallium (Tl)		-	0.5	0.1	0.6
Uranium (U)		-	1.63	0.29	2.12
Vanadium (V)		-	121.00	34.50	123.50
Tungsten (W)		-	1.14	0.021	1.38
Yttrium (Y)		-	18.85	9.01	24.60
Zinc (Zn)		30,000	109.5	27.3	73.8
Zirconium (Zn)		-	103.0	3.8	121.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

		Sampling Date →	23/09/2020	23/09/2020	23/09/2020
		Client ID →	PTM_171876_97.44-97.62m	PTM_171876_98.78-99.28m	PTM_171876_99.28-99.57m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Coal, 10-40% bright	Coal	Carbonaceous Siltstone
pH	0.1	-	9.80	9.10	9.40
Electrical Conductivity	1	-	339	70	228
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	12,800	5,700	2,500
Magnesium (Mg)	50	-	1,100	3,200	1,300
Potassium (K)	50	-	1,800	200	2,500
Sodium (Na)	50	-	1,320	220	1,880
Aluminium (Al)	50	-	6,500	3,100	6,500
Iron (Fe)	50	-	1,770	51,300	19,600
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	1	0	15
Barium (Ba)	10	-	303	31	399
Beryllium (Be)	1	90	1	0	1
Bismith (Bi)	1	-	0	0	1
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	5	4	5
Cobalt (Co)	5	300	1	1	26
Chromium (Cr)	0.1	300	1.38	1.52	3.63
Caesium (Cs)	5	-	2	0	3
Copper (Cu)	2	17,000	27	7	59
Gallium (Ga)	2	-	1	1	1
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	0	0	0
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.05	0.01	0.07
Lanthanum (La)	0.1	-	1.69	1.47	2.19
Lithium (Li)	5	-	6	4	4
Manganese (Mn)	5	19,000	65	990	319
Molybdenum (Mo)		-	0.7	0.1	8.9
Niobium (Nb)		-	0.015	0.02	0.004
Nickel (Ni)		1,200	2.85	0.69	31.10
Phosphorus (P)		-	170.00	300.00	100.00
Lead (Pb)		600	15.6	1.7	25.6
Rubidium (Rb)		-	8.84	0.97	10.75
Rhenium (Re)		-	0.0015	0.0002	0.0005
Sulfur (S)		-	200	300	900
Antimony (Sb)		-	0.1	0.0	1.3
Scandium (Sc)		-	3.2	1.4	4.5
Selenium (Se)		700	0.3	0.1	0.9
Tin (Sn)		-	0.61	0.12	0.55
Strontium (Sr)		-	254.0	34.8	301.0
Tantalum (Ta)		-	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.09	0.01	0.10
Thorium (Th)		-	1.31	0.70	2.45
Titanium (Ti)		-	<5	10.0	<5
Thallium (Tl)		-	0.0	<0.001	0.0
Uranium (U)		-	0.32	0.09	0.45
Vanadium (V)		-	9.70	4.60	14.60
Tungsten (W)		-	0.002	0.008	0.011
Yttrium (Y)		-	3.29	3.09	5.65
Zinc (Zn)		30,000	64	12.4	76.5
Zirconium (Zn)		-	3.1	1.1	2.8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element and Exchangeable Cation Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_100.09-100.35m	PTM_171876_100.62-101.08m	PTM_171876_101.47-101.61m
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Mudstone	Coal, <10% bright	Tuff
pH	0.1	-	9.60	9.40	9.80
Electrical Conductivity	1	-	390	138	462
Major Cations		-	All units mg/kg		
Calcium (Ca)	50	-	2,000	27,400	18,500
Magnesium (Mg)	50	-	6,000	4,900	13,000
Potassium (K)	50	-	36,700	300	30,600
Sodium (Na)	50	-	2,770	330	2,930
Aluminium (Al)	50	-	104,500	2,200	103,000
Iron (Fe)	50	-	14,700	67,900	26,800
Minor and Trace Elements		-	All units mg/kg		
Silver (Ag)	5	-	0	0	0
Arsenic (As)	50	300	2	0	0
Barium (Ba)	10	-	740	65	700
Beryllium (Be)	1	90	2	0	3
Bismith (Bi)	1	-	1	0	1
Cadmium (Cd)	2	90	0	0	0
Cerium (Ce)	2	-	46	19	63
Cobalt (Co)	5	300	2	5	2
Chromium (Cr)	0.1	300	34.20	2.63	5.20
Caesium (Cs)	5	-	35	0	7
Copper (Cu)	2	17,000	64	8	4
Gallium (Ga)	2	-	28	1	24
Germanium (Ge)	5	-	0	0	0
Hafnium (Hf)	5	-	4	0	5
Mercury (Hg)	5	80	0	0	0
Indium (In)	0.1	-	0.07	0.01	0.05
Lanthanum (La)	0.1	-	23.20	6.60	33.00
Lithium (Li)	5	-	12	5	33
Manganese (Mn)	5	19,000	100	1,685	399
Molybdenum (Mo)		-	0.4	0.2	0.8
Niobium (Nb)		-	8.7	0.023	10.5
Nickel (Ni)		1,200	10.15	3.83	7.92
Phosphorus (P)		-	170.00	490.00	100.00
Lead (Pb)		600	19.8	3.6	48.5
Rubidium (Rb)		-	190.50	1.43	108.00
Rhenium (Re)		-	0.0004	0.0004	0.0004
Sulfur (S)		-	400	200	300
Antimony (Sb)		-	0.5	0.1	0.2
Scandium (Sc)		-	15.1	1.9	4.4
Selenium (Se)		700	0.7	0.2	0.2
Tin (Sn)		-	2.89	0.19	5.07
Strontium (Sr)		-	458.0	213.0	595.0
Tantalum (Ta)		-	0.69	<0.005	1.31
Tellerium (Te)		-	0.10	0.02	0.02
Thorium (Th)		-	12.15	1.55	25.60
Titanium (Ti)		-	4420.0	10.0	1570.0
Thallium (Tl)		-	1.3	<0.001	0.6
Uranium (U)		-	2.82	0.34	7.33
Vanadium (V)		-	104.50	11.50	15.80
Tungsten (W)		-	2.63	0.023	1.815
Yttrium (Y)		-	19.20	7.20	25.80
Zinc (Zn)		30,000	14.1	38.8	32.9
Zirconium (Zn)		-	145.0	1.9	110.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

Parameters	Limit of Reporting	Median Crustal Abundance[1,2,3]	Sampling Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client ID →	PTM_171773_21-21.2m	PTM_171773_23.6-23.8m	PTM_171773_28.2-28.4m	PTM_171773_33.5-33.7m	PTM_171773_39.5-39.7m	PTM_171773_51-51.2m	PTM_171773_54.71-54.91m	PTM_171773_65-65.2m	PTM_171773_76.28-76.48m	PTM_171773_78.29-78.36m
				Siltstone; rare sandstone laminae near base of unit	Claystone	Sandstone, fine-medium; minor siltstone laminae	Siltstone	Siltstone; minor sandstone bands	Siltstone	Sandstone, medium	Sandstone, fine; siltstone bands throughout; calcite common cement	Sandstone, fine; siltstone bands throughout; calcite sporadic cement	Siltstone; mudstone throughout
Major Cations	(All units in mg/kg)			Geochemical Abundance Index									
Calcium (Ca)	50	15,000		0	0	0	1	0	0	3	0	0	0
Magnesium (Mg)	50	5,000		0	0	0	0	0	0	1	0	0	0
Potassium (K)	50	14,000		0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000		0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000		0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000		0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)			Geochemical Abundance Index									
Silver (Ag)	5	0.075		0	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6		0	0	1	2	0	0	1	1	0	0
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3		2	2	2	1	2	1	2	2	1	2
Bismith (Bi)	1	----		----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	2	0.35		0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	2	50		0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8		1	0	1	1	1	0	1	1	0	1
Chromium (Cr)	0.1	70		0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	5	4		0	1	0	0	0	0	0	0	0	0
Copper (Cu)	2	30		0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	2	20		0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1		0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	5	6		0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	5	0.06		0	0	0	0	0	0	0	0	0	0
Indium (In)	0.1	1		0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.1	40		0	0	0	0	0	0	0	0	0	0
Lithium (Li)	5	25		0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	0	1	0	1	0	0	0	0
Molybdenum (Mo)	----	1.2		0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	----	10		0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50		0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800		0	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35		0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150		0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007		0	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700		0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	----	1		0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7		1	1	1	0	1	0	1	1	0	1
Selenium (Se)	----	0.4		0	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4		0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250		0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2		0	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----		----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9		0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000		0	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2		1	1	1	1	1	1	1	1	1	1
Uranium (U)	----	2		0	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90		0	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5		0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40		0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90		0	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----		----	----	----	----	----	----	----	----	----	0

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

Parameters	Limit of Reporting	Median Crustal Abundance[1,2,3]	Sampling Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client ID →	PTM_171773_80.49-81.37m	PTM_171773_82.84-83.03m	PTM_171773_83.91-84.19m	PTM_171773_87.5-87.7m	PTM_171773_101.7-101.93m	PTM_171773_103.5-103.8m	PTM_171773_103.98-104.18m	PTM_171773_105.8-106m	PTM_171773_108.5-108.7m	PTM_171773_109.02-109.16m
				Coal, 10-40% bright	Mudstone; carbonaceous in part near top of unit	Carbonaceous Mudstone; coaly lenses throughout	Sandstone, fine-medium	Sandstone, fine; siltstone bands throughout	Carbonaceous Mudstone	Tuff; carbonaceous near top of unit near base of unit	Mudstone; clayey bands near base of unit	Mudstone; carbonaceous in part near base of unit	Carbonaceous Mudstone; coaly lenses throughout
Major Cations	(All units in mg/kg)		Geochemical Abundance Index										
Calcium (Ca)	50	15,000	-2	0	0	0	1	0	0	0	0	0	
Magnesium (Mg)	50	5,000	0	0	0	0	0	1	0	0	0	0	
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0	
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0	
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0	
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0	0	
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index										
Silver (Ag)	5	0.075	0	0	0	0	0	0	0	0	0	0	
Arsenic (As)	50	6	0	1	2	0	0	1	1	0	0	0	
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	
Beryllium (Be)	1	0.3	2	2	1	2	1	2	2	1	2	2	
Bismith (Bi)	1	----	----	----	----	----	----	----	----	----	----	----	
Cadmium (Cd)	2	0.35	0	0	0	0	0	0	0	0	0	0	
Cerium (Ce)	2	50	0	0	0	0	0	0	0	0	0	0	
Cobalt (Co)	5	8	0	1	1	1	0	1	1	0	1	0	
Chromium (Cr)	0.1	70	0	0	0	0	0	0	0	0	0	0	
Caesium (Cs)	5	4	1	0	0	0	0	0	0	0	0	1	
Copper (Cu)	2	30	0	0	0	0	0	0	0	0	0	0	
Gallium (Ga)	2	20	0	0	0	0	0	0	0	0	0	0	
Germanium (Ge)	5	1	0	0	0	0	0	0	0	0	0	0	
Hafnium (Hf)	5	6	0	0	0	0	0	0	0	0	0	0	
Mercury (Hg)	5	0.06	0	0	0	0	0	0	0	0	0	0	
Indium (In)	0.1	1	0	0	0	0	0	0	0	0	0	0	
Lanthanum (La)	0.1	40	0	0	0	0	0	0	0	0	0	0	
Lithium (Li)	5	25	0	0	0	0	0	0	0	0	0	0	
Manganese (Mn)	5	1000	0	0	1	0	1	0	0	0	0	0	
Molybdenum (Mo)	----	1.2	0	0	0	0	0	0	0	0	0	0	
Niobium (Nb)	----	10	0	0	0	0	0	0	0	0	0	0	
Nickel (Ni)	----	50	0	0	0	0	0	0	0	0	0	0	
Phosphorus (P)	----	800	0	0	0	0	0	0	0	0	0	0	
Lead (Pb)	----	35	0	0	0	0	0	0	0	0	0	0	
Rubidium (Rb)	----	150	0	0	0	0	0	0	0	0	0	0	
Rhenium (Re)	----	0.0007	0	0	0	0	0	0	0	0	0	0	
Sulfur (S)	----	700	0	0	0	0	0	0	0	0	0	0	
Antimony (Sb)	----	1	0	0	0	0	0	0	0	0	0	0	
Scandium (Sc)	----	7	1	1	0	1	0	1	1	0	1	1	
Selenium (Se)	----	0.4	0	0	0	0	0	0	0	0	0	0	
Tin (Sn)	----	4	0	0	0	0	0	0	0	0	0	0	
Strontium (Sr)	----	250	0	0	0	0	0	0	0	0	0	0	
Tantalum (Ta)	----	2	0	0	0	0	0	0	0	0	0	0	
Tellerium (Te)	----	----	----	----	----	----	----	----	----	----	----	----	
Thorium (Th)	----	9	0	0	0	0	0	0	0	0	0	0	
Titanium (Ti)	----	5000	0	0	0	0	0	0	0	0	0	0	
Thallium (Tl)	----	0.2	1	1	1	1	1	1	1	1	1	1	
Uranium (U)	----	2	0	0	0	0	0	0	0	0	0	0	
Vanadium (V)	----	90	0	0	0	0	0	0	0	0	0	0	
Tungsten (W)	----	1.5	0	0	0	0	0	0	0	0	0	0	
Yttrium (Y)	----	40	0	0	0	0	0	0	0	0	0	0	
Zinc (Zn)	----	90	0	0	0	0	0	0	0	0	0	0	
Zirconium (Zn)	----	----	0	0	0	0	0	0	0	0	0	0	

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

Parameters	Limit of Reporting	Median Crustal Abundance[1,2,3]	Sampling Date →	23/09/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020
			Client ID →	PTM_171773_109.35-109.43m	PTM_171870_17.29-18.1m	PTM_171870_22.66-23.2m	PTM_171870_30.87-33.92m	PTM_171870_41.99-42.65m	PTM_171870_45.35-48.23m	PTM_171870_57.26-58.92m	PTM_171870_67.32-69.13m	PTM_171870_75.3-76.2m	PTM_171870_76.2-76.31m
				Mudstone	Sandstone, fine-medium	Clay	Siltstone	Sandstone, fine	Siltstone; minor sandstone laminae near base of unit	Siltstone; minor sandstone bands	Siltstone; common sandstone laminae throughout; calcite rare in veins	Coal, 10-40% bright	Claystone
Major Cations	(All units in mg/kg)			Geochemical Abundance Index									
Calcium (Ca)	50	15,000		0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	50	5,000		0	0	0	0	1	0	0	0	0	0
Potassium (K)	50	14,000		0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000		0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000		0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000		0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)			Geochemical Abundance Index									
Silver (Ag)	5	0.075		0	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6		1	2	0	0	1	1	0	0	0	1
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3		2	1	2	1	2	2	1	2	2	2
Bismith (Bi)	1	----		----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	2	0.35		0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	2	50		0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8		1	1	1	0	1	1	0	1	0	1
Chromium (Cr)	0.1	70		0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	5	4		0	0	0	0	0	0	0	0	1	0
Copper (Cu)	2	30		0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	2	20		0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1		0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	5	6		0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	5	0.06		0	0	0	0	0	0	0	0	0	0
Indium (In)	0.1	1		0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.1	40		0	0	0	0	0	0	0	0	0	0
Lithium (Li)	5	25		0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	1	0	1	0	0	0	0	0	0
Molybdenum (Mo)	----	1.2		0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	----	10		0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50		0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800		0	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35		0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150		0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007		0	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700		0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	----	1		0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7		1	0	1	0	1	1	0	1	1	1
Selenium (Se)	----	0.4		0	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4		0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250		0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2		0	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----		----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9		0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000		0	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2		1	1	1	1	1	1	1	1	1	1
Uranium (U)	----	2		0	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90		0	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5		0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40		0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90		0	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----		0	0	0	0	0	0	0	0	0	0

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

Parameters	Limit of Reporting	Median Crustal Abundance[1,2,3]	Sampling Date →	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020
			Client ID →	PTM_171870_76. 31-77.04m	PTM_171870_77. 04-77.82m	PTM_171870_79. 08-81.08m	PTM_171870_85. 51-86.36m	PTM_171870_91. 77-92.35m	PTM_171870_93. 16-94.3m	PTM_171870_94. 3-94.67m	PTM_171870_94. 67-95.05m	PTM_171870_95. 55-96.06m	PTM_171870_96. 06-96.2m
				Coal, <10% bright	Mudstone	Sandstone, fine-medium; common siltstone laminae near middle of unit	Sandstone, coarse	Mudstone	Coal, <10% bright	Siltstone	Coal, dull <1% bright	Coal, <10% bright	Claystone
Major Cations	(All units in mg/kg)			Geochemical Abundance Index									
Calcium (Ca)	50	15,000		0	0	0	0	0	0	0	0	1	0
Magnesium (Mg)	50	5,000		0	0	0	1	0	0	0	0	0	0
Potassium (K)	50	14,000		0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000		0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000		0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000		0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)			Geochemical Abundance Index									
Silver (Ag)	5	0.075		0	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6		2	0	-1	1	1	0	0	0	1	2
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3		1	2	1	2	2	1	2	2	2	1
Bismith (Bi)	1	----		----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	2	0.35		0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	2	50		0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8		1	1	0	1	1	0	1	0	1	1
Chromium (Cr)	0.1	70		0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	5	4		0	0	0	0	0	0	0	1	0	0
Copper (Cu)	2	30		0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	2	20		0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1		0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	5	6		0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	5	0.06		0	0	0	0	0	0	0	0	0	0
Indium (In)	0.1	1		0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.1	40		0	0	0	0	0	0	0	0	0	0
Lithium (Li)	5	25		0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		1	0	1	0	0	0	0	0	0	1
Molybdenum (Mo)	----	1.2		0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	----	10		0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50		0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800		0	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35		0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150		0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007		0	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700		0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	----	1		0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7		0	1	0	1	1	0	1	1	1	0
Selenium (Se)	----	0.4		0	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4		0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250		0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2		0	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----		----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9		0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000		0	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2		1	1	1	1	1	1	1	1	1	1
Uranium (U)	----	2		0	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90		0	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5		0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40		0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90		0	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----		0	0	0	0	---	---	---	---	---	---

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_23. 42-23.69m	PTM_171876_24. 3-24.5m	PTM_171876_26. 9-27.08m	PTM_171876_27. 12-27.35m	PTM_171876_34- 34.2m	PTM_171876_39. 8-40m	PTM_171876_45. 3-45.5m	PTM_171876_52- 52.2m	PTM_171876_58. 4-58.6m	PTM_171876_64- 64.2m
Parameters	**Limit of Reporting**	Median Crustal Abundance[1,2,3]	Sandstone, medium-coarse	Sandstone, medium	Claystone	Claystone	Siltstone; minor sandstone bands near middle of unit	Siltstone; minor sandstone laminae near middle of unit; siderite rare	Sandstone, fine; common siltstone laminae throughout	Sandstone, fine-medium; rare siltstone laminae	Sandstone, very fine; common siltstone laminae	Siltstone; abundant sandstone bands throughout
Major Cations	(All units in mg/kg)		Geochemical Abundance Index									
Calcium (Ca)	50	15,000	2	1	0	0	0	0	0	1	0	0
Magnesium (Mg)	50	5,000	0	-1	1	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index									
Silver (Ag)	5	0.075	1	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6	0	0	1	1	0	0	0	1	2	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3	2	1	2	2	1	2	2	2	1	2
Bismith (Bi)	1	----	----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	2	0.35	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	2	50	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8	1	0	1	1	0	1	0	1	1	1
Chromium (Cr)	0.1	70	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	5	4	0	0	0	0	0	0	1	0	0	0
Copper (Cu)	2	30	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	2	20	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1	0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	5	6	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	5	0.06	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.1	1	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.1	40	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	5	25	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	1	0	0	0	0	0	0	1	0
Molybdenum (Mo)	----	1.2	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	----	10	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007	0	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700	0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	----	1	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7	1	0	1	1	0	1	1	1	0	1
Selenium (Se)	----	0.4	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2	0	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----	----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000	0	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2	1	1	1	1	1	1	1	1	1	1
Uranium (U)	----	2	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90	0	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----	----	----	----	----	----	----	----	----	----	----

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

Parameters	Limit of Reporting	Median Crustal Abundance[1,2,3]	Sampling Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client ID →	PTM_171876_69.2-69.4m	PTM_171876_76.8-77m	PTM_171876_78-78.4m	PTM_171876_81.81-82.04m	PTM_171876_86-86.2m	PTM_171876_90-90.2m	PTM_171876_94-94.2m	PTM_171876_97.44-97.62m	PTM_171876_98.78-99.28m	PTM_171876_99.28-99.57m
				Sandstone, fine; common siltstone bands throughout	Mudstone	Coal, 10-40% bright	Mudstone	Sandstone, medium-coarse	Sandstone, medium-coarse; siderite sporadic disseminated throughout	Siltstone; minor sandstone laminae throughout	Coal, 10-40% bright	Coal	Carbonaceous Siltstone
Major Cations	(All units in mg/kg)			Geochemical Abundance Index									
Calcium (Ca)	50	15,000		1	0	0	0	0	2	0	0	0	0
Magnesium (Mg)	50	5,000		0	1	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000		0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000		0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000		0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000		0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)			Geochemical Abundance Index									
Silver (Ag)	5	0.075		0	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6		0	1	1	0	0	0	1	2	0	0
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3		1	2	2	1	2	2	2	1	2	1
Bismith (Bi)	1	----		----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	2	0.35		0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	2	50		0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8		0	1	1	0	1	0	1	1	1	0
Chromium (Cr)	0.1	70		0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	5	4		0	0	0	0	0	1	0	0	0	0
Copper (Cu)	2	30		0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	2	20		0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1		0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	5	6		0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	5	0.06		0	0	0	0	0	0	0	0	0	0
Indium (In)	0.1	1		0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.1	40		0	0	0	0	0	0	0	0	0	0
Lithium (Li)	5	25		0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		1	0	0	0	0	0	0	1	0	1
Molybdenum (Mo)	----	1.2		0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	----	10		0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50		0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800		0	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35		0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150		0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007		0	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700		0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	----	1		0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7		0	1	1	0	1	1	1	0	1	0
Selenium (Se)	----	0.4		0	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4		0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250		0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2		0	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----		----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9		0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000		0	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2		1	1	1	1	1	1	1	1	1	1
Uranium (U)	----	2		0	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90		0	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5		0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40		0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90		0	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----		----	----	----	----	----	----	----	----	----	----

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index (GAI) Results for Spoil from the Stanmore Project

	Sampling Date →		23/09/2020	23/09/2020	23/09/2020
	Client ID →		PTM_171876_100 .09-100.35m	PTM_171876_100 .62-101.08m	PTM_171876_101 .47-101.61m
Parameters	**Limit of Reporting**	Median Crustal Abundance[1,2,3]	Mudstone	Coal, <10% bright	Tuff
Major Cations	(All units in mg/kg)		Geochemical Abundance Index		
Calcium (Ca)	50	15,000	0	0	0
Magnesium (Mg)	50	5,000	1	0	0
Potassium (K)	50	14,000	0	0	0
Sodium (Na)	50	5,000	0	0	0
Aluminium (Al)	50	71,000	0	0	0
Iron (Fe)	50	40,000	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index		
Silver (Ag)	5	0.075	0	0	----
Arsenic (As)	50	6	1	1	0
Barium (Ba)	10	500	0	0	0
Beryllium (Be)	1	0.3	2	2	1
Bismith (Bi)	1	----	----	----	----
Cadmium (Cd)	2	0.35	0	0	0
Cerium (Ce)	2	50	0	0	0
Cobalt (Co)	5	8	1	1	0
Chromium (Cr)	0.1	70	0	0	0
Caesium (Cs)	5	4	0	0	0
Copper (Cu)	2	30	0	0	0
Gallium (Ga)	2	20	0	0	0
Germanium (Ge)	5	1	0	0	0
Hafnium (Hf)	5	6	0	0	0
Mercury (Hg)	5	0.06	0	0	0
Indium (In)	0.1	1	0	0	0
Lanthanum (La)	0.1	40	0	0	0
Lithium (Li)	5	25	0	0	0
Manganese (Mn)	5	1000	0	0	0
Molybdenum (Mo)	----	1.2	0	0	0
Niobium (Nb)	----	10	0	0	0
Nickel (Ni)	----	50	0	0	0
Phosphorus (P)	----	800	0	0	0
Lead (Pb)	----	35	0	0	0
Rubidium (Rb)	----	150	0	0	0
Rhenium (Re)	----	0.0007	0	0	0
Sulfur (S)	----	700	0	0	0
Antimony (Sb)	----	1	0	0	0
Scandium (Sc)	----	7	1	1	0
Selenium (Se)	----	0.4	0	0	0
Tin (Sn)	----	4	0	0	0
Strontium (Sr)	----	250	0	0	0
Tantalum (Ta)	----	2	0	0	0
Tellerium (Te)	----	----	----	----	----
Thorium (Th)	----	9	0	0	0
Titanium (Ti)	----	5000	0	0	0
Thallium (Tl)	----	0.2	1	1	1
Uranium (U)	----	2	0	0	0
Vanadium (V)	----	90	0	0	0
Tungsten (W)	----	1.5	0	0	0
Yttrium (Y)	----	40	0	0	0
Zinc (Zn)	----	90	0	0	0
Zirconium (Zn)	----	----	----	----	----

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

			Sample Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client Sample ID →	PTM_171773_21-21.2m	PTM_171773_23.6-23.8m	PTM_171773_28.2-28.4m	PTM_171773_33.5-33.7m	PTM_171773_39.5-39.7m	PTM_171773_51-51.2m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Siltstone; rare sandstone laminae near base of unit	Claystone	Sandstone, fine-medium; minor siltstone laminae	Siltstone	Siltstone; minor sandstone bands	Siltstone
pH	0.01 pH unit	6 to 9	-	9.2	9.2	9.4	9.6	9.6	9.5
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	290	363	283	240	271	238
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	126	108	108	170	36	18
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	450	702	3,580	9,180	630	297
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	576	810	3,690	9,350	666	315
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	<2	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	4	14	5	4	5	5
Sodium (Na)	1 mg/L	-	-	53	68	52	45	48	46
Chloride (Cl)	1 mg/L	-	-	24	21	14	10	18	10
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	10	14	21	7	<2	3
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.17	0.16	0.23	0.23	0.18	0.23
Arsenic (As)	0.001 mg/:	0.024**	0.5	<0.002	<0.002	0.234	0.555	<0.002	0.013
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	<0.002	<0.002	0.008	0.003	0.003	0.009
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	<0.002	0.007	0.002	<0.002	<0.002
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.03	0.03	0.04	0.04	0.03	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

			Sample Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client Sample ID →	PTM_171773_54.71-54.91m	PTM_171773_65-65.2m	PTM_171773_76.28-76.48m	PTM_171773_78.29-78.36m	PTM_171773_80.49-81.37m	PTM_171773_82.84-83.03m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Sandstone, medium	Sandstone, fine; siltstone bands throughout; calcite common cement	Sandstone, fine; siltstone bands throughout; calcite sporadic cement	Siltstone; mudstone throughout	Coal, 10-40% bright	Mudstone; carbonaceous in part near top of unit
pH	0.01 pH unit	6 to 9	-	9.4	9.5	9.4	9.2	8.6	9.2
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	195	222	218	209	143	181
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	170	36	18	18	<1.0	18
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	44,000	756	3,400	432	306	162
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	44,200	792	3,420	450	306	180
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	5	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	22	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	4	<2
Potassium (K)	1 mg/L	-	-	6	5	5	2	<2	3
Sodium (Na)	1 mg/L	-	-	36	44	41	44	25	43
Chloride (Cl)	1 mg/L	-	-	5	8	8	8	23	11
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	3	14	17	14	46	40
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.16	0.2	0.16	0.07	0.02	0.1
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.024	0.289	0.201	0.122	<0.002	0.161
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.02	0.013	0.081	0.028	0.023	0.009
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	0.011	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	0.008	0.034	0.04	0.014	0.124
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.011	0.004	0.003	<0.002	0.003
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	0.6	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

			Sample Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client Sample ID →	PTM_171773_83.91-84.19m	PTM_171773_87.5-87.7m	PTM_171773_101.7-101.93m	PTM_171773_103.5-103.8m	PTM_171773_103.98-104.18m	PTM_171773_105.8-106m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Carbonaceous Mudstone; coaly lenses throughout	Sandstone, fine-medium	Sandstone, fine; siltstone bands throughout	Carbonaceous Mudstone	Tuff; carbonaceous near top of unit near base of unit	Mudstone; clayey bands near base of unit
pH	0.01 pH unit	6 to 9	-	9.7	9.7	9.2	9.3	9.4	9.0
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	230	315	391	229	163	173
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	18	18	170	18	18	18
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	189	342	6,630	432	720	315
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	207	360	6,800	450	738	333
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	<2	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	<2	4	16	4	<2	<2
Sodium (Na)	1 mg/L	-	-	48	67	72	47	31	38
Chloride (Cl)	1 mg/L	-	-	9	18	6	10	9	8
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	28	13	11	34	10	51
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.13	0.17	0.27	0.21	0.34	0.18
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.234	0.295	0.282	0.151	0.007	0.186
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.035	0.012	0.016	0.005	0.003	0.003
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.042	0.012	0.022	0.541	0.035	0.953
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.004	0.005	0.024	0.003	0.053
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.06
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.03	0.02	0.04	0.05	0.05	0.04
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

				Sample Date →	23/09/2020	23/09/2020	23/09/2020	05/07/2020	05/07/2020	05/07/2020
				Client Sample ID →	PTM_171773_108.5-108.7m	PTM_171773_109.02-109.16m	PTM_171773_109.35-109.43m	PTM_171870_17.29-18.1m	PTM_171870_22.66-23.2m	PTM_171870_30.87-33.92m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]		Mudstone; carbonaceous in part near base of unit	Carbonaceous Mudstone; coaly lenses throughout	Mudstone	Sandstone, fine-medium	Clay	Siltstone
pH	0.01 pH unit	6 to 9	-		9.5	9.7	9.5	9.2	9.6	9.5
Electrical Conductivity	1 µS/cm	<1,000#	3,580^		168	96	118	346	329	301
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-		54	54	18	36	72	72
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-		99	90	513	1,480	2,070	3,440
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-		152	144	531	1,510	2,140	3,510
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-		<1.0	<1.0	<1.0	<1	<1	<1
Major Ions					All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000		<2	<2	<2	<2	<2	<2
Magnesium (Mg)	1 mg/L	-	-		<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-		<2	<2	<2	9	7	6
Sodium (Na)	1 mg/L	-	-		46	27	24	74	71	68
Chloride (Cl)	1 mg/L	-	-		6	3	5	13	17	10
Fluoride (F)	1 mg/L	-	2							
Sulfate (SO_4^{2-})	1 mg/L	-	1,000		13	4	9	18	4	2
Trace Metals/Metalloids					All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5		0.26	0.38	0.66	0.13	0.09	0.18
Arsenic (As)	0.001 mg/:	0.024**	0.5		0.028	0.016	0.314	0.007	0.008	<0.002
Boron (B)	0.1 mg.L	0.37	5		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-		0.006	0.003	0.004	0.022	0.004	0.009
Beryllium (Be)	0.001 mg/L	-	-		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1		<0.002	<0.002	0.004	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15		0.038	0.009	0.012	<0.002	<0.002	<0.002
Nickel (Ni)	0.001 mg/L	0.011	1		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-		<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-		0.003	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.01 mg/L	0.011	0.02		0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-		<0.02	0.04	0.09	0.02	0.04	0.03
Zinc (Zn)	0.01 mg/L	0.008	20		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

		Sample Date →		05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020
		Client Sample ID →		PTM_171870_41.99-42.65m	PTM_171870_45.35-48.23m	PTM_171870_57.26-58.92m	PTM_171870_67.32-69.13m	PTM_171870_75.3-76.2m	PTM_171870_76.2-76.31m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Sandstone, fine	Siltstone; minor sandstone laminae near base of unit	Siltstone; minor sandstone bands	Siltstone; common sandstone laminae throughout; calcite rare in veins	Coal, 10-40% bright	Claystone
pH	0.01 pH unit	6 to 9	-	9.4	9.3	9.4	9.2	4.5	5.4
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	273	249	287	283	272	345
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	72	72	108	90	<1	<1
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	4,230	666	2,160	4,680	74	119
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	4,300	738	2,270	4,770	74	119
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1	<1	<1	<1	<1	417
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	5	4
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	2	2
Potassium (K)	1 mg/L	-	-	5	6	7	8	2	11
Sodium (Na)	1 mg/L	-	-	52	50	57	54	21	61
Chloride (Cl)	1 mg/L	-	-	8	10	9	12	14	11
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	8	6	3	10	34	80
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.16	0.23	0.14	0.12	<0.02	0.12
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.007	0.077	0.016	0.094	<0.002	<0.002
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Barium (Ba)	0.001 mg/L	-	-	0.01	0.007	0.022	0.021	0.081	0.159
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	0.036	0.025
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	0.01	<0.002	0.004	<0.002	<0.002
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.003	<0.002	0.002	<0.002	0.003
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	0.03
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	0.3	0.5
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.03	0.02	0.03	0.02	<0.02	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

			Sample Date →	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020	05/07/2020
			Client Sample ID →	PTM_171870_76.31-77.04m	PTM_171870_77.04-77.82m	PTM_171870_79.08-81.08m	PTM_171870_85.51-86.36m	PTM_171870_91.77-92.35m	PTM_171870_93.16-94.3m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Coal, <10% bright	Mudstone	Sandstone, fine-medium; common siltstone laminae near middle of unit	Sandstone, coarse	Mudstone	Coal, <10% bright
pH	0.01 pH unit	6 to 9	-	4.5	5.1	8.2	9.7	9.5	8.5
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	160	304	295	345	394	72
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	<1	<1	36	108	72	<1
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	23	70	774	1,890	1,100	567
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	23	70	810	2,000	1,170	567
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	617	517	<1	<1	<1	<1
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	2	<2	<2	<2	7
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	<2	8	5	7	7	2
Sodium (Na)	1 mg/L	-	-	17	49	59	74	84	22
Chloride (Cl)	1 mg/L	-	-	13	8	13	10	9	8
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	17	61	30	17	49	2
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.04	0.1	0.12	0.31	0.15	0.08
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.008	0.006	0.321	0.935	0.432	<0.002
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.046	0.145	0.021	0.028	0.045	0.057
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	0.008	0.027	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	<0.002	0.112	0.029	0.328	0.008
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	0.002	0.002	0.014	0.009	0.042	<0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	0.3	<0.2	<0.2	<0.2	0.4
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	0.02	0.08	0.04	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

		Sample Date →		05/07/2020	05/07/2020	05/07/2020	05/07/2020	23/09/2020	23/09/2020
		Client Sample ID →		PTM_171870_94.3-94.67m	PTM_171870_94.67-95.05m	PTM_171870_95.55-96.06m	PTM_171870_96.06-96.2m	PTM_171876_23.42-23.69m	PTM_171876_24.3-24.5m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Siltstone	Coal, dull <1% bright	Coal, <10% bright	Claystone	Sandstone, medium-coarse	Sandstone, medium
pH	0.01 pH unit	6 to 9	-	9.3	8.4	9.4	9.6	9.2	9.2
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	338	82	197	493	230	221
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	18	<1	54	108	170	170
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	648	182	7,720	7,990	36,200	15,500
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	666	182	7,780	8,100	36,400	15,600
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1	<1	<1	<1	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	3	3
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	3	<2	3	4	7	4
Sodium (Na)	1 mg/L	-	-	71	22	54	106	43	40
Chloride (Cl)	1 mg/L	-	-	7	7	7	9	14	20
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	43	3	4	23	4	4
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.24	0.12	0.23	0.23	0.11	0.08
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.34	0.004	0.046	0.006	0.002	<0.002
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.013	0.002	0.044	0.035	<0.002	<0.002
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	0.004	0.003
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.876	0.017	0.023	0.12	<0.002	<0.002
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	0.061	<0.002	<0.002	0.004	<0.002	<0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	0.06	<0.02	<0.02	0.03	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.05	0.02	<0.02	0.03	<0.02	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

		Sample Date →		23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
		Client Sample ID →		PTM_171876_26.9-27.08m	PTM_171876_27.12-27.35m	PTM_171876_34-34.2m	PTM_171876_39.8-40m	PTM_171876_45.3-45.5m	PTM_171876_52-52.2m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Claystone	Claystone	Siltstone; minor sandstone bands near middle of unit	Siltstone; minor sandstone laminae near middle of unit; siderite rare disseminated	Sandstone, fine; common siltstone laminae throughout	Sandstone, fine-medium; rare siltstone laminae
pH	0.01 pH unit	6 to 9	-	9.2	9.0	9.1	9.3	9.4	9.4
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	271	396	164	127	286	234
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	54	72	36	170	170	170
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	630	1,100	504	3,740	2,380	10,000
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	684	1,170	540	3,910	250	10,200
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	<2	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	12	19	5	4	8	10
Sodium (Na)	1 mg/L	-	-	75	75	34	25	56	43
Chloride (Cl)	1 mg/L	-	-	41	30	16	11	11	8
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	20	25	2	<2	<2	7
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.06	0.08	0.33	0.41	0.23	0.3
Arsenic (As)	0.001 mg/:	0.024**	0.5	<0.002	0.002	<0.002	0.003	<0.002	0.257
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.008	0.022	<0.002	<0.002	0.004	0.005
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	<0.002	<0.002	<0.002	<0.002	0.006
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.006
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	0.03	0.06	0.04	0.03
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

		Sample Date →		23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
		Client Sample ID →		PTM_171876_58.4-58.6m	PTM_171876_64-64.2m	PTM_171876_69.2-69.4m	PTM_171876_76.8-77m	PTM_171876_78-78.4m	PTM_171876_81.81-82.04m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Sandstone, very fine; common siltstone laminae	Siltstone; abundant sandstone bands throughout	Sandstone, fine; common siltstone bands throughout	Mudstone	Coal, 10-40% bright	Mudstone
pH	0.01 pH unit	6 to 9	-	9.2	9.5	9.3	8.8	8.9	8.9
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	163	255	236	241	112	97
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	36	108	170	36	54	36
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	900	2,560	9,860	540	495	657
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	936	2,660	10,000	576	549	693
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	7	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	3	11	9	3	<2	2
Sodium (Na)	1 mg/L	-	-	34	50	45	66	30	21
Chloride (Cl)	1 mg/L	-	-	13	7	5	14	27	12
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	5	8	5	9	<2	9
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.32	0.26	0.27	0.04	0.06	0.51
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.012	0.107	0.01	0.022	<0.002	0.038
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	<0.002	0.007	0.016	0.024	0.039	0.003
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	<0.002	0.002	0.004	0.067	0.015	0.01
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.003	<0.002	0.002	<0.002	0.003
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	0.03
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.04	0.04	<0.02	0.02	<0.02	0.04
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

			Sample Date →	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020	23/09/2020
			Client Sample ID →	PTM_171876_86-86.2m	PTM_171876_90-90.2m	PTM_171876_94-94.2m	PTM_171876_97.44-97.62m	PTM_171876_98.78-99.28m	PTM_171876_99.28-99.57m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Sandstone, medium-coarse	Sandstone, medium-coarse; siderite sporadic disseminated throughout	Siltstone; minor sandstone laminae throughout	Coal, 10-40% bright	Coal	Carbonaceous Siltstone
pH	0.01 pH unit	6 to 9	-	9.6	9.5	9.6	9.8	9.1	9.4
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	328	323	274	339	70	228
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	36	170	72	36	18	54
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	594	24,500	900	684	855	630
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	630	24,600	972	720	873	684
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	<2	<2	<2	6	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Potassium (K)	1 mg/L	-	-	9	14	7	5	3	4
Sodium (Na)	1 mg/L	-	-	79	70	59	72	25	55
Chloride (Cl)	1 mg/L	-	-	10	5	6	4	9	8
Fluoride (F)	1 mg/L	-	2						
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	17	11	12	5	<2	54
Trace Metals/Metalloids				All units mg/L					
Aluminium (Al)	0.01 mg/L	0.055	5	0.29	0.14	0.28	0.33	0.08	0.21
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.345	0.048	0.267	0.025	<0.002	0.397
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.024	0.034	0.011	0.018	0.039	0.007
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.016	0.014	0.028	0.044	0.004	1.13
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	0.004	0.004	0.004	0.002	<0.002	0.047
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	0.3	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	0.07	<0.02	0.04	0.08	<0.02	0.06
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-Element Test Results for Water Extracts from Spoil from the Stanmore Project

		Sample Date →		23/09/2020	23/09/2020	23/09/2020
		Client Sample ID →		PTM_171876_100.09-100.35m	PTM_171876_100.62-101.08m	PTM_171876_101.47-101.61m
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Mudstone	Coal, <10% bright	Tuff
pH	0.01 pH unit	6 to 9	-	9.6	9.4	9.8
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	390	138	462
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	54	18	216
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	522	999	1,640
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	576	1,020	1,850
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0
Major Ions					All units mg/L	
Calcium (Ca)	1 mg/L	-	1,000	<2	2	<2
Magnesium (Mg)	1 mg/L	-	-	<2	<2	<2
Potassium (K)	1 mg/L	-	-	6	4	8
Sodium (Na)	1 mg/L	-	-	71	37	108
Chloride (Cl)	1 mg/L	-	-	10	6	8
Fluoride (F)	1 mg/L	-	2			
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	18	2	3
Trace Metals/Metalloids					All units mg/L	
Aluminium (Al)	0.01 mg/L	0.055	5	0.17	0.2	0.22
Arsenic (As)	0.001 mg/:	0.024**	0.5	0.019	<0.002	0.004
Boron (B)	0.1 mg.L	0.37	5	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.011	0.048	0.028
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002
Bismith (Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002	0.01	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	- (hex)*	1 (total)	<0.002	<0.002	<0.002
Chromium (Cr)	0.001 mg/L	0.001	1	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.022	0.011	0.069
Nickel (Ni)	0.001 mg/L	0.011	1	0.003	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	0.003	<0.002	<0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	0.04	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	0.006
Vanadium (V)	0.01 mg/L	-	-	0.06	<0.02	<0.02
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Attachment C: Coarse and fine reject geochemical data

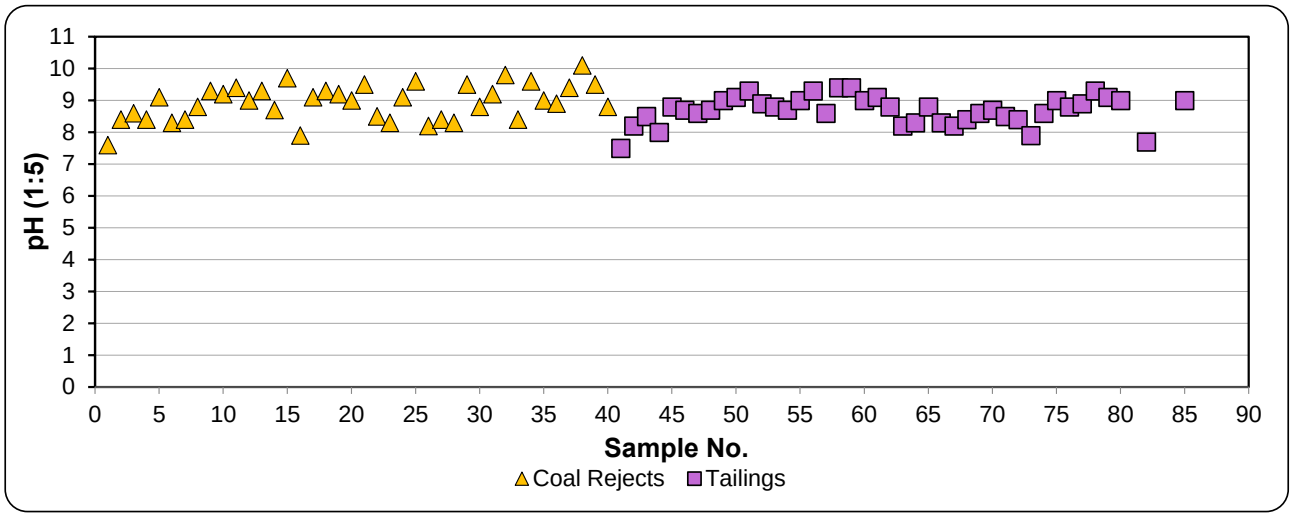

Figure 11-7: pH results for PTM coal rejects and fine rejects

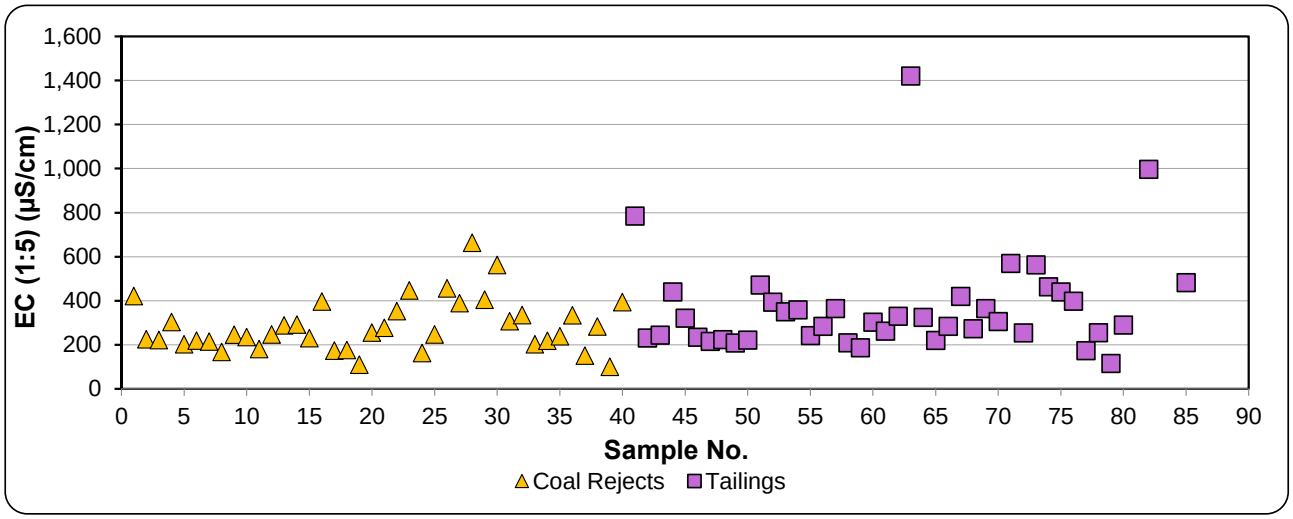

Figure 11-8: EC results for PTM coal rejects and fine rejects

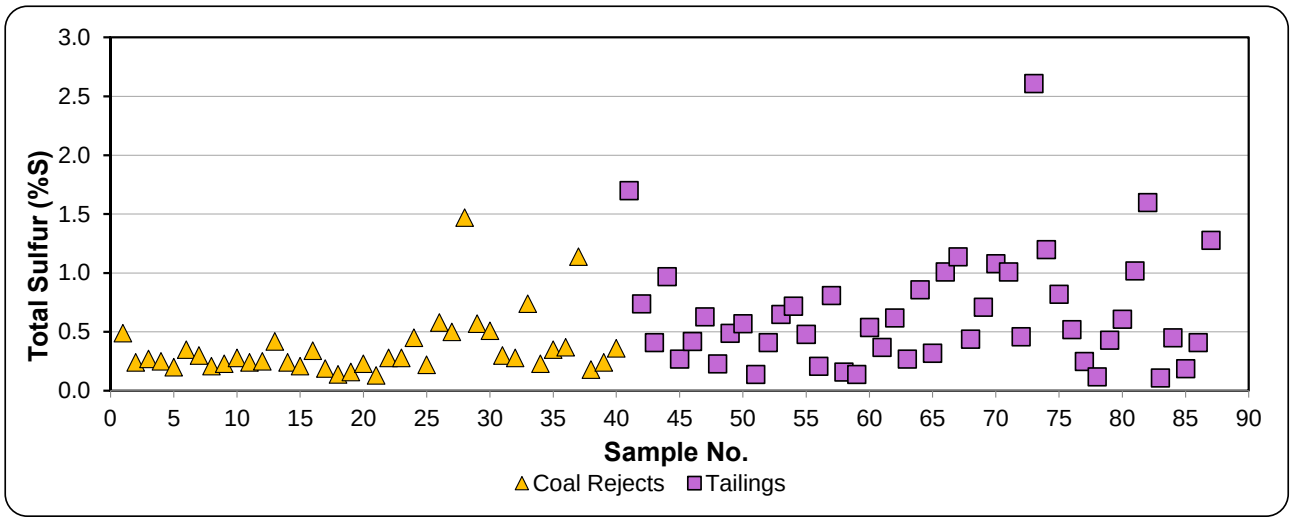

Figure 11-9: Total S results for PTM coal rejects and fine rejects

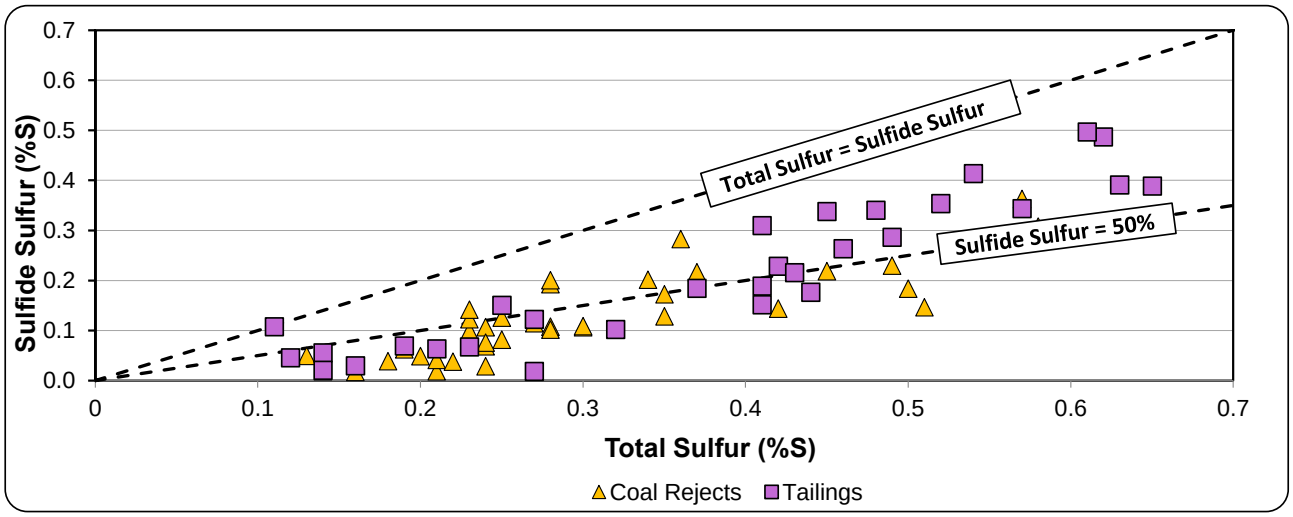

Figure 11-10: Relationship between total S and sulfide S

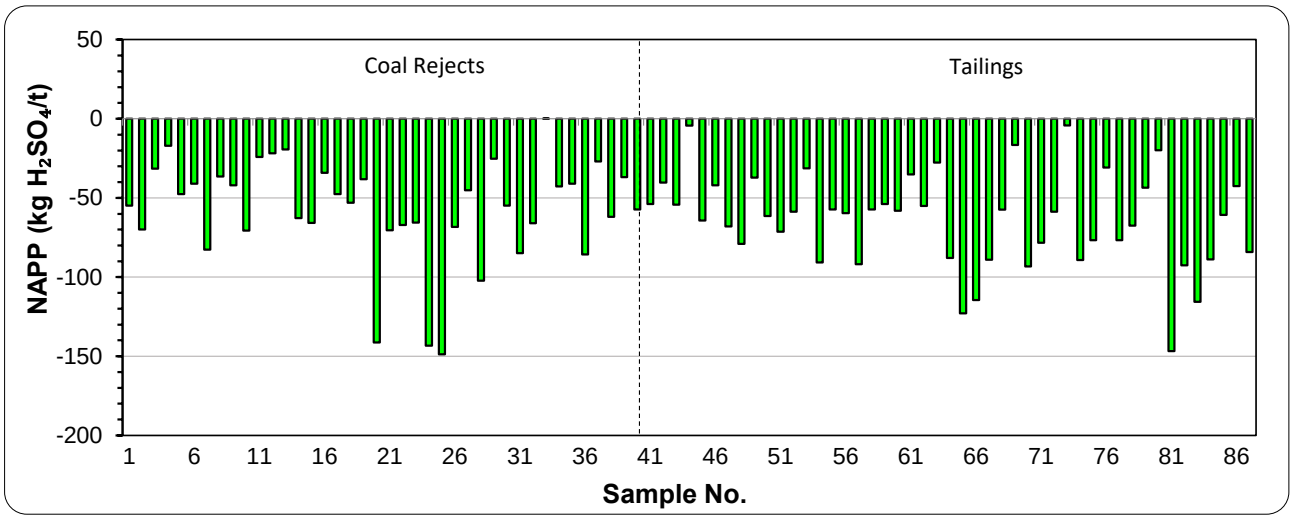

Figure 11-11: NAPP values for PTM coal rejects and fine rejects

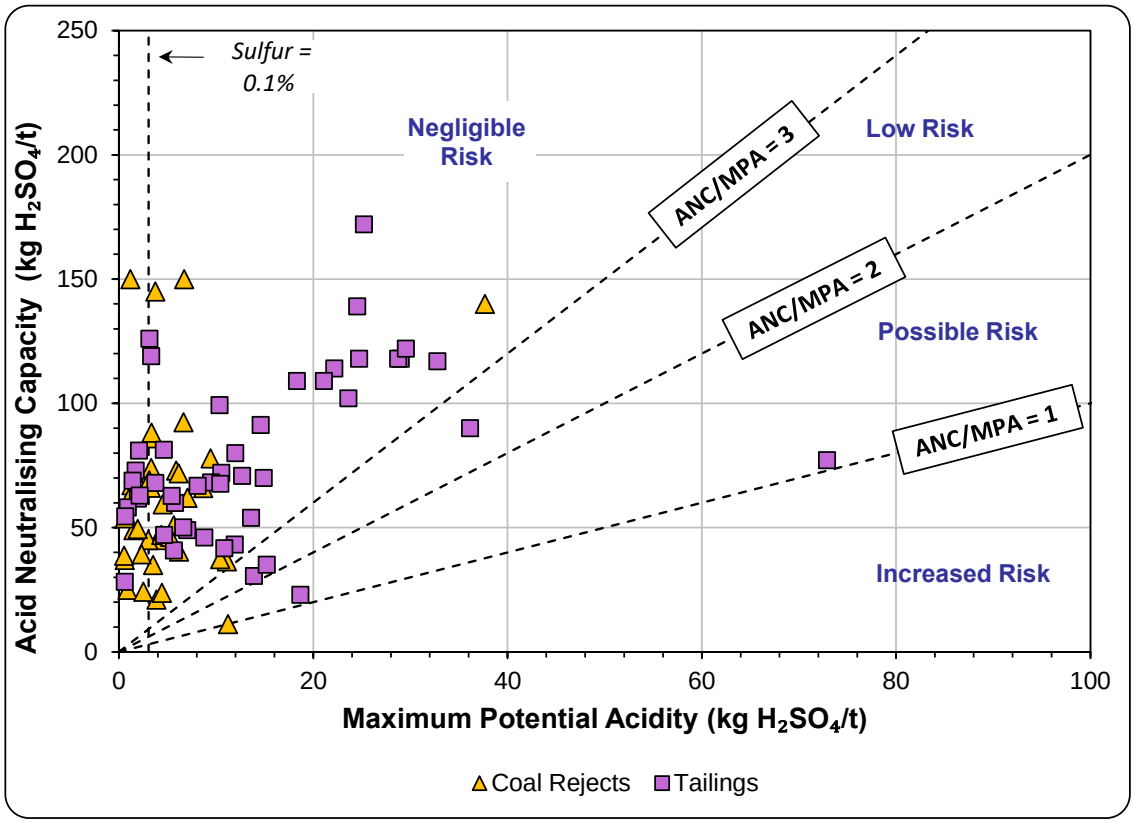

Figure 11-12: Relationship between ANC and MPA

Table C1: Acid Base Account Results for Coal Rejects and Tailings from the Stanmore Project

Sample No.	Client Sample ID	Sample Lithology	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC[2] (Scr)	MPA[2] (Scr)	NAPP[2] (Scr)	ANC: MPA Ratio	Sample Classification[3]
				(µS/cm)	(%)	(%)	(kg H_2SO_4/t)							
1	PTM_Reject_16-22Sep2020	Coal Rejects	7.60	421	0.49	0.230	62.0	7.0	-55.0	62.0	7.0	-55.0	8.8	Non-Acid Forming
2	PTM_Reject_23-29Sep2020	Coal Rejects	8.40	225	0.24	0.069	72.0	2.1	-69.9	72.0	2.1	-69.9	34.1	Non-Acid Forming (Barren)
3	PTM_Reject_30Sep-06Oct2020	Coal Rejects	8.60	222	0.27	0.115	35.0	3.5	-31.5	35.0	3.5	-31.5	9.9	Non-Acid Forming
4	PTM_Reject_07-13Oct2020	Coal Rejects	8.40	303	0.25	0.126	21.0	3.9	-17.1	21.0	3.9	-17.1	5.4	Non-Acid Forming
5	PTM_Reject_14-20Oct2020	Coal Rejects	9.10	202	0.20	0.049	49.0	1.5	-47.5	49.0	1.5	-47.5	32.7	Non-Acid Forming (Barren)
6	PTM_Reject_21-27Oct2020	Coal Rejects	8.30	219	0.35	0.129	45.0	4.0	-41.0	45.0	4.0	-41.0	11.4	Non-Acid Forming
7	PTM_Reject_04-10Nov2020	Coal Rejects	8.40	214	0.30	0.107	86.0	3.3	-82.7	86.0	3.3	-82.7	26.2	Non-Acid Forming
8	PTM_Reject_11-17Nov2020	Coal Rejects	8.80	168	0.21	0.019	37.0	0.6	-36.4	37.0	0.6	-36.4	63.6	Non-Acid Forming (Barren)
9	PTM_Reject_18-24Nov2020	Coal Rejects	9.30	246	0.23	0.099	45.0	3.0	-42.0	45.0	3.0	-42.0	14.8	Non-Acid Forming (Barren)
10	PTM_Reject_25Nov-02Dec2020	Coal Rejects	9.20	235	0.28	0.108	74.0	3.3	-70.7	74.0	3.3	-70.7	22.4	Non-Acid Forming
11	PTM_Reject_01-07Apr2021	Coal Rejects	9.40	181	0.24	0.029	25.0	0.9	-24.1	25.0	0.9	-24.1	28.1	Non-Acid Forming (Barren)
12	PTM_Reject_08-14Apr2021	Coal Rejects	9.00	247	0.25	0.082	24.2	2.5	-21.7	24.2	2.5	-21.7	9.6	Non-Acid Forming (Barren)
13	PTM_Reject_15-21Apr2021	Coal Rejects	9.30	288	0.42	0.144	23.8	4.4	-19.4	23.8	4.4	-19.4	5.4	Non-Acid Forming
14	PTM_Reject_8Sep-14Sep	Coal Rejects	8.70	291	0.24	0.107	66.1	3.3	-62.8	66.1	3.3	-62.8	20.2	Non-Acid Forming
15	PTM_Reject_15Sep-21Sep	Coal Rejects	9.70	230	0.21	0.042	67.1	1.3	-65.8	67.1	1.3	-65.8	52.2	Non-Acid Forming (Barren)
16	PTM_Reject_22Sep-28Sep	Coal Rejects	7.90	396	0.34	0.202	40.4	6.2	-34.2	40.4	6.2	-34.2	6.5	Non-Acid Forming
17	PTM_Reject_6Oct-12Oct	Coal Rejects	9.10	173	0.19	0.063	49.4	1.9	-47.5	49.4	1.9	-47.5	25.6	Non-Acid Forming (Barren)
18	PTM_Reject_13Oct-19Oct	Coal Rejects	9.30	176	0.14	0.019	53.7	0.6	-53.1	53.7	0.6	-53.1	92.3	Non-Acid Forming (Barren)
19	PTM_Reject_20Oct-26Oct	Coal Rejects	9.20	110	0.16	0.018	38.7	0.6	-38.1	38.7	0.6	-38.1	70.2	Non-Acid Forming (Barren)
20	PTM_Reject_17Nov-23Nov	Coal Rejects	9.00	255	0.23	0.123	145.0	3.8	-141.2	145.0	3.8	-141.2	38.5	Non-Acid Forming
21	PTM_Reject_1Dec-7Dec	Coal Rejects	9.50	277	0.13	0.050	72.0	1.5	-70.5	72.0	1.5	-70.5	47.0	Non-Acid Forming (Barren)
22	PTM_Reject_19Jan-25Jan	Coal Rejects	8.50	353	0.28	0.193	73.0	5.9	-67.1	73.0	5.9	-67.1	12.4	Non-Acid Forming
23	PTM_Reject_12Jan-18Jan	Coal Rejects	8.30	447	0.28	0.201	71.8	6.2	-65.6	71.8	6.2	-65.6	11.7	Non-Acid Forming
24	Plant Reject L13	Coal Rejects	9.10	163	0.45	0.219	150.0	6.7	-143.3	150.0	6.7	-143.3	22.4	Non-Acid Forming
25	Reject V1	Coal Rejects	9.60	247	0.22	0.038	150.0	1.2	-148.8	150.0	1.2	-148.8	128.9	Non-Acid Forming (Barren)
26	Poitrel Reject Q4FY17	Coal Rejects	8.20	456	0.58	0.308	77.8	9.4	-68.4	77.8	9.4	-68.4	8.2	Non-Acid Forming
27	PTM_WS_PWE_Rej_Q1FY18	Coal Rejects	8.40	389	0.50	0.184	50.9	5.6	-45.3	50.9	5.6	-45.3	9.0	Non-Acid Forming
28	PTM_WS_PWE_Rej_Q2FY18	Coal Rejects	8.30	663	1.47	1.230	140.0	37.7	-102.3	140.0	37.7	-102.3	3.7	Non-Acid Forming
29	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.50	404	0.57	0.363	36.4	11.1	-25.3	36.4	11.1	-25.3	3.3	Non-Acid Forming
30	PTM_WS_PWE_CHPPRJ	Coal Rejects	8.80	562	0.51	0.147	59.4	4.5	-54.9	59.4	4.5	-54.9	13.2	Non-Acid Forming
31	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.20	307	0.30	0.109	88.2	3.3	-84.9	88.2	3.3	-84.9	26.4	Non-Acid Forming
32	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.80	335	0.28	0.102	69.0	3.1	-65.9	69.0	3.1	-65.9	22.1	Non-Acid Forming
33	PTM_WS_PWE_CHPPRJ	Coal Rejects	8.40	202	0.74	0.367	11.2	11.2	0.0	11.2	11.2	0.0	1.0	Uncertain
34	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.60	218	0.23	0.142	47.0	4.3	-42.7	47.0	4.3	-42.7	10.8	Non-Acid Forming
35	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.00	238	0.35	0.173	46.3	5.3	-41.0	46.3	5.3	-41.0	8.7	Non-Acid Forming
36	PTM_WS_PWE_CHPPRJ	Coal Rejects	8.90	333	0.37	0.217	92.4	6.6	-85.8	92.4	6.6	-85.8	13.9	Non-Acid Forming
37	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.40	151	1.14	0.340	37.3	10.4	-26.9	37.3	10.4	-26.9	3.6	Non-Acid Forming
38	PTM_WS_PWE_CHPPRJ	Coal Rejects	10.10	283	0.18	0.039	63.1	1.2	-61.9	63.1	1.2	-61.9	52.8	Non-Acid Forming (Barren)

Table C1: Acid Base Account Results for Coal Rejects and Tailings from the Stanmore Project

Sample No.	Client Sample ID	Sample Lithology	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC[2] (Scr)	MPA[2] (Scr)	NAPP[2] (Scr)	ANC: MPA Ratio	Sample Classification[3]
				(µS/cm)	(%)	(%)	(kg H_2SO_4/t)							
39	PTM_WS_PWE_CHPPRJ	Coal Rejects	9.50	100	0.24	0.076	39.2	2.3	-36.9	39.2	2.3	-36.9	16.8	Non-Acid Forming (Barren)
40	PTM_WS_PWE_CHPPRJ	Coal Rejects	8.80	394	0.36	0.283	65.9	8.7	-57.2	65.9	8.7	-57.2	7.6	Non-Acid Forming
41	PTM_TailsU/F_16-22Sep2020	Tailings	7.50	785	1.70	1.180	90.0	36.1	-53.9	90.0	36.1	-53.9	2.5	Non-Acid Forming
42	PTM_TailsU/F_23-29Sep2020	Tailings	8.20	231	0.74	0.444	54.0	13.6	-40.4	54.0	13.6	-40.4	4.0	Non-Acid Forming
43	PTM_TailsU/F_30Sep-06Oct2020	Tailings	8.50	245	0.41	0.189	60.0	5.8	-54.2	60.0	5.8	-54.2	10.4	Non-Acid Forming
44	PTM_TailsU/F_07-13Oct2020	Tailings	8.00	441	0.97	0.610	23.0	18.7	-4.3	23.0	18.7	-4.3	1.2	Uncertain
45	PTM_TailsU/F_14-20Oct2020	Tailings	8.80	321	0.27	0.123	68.0	3.8	-64.2	68.0	3.8	-64.2	18.1	Non-Acid Forming
46	PTM_TailsU/F_21-27Oct2020	Tailings	8.70	235	0.42	0.229	49.0	7.0	-42.0	49.0	7.0	-42.0	7.0	Non-Acid Forming
47	PTM_TailsU/F_04-10Nov2020	Tailings	8.60	216	0.63	0.391	80.0	12.0	-68.0	80.0	12.0	-68.0	6.7	Non-Acid Forming
48	PTM_TailsU/F_11-17Nov2020	Tailings	8.70	224	0.23	0.068	81.0	2.1	-78.9	81.0	2.1	-78.9	38.9	Non-Acid Forming (Barren)
49	PTM_TailsU/F_18-24Nov2020	Tailings	9.00	208	0.49	0.287	46.0	8.8	-37.2	46.0	8.8	-37.2	5.2	Non-Acid Forming
50	PTM_TailsU/F_25Nov-02Dec2020	Tailings	9.10	222	0.57	0.344	72.0	10.5	-61.5	72.0	10.5	-61.5	6.8	Non-Acid Forming
51	PTM_TailsU/F_01-07Apr2021	Tailings	9.30	472	0.14	0.056	73.0	1.7	-71.3	73.0	1.7	-71.3	42.6	Non-Acid Forming (Barren)
52	PTM_TailsU/F_08-14Apr2021	Tailings	8.90	394	0.41	0.310	68.2	9.5	-58.7	68.2	9.5	-58.7	7.2	Non-Acid Forming
53	PTM_TailsU/F_15-21Apr2021	Tailings	8.80	351	0.65	0.389	43.2	11.9	-31.3	43.2	11.9	-31.3	3.6	Non-Acid Forming
54	PTM_TailsU/F_8Sep-14Sep	Tailings	8.70	359	0.72	0.598	109.0	18.3	-90.7	109.0	18.3	-90.7	6.0	Non-Acid Forming
55	PTM_TailsU/F_6Oct-12Oct	Tailings	9.00	242	0.48	0.341	67.6	10.4	-57.2	67.6	10.4	-57.2	6.5	Non-Acid Forming
56	PTM_TailsU/F_15Sep-21Sep	Tailings	9.30	284	0.21	0.064	61.6	2.0	-59.6	61.6	2.0	-59.6	31.4	Non-Acid Forming (Barren)
57	PTM_TailsU/F_22Sep-28Sep	Tailings	8.60	365	0.81	0.724	114.0	22.2	-91.8	114.0	22.2	-91.8	5.1	Non-Acid Forming
58	PTM_TailsU/F_13Oct-19Oct	Tailings	9.40	210	0.16	0.030	58.1	0.9	-57.2	58.1	0.9	-57.2	63.2	Non-Acid Forming (Barren)
59	PTM_TailsU/F_20Oct-26Oct	Tailings	9.40	187	0.14	0.021	54.5	0.6	-53.9	54.5	0.6	-53.9	84.7	Non-Acid Forming (Barren)
60	PTM_TailsU/F_17Nov-23Nov	Tailings	9.00	303	0.54	0.414	70.8	12.7	-58.1	70.8	12.7	-58.1	5.6	Non-Acid Forming
61	PTM_TailsU/F_1Dec-7Dec	Tailings	9.10	262	0.37	0.185	40.8	5.7	-35.1	40.8	5.7	-35.1	7.2	Non-Acid Forming
62	PTM_TailsU/F_19Jan-25Jan	Tailings	8.80	330	0.62	0.487	70.0	14.9	-55.1	70.0	14.9	-55.1	4.7	Non-Acid Forming
63	RMI-Surface-WC12	Tailings	8.20	1,420	0.27	0.019	28.2	0.6	-27.6	28.2	0.6	-27.6	48.5	Non-Acid Forming (Barren)
64	Reject Thick 22/2 DS	Tailings	8.30	325	0.86	0.689	109.0	21.1	-87.9	109.0	21.1	-87.9	5.2	Non-Acid Forming
65	Tailings V1	Tailings	8.80	220	0.32	0.103	126.0	3.2	-122.8	126.0	3.2	-122.8	39.9	Non-Acid Forming
66	Poitrel Tailings Q4FY17	Tailings	8.30	284	1.01	0.801	139.0	24.5	-114.5	139.0	24.5	-114.5	5.7	Non-Acid Forming
67	PTM_WS_PWE_Tail_Q1FY18	Tailings	8.20	420	1.14	0.947	118.0	29.0	-89.0	118.0	29.0	-89.0	4.1	Non-Acid Forming
68	PTM_WS_PWE_Tail_Q2FY18	Tailings	8.40	273	0.44	0.177	62.8	5.4	-57.4	62.8	5.4	-57.4	11.6	Non-Acid Forming
69	PTM_WS_PWE_CHPPTA	Tailings	8.60	365	0.71	0.454	30.5	13.9	-16.6	30.5	13.9	-16.6	2.2	Non-Acid Forming
70	PTM_WS_PWE_CHPPTA	Tailings	8.70	306	1.08	0.807	118.0	24.7	-93.3	118.0	24.7	-93.3	4.8	Non-Acid Forming
71	PTM_WS_PWE_CHPPTA	Tailings	8.50	569	1.01	0.771	102.0	23.6	-78.4	102.0	23.6	-78.4	4.3	Non-Acid Forming
72	PTM_WS_PWE_CHPPTA	Tailings	8.40	254	0.46	0.264	66.8	8.1	-58.7	66.8	8.1	-58.7	8.3	Non-Acid Forming
73	PTM_WS_PWE_CHPPTA	Tailings	7.90	564	2.61	2.380	77.1	72.9	-4.2	77.1	72.9	-4.2	1.1	Uncertain
74	PTM_WS_PWE_CHPPTA	Tailings	8.60	463	1.20	0.939	118.0	28.8	-89.2	118.0	28.8	-89.2	4.1	Non-Acid Forming
75	PTM_WS_PWE_CHPPTA	Tailings	9.00	441	0.82	0.476	91.3	14.6	-76.7	91.3	14.6	-76.7	6.3	Non-Acid Forming
76	PTM_WS_PWE_CHPPTA	Tailings	8.80	399	0.52	0.354	41.7	10.8	-30.9	41.7	10.8	-30.9	3.8	Non-Acid Forming

Table C1: Acid Base Account Results for Coal Rejects and Tailings from the Stanmore Project

Sample No.	Client Sample ID	Sample Lithology	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC[2] (Scr)	MPA[2] (Scr)	NAPP[2] (Scr)	ANC: MPA Ratio	Sample Classification[3]
				(µS/cm)	(%)	(%)	(kg H_2SO_4/t)							
77	PTM_WS_PWE_CHPPTA	Tailings	8.90	174	0.25	0.151	81.3	4.6	-76.7	81.3	4.6	-76.7	17.6	Non-Acid Forming
78	PTM_WS_PWE_CHPPTA	Tailings	9.30	255	0.12	0.046	68.9	1.4	-67.5	68.9	1.4	-67.5	48.9	Non-Acid Forming (Barren)
79	PTM_WS_PWE_CHPPTA	Tailings	9.10	116	0.43	0.216	50.1	6.6	-43.5	50.1	6.6	-43.5	7.6	Non-Acid Forming
80	PTM_WS_PWE_CHPPTA	Tailings	9.00	290	0.61	0.497	35.1	15.2	-19.9	35.1	15.2	-19.9	2.3	Non-Acid Forming
81	Red Mt Thick. U/F 9/09/2019	Tailings			1.02	0.823	172.0	25.2	-146.8	172.0	25.2	-146.8	6.8	Non-Acid Forming
82	PTM - RM Thick. U/F 17/09/2019	Tailings	7.70	997	1.60	0.964	122.0	29.5	-92.5	122.0	29.5	-92.5	4.1	Non-Acid Forming
83	RM 11/10 UF	Tailings			0.11	0.108	119.0	3.3	-115.7	119.0	3.3	-115.7	36.0	Non-Acid Forming
84	PTM UF 8/11/19	Tailings			0.45	0.338	99.3	10.4	-88.9	99.3	10.4	-88.9	9.6	Non-Acid Forming
85	RM UF 11/12/19	Tailings	9.00	483	0.19	0.070	62.9	2.1	-60.8	62.9	2.1	-60.8	29.3	Non-Acid Forming (Barren)
86	RM 17/1/20 UF	Tailings			0.41	0.152	47.1	4.7	-42.4	47.1	4.7	-42.4	10.1	Non-Acid Forming
87	PTM C1A	Tailings			1.28	1.070	117.0	32.8	-84.2	117.0	32.8	-84.2	3.6	Non-Acid Forming

Notes:

1. Current pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; NAPP = Net Acid Producing Potential; NAG = Net Acid Generation.
3. Sample classification criteria detail provided in report text.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used .

Table C2: Multi-Element and Exchangeable Cation Results for Coal Rejects and Tailings from the Stanmore Project

		Sampling Date →	22/9/2020	6/10/2020	27/10/2020	17/11/2020
		Client ID →	PTM_Reject_04-10Nov2020	PTM_Reject_01-07Apr2021	PTM_Reject_15-21Apr2021	PTM_Reject_8Sep-14Sep
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Coal Rejects	Coal Rejects	Coal Rejects	Coal Rejects
pH	0.1	-	8.40	9.40	9.30	8.70
Electrical Conductivity	1	-	214	181	288	291
Major Cations		-	All units mg/kg			
Calcium (Ca)	50	-	39,300	18,200	8,600	21,600
Magnesium (Mg)	50	-	2,500	3,000	1,300	3,200
Potassium (K)	50	-	400	700	900	600
Sodium (Na)	50	-	250	310	490	320
Aluminium (Al)	50	-	4,100	5,200	3,200	4,200
Iron (Fe)	50	-	8,700	17,800	7,900	23,400
Minor and Trace Elements		-	All units mg/kg			
Silver (Ag)	5	-	0.036	0.029	0.085	0.042
Arsenic (As)	50	300	2.69	3.57	5.82	3.69
Gold (Au)	10	-	<0.0002	<0.0002	<0.0002	<0.0002
Boron (B)	1	20,000	<10	<10	<10	<10
Barium (Ba)	1	-	74.6	143.5	789.0	431.0
Beryllium (Be)	2	90	0.38	0.39	0.58	0.47
Bismith (Bi) **	2	-	0.182	0.182	0.284	0.245
Cadmium (Cd)	5	90	0.07	0.08	0.13	0.07
Cerium (Ce)	0.1	-	6.81	7.09	5.35	6.94
Cobalt (Co)	5	300	2.74	5.65	3.55	3.45
Chromium (Cr)	2	300	7.62	3.27	2.12	10.85
Caesium (Cs)	2	-	1.07	1.73	4.67	1.98
Copper (Cu)	5	17,000	41	22	49	68
Gallium (Ga)	5	-	1.37	1.05	0.73	1.60
Germanium (Ge)	5	-	0.072	0.071	0.041	0.062
Hafnium (Hf)	0.1	-	0.105	0.087	0.118	0.103
Mercury (Hg)	0.1	80	0.04	0.03	0.09	0.05
Indium (In)	5	-	0.029	0.022	0.034	0.036
Lanthanum (La)	5	-	2.2	2.9	2.2	2.7
Lithium (Li)		-	6.6	6.6	3.4	5.5
Manganese (Mn)		19,000	244	370	249	630
Molybdenum (Mo)		-	2.07	1.13	3.15	3.11
Niobium (Nb)		-	0.04	0.03	0.02	0.05
Nickel (Ni)		1,200	6.0	9.3	6.0	9.6
Phosphorus (P)		-	850	480	140	790
Lead (Pb)		600	6.92	6.95	11.95	10.5
Palladium (Pd)		-	<0.001	0.003	<0.001	0.001
Platinum (Pt)		-	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)		-	3.1	4.5	9.7	5.2
Rhenium (Re)		-	0.001	0.000	0.001	0.001
Sulfur (S)		-	1500	500	2500	1500
Antimony (Sb)		-	0.3	0.3	0.4	0.3
Scandium (Sc)		-	4.17	2.30	3.03	3.41
Selenium (Se)		700	0.34	0.38	0.53	0.58
Tin (Sn)		-	0.90	0.32	0.32	2.01
Strontium (Sr)		-	153.5	142.5	130.5	120.0
Tantalum (Ta)		-	<0.005	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.036	0.032	0.067	0.042
Thorium (Th)		-	1.48	1.12	1.255	1.65
Titanium (Ti)		-	10	10	10	10
Thallium (Tl)		-	0.002	0.002	0.009	0.003
Uranium (U)		-	0.426	0.228	0.295	0.407
Vanadium (V)		-	11.3	9.4	9.9	12.7
Tungsten (W)		-	2.8	0.0	0.0	0.4
Yttrium (Y)		-	7.9	4.7	3.2	6.8
Zinc (Zn)		30,000	22.1	24.4	41.6	27.6
Zirconium (Zn)		-	4.2	2.6	4.0	3.8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table C2: Multi-Element and Exchangeable Cation Results for Coal Rejects and Tailings from the Stanmore Project

			Sampling Date →	10/11/2020	7/4/2021	21/4/2021	7/4/2021
			Client ID →	PTM_Reject_6Oct-12Oct	PTM_Reject_20Oct-26Oct	PTM_Reject_1Dec-7Dec	PTM_TailsU/F_16-22Sep2020
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C		Coal Rejects	Coal Rejects	Coal Rejects	Tailings
pH	0.1	-		9.10	9.20	9.50	7.50
Electrical Conductivity	1	-		173	110	277	785
Major Cations		-		All units mg/kg			
Calcium (Ca)	50	-		18,000	13,200	26,100	32,400
Magnesium (Mg)	50	-		1,500	1,900	2,300	3,000
Potassium (K)	50	-		600	300	900	500
Sodium (Na)	50	-		260	270	530	220
Aluminium (Al)	50	-		4,300	3,800	5,300	3,900
Iron (Fe)	50	-		8,300	36,500	18,300	27,100
Minor and Trace Elements		-		All units mg/kg			
Silver (Ag)	5	-		0.037	0.032	0.066	0.036
Arsenic (As)	50	300		1.97	3.58	5.46	3.14
Gold (Au)	10	-		<0.0002	<0.0002	<0.0002	<0.0002
Boron (B)	1	20,000		<10	<10	<10	<10
Barium (Ba)	1	-		304.0	38.6	191.5	128.5
Beryllium (Be)	2	90		0.46	0.35	0.77	0.43
Bismith (Bi) **	2	-		0.248	0.204	0.317	0.287
Cadmium (Cd)	5	90		0.06	0.05	0.09	0.10
Cerium (Ce)	0.1	-		4.70	8.79	7.11	5.43
Cobalt (Co)	5	300		2.18	3.97	5.60	2.21
Chromium (Cr)	2	300		8.62	10.85	11.45	8.63
Caesium (Cs)	2	-		1.77	0.82	2.90	1.82
Copper (Cu)	5	17,000		47	46	60	29
Gallium (Ga)	5	-		1.52	1.63	1.88	1.93
Germanium (Ge)	5	-		0.066	0.104	0.048	0.063
Hafnium (Hf)	0.1	-		0.114	0.093	0.107	0.133
Mercury (Hg)	0.1	80		0.03	0.03	0.06	0.06
Indium (In)	5	-		0.032	0.027	0.044	0.054
Lanthanum (La)	5	-		1.9	3.4	2.9	1.8
Lithium (Li)		-		8.6	4.9	6.5	5.8
Manganese (Mn)		19,000		165.5	933	482	390
Molybdenum (Mo)		-		1.84	1.98	4.69	1.98
Niobium (Nb)		-		0.05	0.06	0.03	0.03
Nickel (Ni)		1,200		7.1	8.8	13.0	5.9
Phosphorus (P)		-		690	810	790	890
Lead (Pb)		600		9.42	9.36	14.2	8.51
Palladium (Pd)		-		<0.001	<0.001	0.001	<0.001
Platinum (Pt)		-		<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)		-		4.4	2.5	7.3	5.0
Rhenium (Re)		-		0.001	0.001	0.001	0.001
Sulfur (S)		-		900	200	600	15500
Antimony (Sb)		-		0.2	0.2	0.3	0.4
Scandium (Sc)		-		2.95	2.82	5.33	5.54
Selenium (Se)		700		0.53	0.59	0.56	0.68
Tin (Sn)		-		1.14	1.16	1.28	0.70
Strontium (Sr)		-		102.0	59.3	162.0	127.0
Tantalum (Ta)		-		<0.005	<0.005	<0.005	<0.005
Tellerium (Te)		-		0.04	0.03	0.05	0.10
Thorium (Th)		-		1.47	2.07	1.92	1.51
Titanium (Ti)		-		10	10	10	10
Thallium (Tl)		-		0.002	0.002	0.018	0.015
Uranium (U)		-		0.317	0.375	0.448	0.504
Vanadium (V)		-		10.3	12.0	15.7	16.0
Tungsten (W)		-		0.6	0.3	0.6	0.8
Yttrium (Y)		-		5.8	5.9	8.6	8.7
Zinc (Zn)		30,000		19.2	20.9	40.9	29.8
Zirconium (Zn)		-		3.8	3.3	4.8	4.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table C2: Multi-Element and Exchangeable Cation Results for Coal Rejects and Tailings from the Stanmore Project

		Sampling Date →	21/4/2021	14/9/2021	12/10/2021	14/9/2021
		Client ID →	PTM_TailsU/F_30Sep-06Oct2020	PTM_TailsU/F_21-27Oct2020	PTM_TailsU/F_11-17Nov2020	PTM_TailsU/F_01-07Apr2021
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Tailings	Tailings	Tailings	Tailings
pH	0.1	-	8.50	8.70	8.70	9.30
Electrical Conductivity	1	-	245	235	224	472
Major Cations		-	All units mg/kg			
Calcium (Ca)	50	-	20,700	19,500	31,300	25,200
Magnesium (Mg)	50	-	2,800	2,100	2,500	4,500
Potassium (K)	50	-	500	500	300	1,100
Sodium (Na)	50	-	440	330	320	640
Aluminium (Al)	50	-	4,000	4,200	4,000	11,100
Iron (Fe)	50	-	19,600	18,800	16,900	34,800
Minor and Trace Elements		-	All units mg/kg			
Silver (Ag)	5	-	0.029	0.035	0.021	0.042
Arsenic (As)	50	300	2.66	3.70	2.32	6.81
Gold (Au)	10	-	<0.0002	<0.0002	<0.0002	<0.0002
Boron (B)	1	20,000	<10	<10	<10	<10
Barium (Ba)	1	-	494.0	85.2	45.7	429.0
Beryllium (Be)	2	90	0.42	0.41	0.31	0.67
Bismith (Bi) **	2	-	0.285	0.278	0.176	0.445
Cadmium (Cd)	5	90	0.07	0.06	0.09	0.09
Cerium (Ce)	0.1	-	7.31	7.33	6.79	8.52
Cobalt (Co)	5	300	2.49	3.11	2.68	8.73
Chromium (Cr)	2	300	6.93	5.74	7.64	5.46
Caesium (Cs)	2	-	1.74	2.17	0.78	2.42
Copper (Cu)	5	17,000	31	28	27	30
Gallium (Ga)	5	-	1.60	1.73	1.78	3.05
Germanium (Ge)	5	-	0.071	0.057	0.078	0.040
Hafnium (Hf)	0.1	-	0.122	0.116	0.097	0.111
Mercury (Hg)	0.1	80	0.05	0.06	0.05	0.06
Indium (In)	5	-	0.036	0.031	0.033	0.040
Lanthanum (La)	5	-	2.5	2.7	2.3	3.1
Lithium (Li)		-	5.0	5.5	5.3	14.2
Manganese (Mn)		19,000	369	397	415	432
Molybdenum (Mo)		-	1.64	3.02	1.45	2.01
Niobium (Nb)		-	0.03	0.02	0.04	0.02
Nickel (Ni)		1,200	5.6	6.0	6.6	15.2
Phosphorus (P)		-	910	400	710	550
Lead (Pb)		600	9.5	6.72	6.68	11.4
Palladium (Pd)		-	<0.001	<0.001	<0.001	<0.001
Platinum (Pt)		-	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)		-	4.7	5.5	2.3	6.6
Rhenium (Re)		-	0.001	0.001	0.001	0.000
Sulfur (S)		-	2600	2800	1000	900
Antimony (Sb)		-	0.2	0.3	0.2	0.5
Scandium (Sc)		-	4.07	3.26	4.19	3.68
Selenium (Se)		700	0.60	0.41	0.56	0.39
Tin (Sn)		-	0.67	0.67	0.45	0.96
Strontium (Sr)		-	96.6	95.2	98.7	247.0
Tantalum (Ta)		-	<0.005	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.06	0.06	0.03	0.05
Thorium (Th)		-	1.70	1.74	1.50	1.89
Titanium (Ti)		-	10	10	10	10
Thallium (Tl)		-	0.010	0.010	0.004	0.021
Uranium (U)		-	0.396	0.388	0.313	0.372
Vanadium (V)		-	13.1	13.0	11.3	16.2
Tungsten (W)		-	0.3	0.2	1.4	0.2
Yttrium (Y)		-	6.3	4.9	6.1	7.2
Zinc (Zn)		30,000	23.1	19.8	27.5	37.1
Zirconium (Zn)		-	3.9	4.0	3.2	3.2

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table C2: Multi-Element and Exchangeable Cation Results for Coal Rejects and Tailings from the Stanmore Project

		Sampling Date →	12/10/2021	26/10/2021	7/12/2021	26/10/2021
		Client ID →	PTM_TailsU/F_15-21Apr2021	PTM_TailsU/F_8Sep-14Sep	PTM_TailsU/F_6Oct-12Oct	PTM_TailsU/F_20Oct-26Oct
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Tailings	Tailings	Tailings	Tailings
pH	0.1	-	8.80	8.70	9.00	9.40
Electrical Conductivity	1	-	351	359	242	187
Major Cations		-	All units mg/kg			
Calcium (Ca)	50	-	14,600	37,400	23,800	17,900
Magnesium (Mg)	50	-	1,900	3,700	1,900	2,300
Potassium (K)	50	-	800	700	600	400
Sodium (Na)	50	-	360	310	280	300
Aluminium (Al)	50	-	4,600	4,200	4,200	4,300
Iron (Fe)	50	-	15,000	23,700	17,500	16,400
Minor and Trace Elements		-	All units mg/kg			
Silver (Ag)	5	-	0.048	0.052	0.031	0.025
Arsenic (As)	50	300	4.18	4.75	2.76	3.90
Gold (Au)	10	-	0	<0.0002	<0.0002	<0.0002
Boron (B)	1	20,000	<10	<10	<10	<10
Barium (Ba)	1	-	337.0	402.0	594.0	66.0
Beryllium (Be)	2	90	0.50	0.52	0.43	0.39
Bismith (Bi) **	2	-	0.300	0.293	0.260	0.271
Cadmium (Cd)	5	90	0.11	0.10	0.10	0.06
Cerium (Ce)	0.1	-	8.38	5.64	5.24	8.48
Cobalt (Co)	5	300	3.31	3.92	2.45	3.46
Chromium (Cr)	2	300	4.60	10.00	8.29	8.44
Caesium (Cs)	2	-	2.94	2.19	1.78	1.36
Copper (Cu)	5	17,000	33	40	35	33
Gallium (Ga)	5	-	1.52	1.94	1.82	1.81
Germanium (Ge)	5	-	0.041	0.050	0.064	0.067
Hafnium (Hf)	0.1	-	0.115	0.104	0.106	0.101
Mercury (Hg)	0.1	80	0.07	0.07	0.05	0.04
Indium (In)	5	-	0.041	0.060	0.051	0.033
Lanthanum (La)	5	-	3.2	2.0	1.9	3.2
Lithium (Li)		-	4.9	4.9	7.7	5.0
Manganese (Mn)		19,000	222	356	249	368
Molybdenum (Mo)		-	2.72	2.04	1.93	2.92
Niobium (Nb)		-	0.03	0.05	0.04	0.04
Nickel (Ni)		1,200	6.1	9.7	7.2	7.6
Phosphorus (P)		-	520	720	750	470
Lead (Pb)		600	10.25	11.2	9.96	8.73
Palladium (Pd)		-	<0.001	<0.001	<0.001	<0.001
Platinum (Pt)		-	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)		-	7.2	6.4	4.5	4.2
Rhenium (Re)		-	0.001	0.001	0.001	0.001
Sulfur (S)		-	5900	7200	4600	200
Antimony (Sb)		-	0.3	0.4	0.3	0.2
Scandium (Sc)		-	3.74	6.28	4.42	3.70
Selenium (Se)		700	0.59	0.69	0.74	0.48
Tin (Sn)		-	0.49	1.16	0.65	0.80
Strontium (Sr)		-	90.5	184.0	110.5	74.6
Tantalum (Ta)		-	<0.005	<0.005	<0.005	<0.005
Tellerium (Te)		-	0.07	0.10	0.04	0.04
Thorium (Th)		-	1.61	1.40	1.55	1.95
Titanium (Ti)		-	10	10	10	10
Thallium (Tl)		-	0.009	0.015	0.011	0.005
Uranium (U)		-	0.46	0.412	0.413	0.372
Vanadium (V)		-	21.5	14.0	12.0	13.7
Tungsten (W)		-	0.1	0.8	0.7	0.4
Yttrium (Y)		-	5.5	7.5	7.9	6.5
Zinc (Zn)		30,000	32.3	36.4	23.3	19.4
Zirconium (Zn)		-	3.9	3.6	3.5	3.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table C2: Multi-Element and Exchangeable Cation Results for Coal Rejects and Tailings from the Stanmore Project

		Sampling Date →	7/12/2021	19/4/2021
		Client ID →	PTM_TailsU/F_1 Dec-7Dec	RMI-Surface-WC12
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Tailings	Tailings
pH	0.1	-	9.10	8.20
Electrical Conductivity	1	-	262	1,420
Major Cations		-	All units mg/kg	
Calcium (Ca)	50	-	14,200	3,700
Magnesium (Mg)	50	-	1,400	1,600
Potassium (K)	50	-	500	1,100
Sodium (Na)	50	-	280	630
Aluminium (Al)	50	-	3,300	4,900
Iron (Fe)	50	-	13,700	11,400
Minor and Trace Elements		-	All units mg/kg	
Silver (Ag)	5	-	0.028	0.052
Arsenic (As)	50	300	2.51	5.75
Gold (Au)	10	-	<0.0002	<0.0002
Boron (B)	1	20,000	<10	<10
Barium (Ba)	1	-	829.0	182.0
Beryllium (Be)	2	90	0.39	0.65
Bismith (Bi) **	2	-	0.424	0.309
Cadmium (Cd)	5	90	0.08	0.08
Cerium (Ce)	0.1	-	4.39	9.10
Cobalt (Co)	5	300	2.49	4.04
Chromium (Cr)	2	300	8.56	4.40
Caesium (Cs)	2	-	1.50	3.92
Copper (Cu)	5	17,000	33	41
Gallium (Ga)	5	-	1.44	1.68
Germanium (Ge)	5	-	0.084	0.035
Hafnium (Hf)	0.1	-	0.089	0.113
Mercury (Hg)	0.1	80	0.03	0.06
Indium (In)	5	-	0.039	0.041
Lanthanum (La)	5	-	1.6	3.4
Lithium (Li)		-	4.2	3.9
Manganese (Mn)		19,000	230	189.5
Molybdenum (Mo)		-	1.73	10.25
Niobium (Nb)		-	0.06	0.02
Nickel (Ni)		1,200	7.2	8.4
Phosphorus (P)		-	580	250
Lead (Pb)		600	10.4	13.7
Palladium (Pd)		-	0.001	<0.001
Platinum (Pt)		-	<0.002	<0.002
Rubidium (Rb)		-	4.3	8.9
Rhenium (Re)		-	0.001	0.001
Sulfur (S)		-	2400	300
Antimony (Sb)		-	0.2	0.3
Scandium (Sc)		-	3.03	2.99
Selenium (Se)		700	0.70	0.42
Tin (Sn)		-	0.88	0.47
Strontium (Sr)		-	78.0	80.5
Tantalum (Ta)		-	<0.005	<0.005
Tellerium (Te)		-	0.04	0.05
Thorium (Th)		-	1.13	1.93
Titanium (Ti)		-	10	10
Thallium (Tl)		-	0.006	0.018
Uranium (U)		-	0.31	0.453
Vanadium (V)		-	12.1	17.2
Tungsten (W)		-	0.9	0.0
Yttrium (Y)		-	5.3	3.8
Zinc (Zn)		30,000	25.8	34.1
Zirconium (Zn)		-	3.2	3.7

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM), Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table C3: Geochemical Abundance Index (GAI) Results for Coal Rejects and Tailings from the Stanmore Project

	Sampling Date →		22/09/2020	6/10/2020	27/10/2020	17/11/2020	10/11/2020	7/04/2021	21/04/2021	7/04/2021	21/04/2021
	Client ID →		PTM_Reject_04-10Nov2020	PTM_Reject_01-07Apr2021	PTM_Reject_15-21Apr2021	PTM_Reject_8Sep-14Sep	PTM_Reject_6Oct-12Oct	PTM_Reject_20Oct-26Oct	PTM_Reject_1Dec-7Dec	PTM_TailsU/F_16-22Sep2020	PTM_TailsU/F_30Sep-06Oct2020
Parameters	**Limit of Reporting**	Median Crustal Abundance[1,2,3]	Coal Rejects	Coal Rejects	Coal Rejects	Coal Rejects	Coal Rejects	Coal Rejects	Coal Rejects	Tailings	Tailings
Major Cations	(All units in mg/kg)		Geochemical Abundance Index								
Calcium (Ca)	50	15,000	1	0	0	0	0	0	0	1	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index								
Silver (Ag)	5	0.075	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6	0	0	0	0	0	0	0	0	0
Gold (Au)	10	0.001	0	0	0	0	0	0	0	0	0
Boron (B)	1	20	0	0	0	0	0	0	0	0	0
Barium (Ba)	1	500	0	0	0	0	0	0	0	0	0
Beryllium (Be)	2	0.3	0	0	0	0	0	0	1	0	0
Bismith (Bi)	2	----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	5	0.35	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.1	50	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8	0	0	0	0	0	0	0	0	0
Chromium (Cr)	2	70	0	0	0	0	0	0	0	0	0
Caesium (Cs)	2	4	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	30	0	0	0	1	0	0	0	0	0
Gallium (Ga)	5	20	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	0	0
Indium (In)	5	1	0	0	0	0	0	0	0	0	0
Lanthanum (La)	5	40	0	0	0	0	0	0	0	0	0
Lithium (Li)	----	25	0	0	0	0	0	0	0	0	0
Manganese (Mn)	----	1000	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	----	1.2	0	0	1	1	0	0	1	0	0
Niobium (Nb)	----	10	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35	0	0	0	0	0	0	0	0	0
Palladium (Pd)	----	0.015	0	0	0	0	0	0	0	0	0
Platinum (Pt)	----	0.005	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700	1	0	1	1	0	0	0	4	1
Antimony (Sb)	----	1	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7	0	0	0	0	0	0	0	0	0
Selenium (Se)	----	0.4	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2	0	0	0	0	0	0	0	0	0
Uranium (U)	----	2	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----	----	----	----	----	----	----	----	----	----

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table C3: Geochemical Abundance Index (GAI) Results for Coal Rejects and Tailings from the Stanmore Project

	Sampling Date →		14/09/2021	12/10/2021	14/09/2021	12/10/2021	26/10/2021	7/12/2021	26/10/2021	7/12/2021	19/04/2021
	Client ID →		PTM_TailsU/F_21-27Oct2020	PTM_TailsU/F_11-17Nov2020	PTM_TailsU/F_01-07Apr2021	PTM_TailsU/F_15-21Apr2021	PTM_TailsU/F_8Sep-14Sep	PTM_TailsU/F_6Oct-12Oct	PTM_TailsU/F_20Oct-26Oct	PTM_TailsU/F_1Dec-7Dec	RMI-Surface-WC12
Parameters	**Limit of Reporting**	Median Crustal Abundance[1,2,3]	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings
Major Cations	(All units in mg/kg)		Geochemical Abundance Index								
Calcium (Ca)	50	15,000	0	0	0	0	1	0	0	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index								
Silver (Ag)	5	0.075	0	0	0	0	0	0	0	0	0
Arsenic (As)	50	6	0	0	0	0	0	0	0	0	0
Gold (Au)	10	0.001	0	0	0	0	0	0	0	0	0
Boron (B)	1	20	0	0	0	0	0	0	0	0	0
Barium (Ba)	1	500	0	0	0	0	0	0	0	0	0
Beryllium (Be)	2	0.3	0	0	1	0	0	0	0	0	1
Bismith (Bi)	2	----	----	----	----	----	----	----	----	----	----
Cadmium (Cd)	5	0.35	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.1	50	0	0	0	0	0	0	0	0	0
Cobalt (Co)	5	8	0	0	0	0	0	0	0	0	0
Chromium (Cr)	2	70	0	0	0	0	0	0	0	0	0
Caesium (Cs)	2	4	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	30	0	0	0	0	0	0	0	0	0
Gallium (Ga)	5	20	0	0	0	0	0	0	0	0	0
Germanium (Ge)	5	1	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	0	0
Indium (In)	5	1	0	0	0	0	0	0	0	0	0
Lanthanum (La)	5	40	0	0	0	0	0	0	0	0	0
Lithium (Li)	----	25	0	0	0	0	0	0	0	0	0
Manganese (Mn)	----	1000	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	----	1.2	1	0	0	1	0	0	1	0	3
Niobium (Nb)	----	10	0	0	0	0	0	0	0	0	0
Nickel (Ni)	----	50	0	0	0	0	0	0	0	0	0
Phosphorus (P)	----	800	0	0	0	0	0	0	0	0	0
Lead (Pb)	----	35	0	0	0	0	0	0	0	0	0
Palladium (Pd)	----	0.015	0	0	0	0	0	0	0	0	0
Platinum (Pt)	----	0.005	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	----	150	0	0	0	0	0	0	0	0	0
Rhenium (Re)	----	0.0007	0	0	0	0	0	0	0	0	0
Sulfur (S)	----	700	1	0	0	2	3	2	0	1	0
Antimony (Sb)	----	1	0	0	0	0	0	0	0	0	0
Scandium (Sc)	----	7	0	0	0	0	0	0	0	0	0
Selenium (Se)	----	0.4	0	0	0	0	0	0	0	0	0
Tin (Sn)	----	4	0	0	0	0	0	0	0	0	0
Strontium (Sr)	----	250	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	----	2	0	0	0	0	0	0	0	0	0
Tellerium (Te)	----	----	----	----	----	----	----	----	----	----	----
Thorium (Th)	----	9	0	0	0	0	0	0	0	0	0
Titanium (Ti)	----	5000	0	0	0	0	0	0	0	0	0
Thallium (Tl)	----	0.2	0	0	0	0	0	0	0	0	0
Uranium (U)	----	2	0	0	0	0	0	0	0	0	0
Vanadium (V)	----	90	0	0	0	0	0	0	0	0	0
Tungsten (W)	----	1.5	0	0	0	0	0	0	0	0	0
Yttrium (Y)	----	40	0	0	0	0	0	0	0	0	0
Zinc (Zn)	----	90	0	0	0	0	0	0	0	0	0
Zirconium (Zn)	----	----	----	----	----	----	----	----	----	----	----

Notes: GAI's greater than or equal to 3 are highlighted. Apparent gold enrichment is an artifact of the laboratory Limit of Reporting (LoR)

1. Median Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).

2. When no GARD Guide value is available for particular element, then values are taken from Bowen (1979) Environmental Chemistry of the Elements, p 60-61.

3. If no guide value from GARD or Bowen H.J.M. (1979) exists, up to date, curated data is provided by CRC Handbook of Chemistry and Physics (2000).

Table C4: Multi-Element Test Results for Water Extracts from Coal Rejects and Tailings from the Stanmore Project

			Sample Date →	10/11/2020	7/04/2021	21/04/2021	14/09/2021	12/10/2021	26/10/2021
			Client Sample ID →	PTM_Reject_04-10Nov2020	PTM_Reject_01-07Apr2021	PTM_Reject_15-21Apr2021	PTM_Reject_8Sep-14Sep	PTM_Reject_6Oct-12Oct	PTM_Reject_20Oct-26Oct
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Reject	Reject	Reject	Reject	Reject	Reject
pH	0.01 pH unit	6 to 9	-	8.4	9.4	9.3	8.7	9.1	9.2
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	214	181	288	291	173	110
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	31	32	16	<1.0	36	18
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	8,000	1,320	832	4,120	2,960	999
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	8,030	1,350	849	4,120	3,000	1,020
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	7	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	20	2	<2	16	3	<2
Magnesium (Mg)	1 mg/L	-	-	7	<2	<2	8	<2	<2
Potassium (K)	1 mg/L	-	-	4	<2	2	4	3	<2
Sodium (Na)	1 mg/L	-	-	31	35	52	45	34	33
Chloride (Cl)	1 mg/L	-	-	10	9	15	6	12	10
Fluoride (F)	1 mg/L	-	2	0.2	---	---	---	---	---
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	86	21	57	119	31	17
Trace Metals/Metalloids				All units mg/L					
Silver (Ag)	0.1 mg/L	0.00005	-		<0.2	<0.2	<0.2	<0.2	<0.2
Aluminium (Al)	0.01 mg/L	0.055**	5	<0.02	0.06	0.02	<0.02	<0.02	0.04
Arsenic (As)	0.001 mg/L	0.024	0.5	<0.002	0.011	0.061	<0.002	0.005	0.003
Boron (B)	0.1 mg/L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.019	0.105	0.078	0.046	0.049	0.023
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith(Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002(hex)*	0.01(total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr))	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	0.008	<0.002	<0.002	0.011	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.043	0.055	0.066	0.057	0.05	0.023
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.004	0.003	0.003	0.005	0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	0.6	0.2	0.2	0.8	<0.2	<0.2
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thallium (Tl)	0.001 mg/L	-	-	---	<0.002	<0.002	<0.002	<0.002	<0.002
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tungsten (W)	0.1 mg/L	-	-	2.2	---	---	---	---	---
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	0.018	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table C4: Multi-Element Test Results for Water Extracts from Coal Rejects and Tailings from the Stanmore Project

			Sample Date →	7/12/2021	22/09/2020	6/10/2020	27/10/2020	17/11/2020	7/04/2021
			Client Sample ID →	PTM_Reject_1Dec-7Dec	PTM_TailsU/F_16-22Sep2020	PTM_TailsU/F_30Sep-06Oct2020	PTM_TailsU/F_21-27Oct2020	PTM_TailsU/F_11-17Nov2020	PTM_TailsU/F_01-07Apr2021
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Reject	Tailings	Tailings	Tailings	Tailings	Tailings
pH	0.01 pH unit	6 to 9	-	9.5	7.5	8.5	8.7	8.7	9.3
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	277	785	245	235	224	472
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	36	<1.0	61	31	123	97
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	883	4,510	4,250	4,790	4,400	4,090
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	918	4,510	4,310	4,820	4,520	4,190
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	18	<1.0	<1.0	<1.0	<1.0
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	<2	159	9	6	7	4
Magnesium (Mg)	1 mg/L	-	-	<2	38	6	4	4	2
Potassium (K)	1 mg/L	-	-	2	2	3	3	2	2
Sodium (Na)	1 mg/L	-	-	54	15	39	45	47	73
Chloride (Cl)	1 mg/L	-	-	11	12	22	23	33	73
Fluoride (F)	1 mg/L	-	2	---	---	0.3	0.3	0.2	---
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	31	504	64	63	51	55
Trace Metals/Metalloids				All units mg/L					
Silver (Ag)	0.1 mg/L	0.00005	-	<0.2					<0.2
Aluminium (Al)	0.01 mg/L	0.055**	5	0.06	<0.02	<0.02	0.02	0.07	0.04
Arsenic (As)	0.001 mg/L	0.024	0.5	0.036	<0.002	<0.002	0.005	<0.002	0.005
Boron (B)	0.1 mg/L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.001 mg/L	-	-	0.016	0.02	0.057	0.09	0.063	0.093
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismith(Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.001 mg/L	0.0002(hex)*	0.01(total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.001 mg/L	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr))	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.009
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Manganese (Mn)	0.001 mg/L	1.9	-	<0.002	0.902	0.011	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.078	0.01	0.038	0.081	0.028	0.053
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<2
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.001 mg/L	-	-	0.004	<0.002	<0.002	0.004	<0.002	0.002
Selenium (Se)	0.01 mg/L	0.011	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Strontium (Sr)	0.1 mg/L	-	-	<0.2	1.8	0.5	0.4	0.3	0.4
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thallium (Tl)	0.001 mg/L	-	-	<0.002	---	---	---	---	<0.002
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tungsten (W)	0.1 mg/L	-	-	---	0.6	0.2	0.2	1.2	---
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

Table C4: Multi-Element Test Results for Water Extracts from Coal Rejects and Tailings from the Stanmore Project

		Sample Date →		21/04/2021	14/09/2021	12/10/2021	26/10/2021	7/12/2021	19/04/2021
		Client Sample ID →		PTM_TailsU/F_15-21Apr2021	PTM_TailsU/F_8Sep-14Sep	PTM_TailsU/F_6Oct-12Oct	PTM_TailsU/F_20Oct-26Oct	PTM_TailsU/F_1Dec-7Dec	RMI-Surface-WC12
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings
pH	0.01 pH unit	6 to 9	-	8.8	8.7	9.0	9.4	9.1	8.2
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	351	359	242	187	262	1,420
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	32	<1.0	18	36	18	9
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	2,090	6,320	3,100	1,140	1,890	52
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	2,120	6,320	3,120	1,180	1,910	62
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Major Ions				All units mg/L					
Calcium (Ca)	1 mg/L	-	1,000	9	16	8	<2	4	<1
Magnesium (Mg)	1 mg/L	-	-	4	9	4	<2	2	<1
Potassium (K)	1 mg/L	-	-	2	4	2	<2	2	1
Sodium (Na)	1 mg/L	-	-	53	48	42	39	47	52
Chloride (Cl)	1 mg/L	-	-	42	25	22	25	35	31
Fluoride (F)	1 mg/L	-	2	---	---	---	---	---	0.2
Sulfate (SO_4^{2-})	1 mg/L	-	1,000	85	118	68	8	47	19
Trace Metals/Metalloids				All units mg/L					
Silver (Ag)	0.1 mg/L	0.00005	-	<0.2	<0.2	<0.2	<0.2	<0.2	
Aluminium (Al)	0.01 mg/L	0.055**	5	<0.02	<0.02	<0.02	0.06	<0.02	0.03
Arsenic (As)	0.001 mg/L	0.024	0.5	0.003	0.003	<0.002	0.012	0.002	0.032
Boron (B)	0.1 mg/L	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05
Barium (Ba)	0.001 mg/L	-	-	0.054	0.033	0.059	0.053	0.066	0.042
Beryllium (Be)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Bismith(Bi)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Cadmium (Cd)	0.001 mg/L	0.0002(hex)*	0.01(total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0001
Cobalt (Co)	0.001 mg/L	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Chromium (Cr))	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Copper (Cu)	0.001 mg/L	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Iron (Fe)	0.1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05
Mercury (Hg)	0.0001 mg/L	0.0006	0.002	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Manganese (Mn)	0.001 mg/L	1.9	-	0.003	0.006	<0.002	<0.002	<0.002	0.002
Molybdenum (Mo)	0.001 mg/L	-	0.15	0.043	0.037	0.041	0.034	0.024	0.043
Nickel (Ni)	0.001 mg/L	0.011	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Phosphorus (P)	1 mg/L	-	-	<2	<2	<2	<2	<2	<1
Lead (Pb)	0.001 mg/L	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Antimony (Sb)	0.001 mg/L	-	-	<0.002	0.002	0.003	0.002	<0.002	<0.001
Selenium (Se)	0.01 mg/L	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Tin (Sn)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.001
Strontium (Sr)	0.1 mg/L	-	-	0.6	0.5	0.5	<0.2	<0.2	0.074
Thorium (Th)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Titanium (Ti)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Thallium (Tl)	0.001 mg/L	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Uranium (U)	0.001 mg/L	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
Vanadium (V)	0.01 mg/L	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Tungsten (W)	0.1 mg/L	-	-	---	---	---	---	---	---
Zinc (Zn)	0.01 mg/L	0.008	20	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005
Zirconium (Zr)	0.01 mg/L	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent. ** 0.013 mg/L for pentavalent Arsenic (V).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm. ^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC.
TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water. pH and EC of composites are median pH and EC values of individual samples reported in Table C2.

1. ANZG (2018). Trigger values for freshwater aquatic ecosystems (95% species protection level)
2. ANZG (2018). Recommended guideline limits for Livestock Drinking Water.

MINE WASTE AND
WATER MANAGEMENT

Appendix 7 Landform Design (28 June 2024)

REHABILITATION LANDFORM DESIGN: POITREL MINE

Stanmore Resources

June 2024

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Client: Stanmore Resources

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1 (final)	E. Howard		27/06/2024

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1 INTRODUCTION

1.1 Background

Queensland legislation requires all mines with a site-specific Environmental Authority (EA) to prepare a Progressive Rehabilitation and Closure Plan (PRC plan). The PRC plan must be developed in accordance with the Guideline – Progressive Rehabilitation and Closure Plans (DES 2023) (ESR/2019/4964) (Guideline).

The primary purpose of the PRC plan is for the holder of an EA to plan for how and where activities will be carried out on land in a way that maximises progressive rehabilitation to a stable condition and to provide for the condition to which the holder must rehabilitate the land before the EA is surrendered.

Stanmore SMC Pty Ltd, a wholly owned entity of Stanmore Resources Ltd (Stanmore) are the holders of an EA for mining activity at Poitrel Mine (EA reference: EPML00963013).

1.2 Location

Poitrel is an open cut coal mine in the Bowen Basin, located approximately 20km east of Moranbah, and is situated in the Isaac Regional Council Local Government Area (Figure 1). The mine is south of the Peak Downs Highway, directly to the west of the existing Daunia coal mine and south of the Millennium coal mine.

1.3 Mining

Mining at PTM commenced in 2006 and uses open cut strip mining techniques with an excavator, truck and dozer fleet. Run-of-mine (ROM) coal is transported to Red Mountain Joint Venture (RNJV) Coal Handling and Processing Plant (CHPP) located on the adjoining infrastructure Mining Lease (ML) 70312. The coal forms part of the Leichhardt and Vermont Seams.

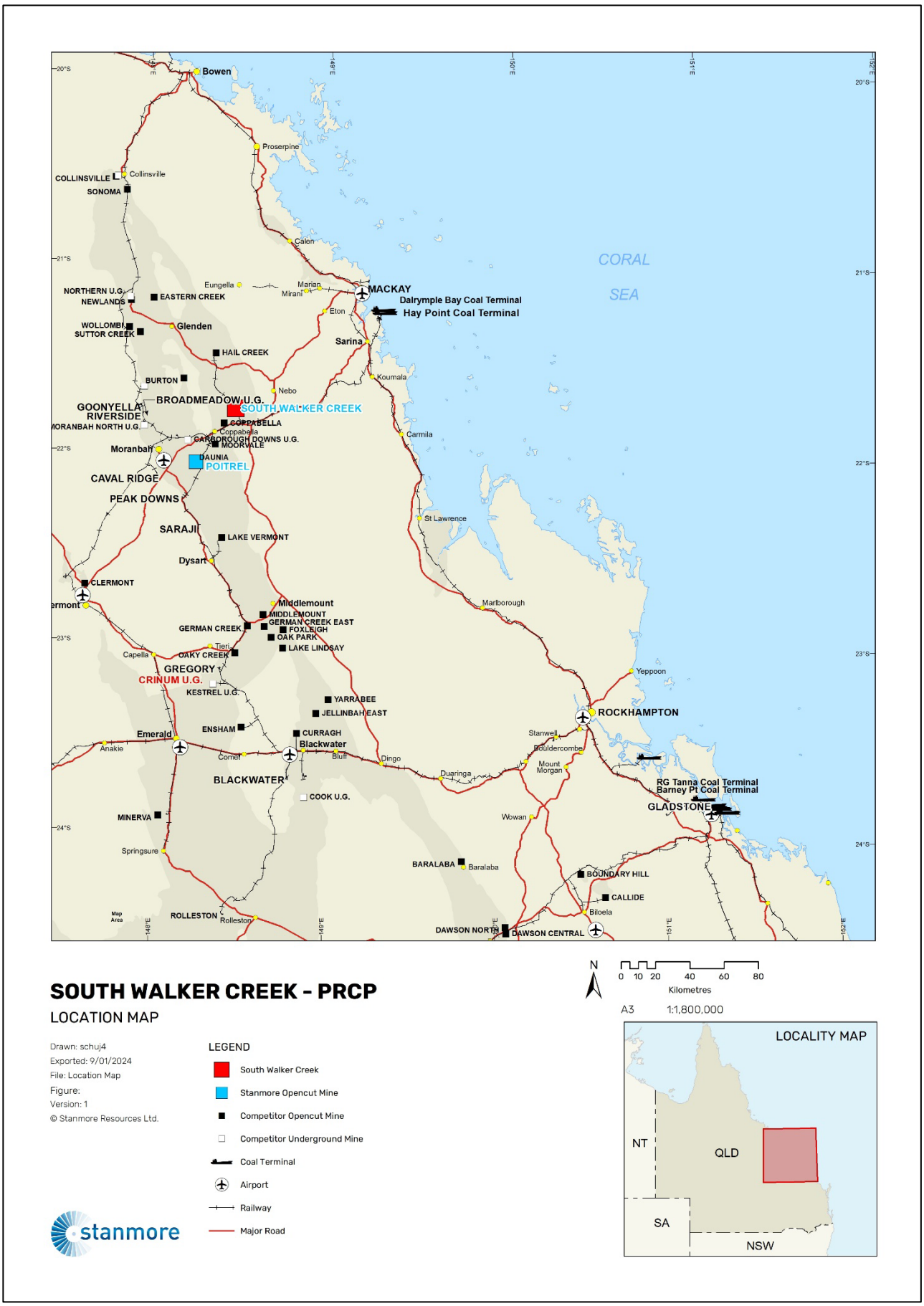

Figure 1: Location of Poitrel (Source: Stanmore).

2 SCOPE OF WORK

To assist in the development of the rehabilitation landform design, Landloch completed the following tasks:

- Review existing information on the post mining land use, soils, spoils, and the proposed rehabilitation landform design.
- Model long-term erosion for the proposed cover materials.
- Undertake landform evolution modelling of the proposed rehabilitation landform (limitations to this modelling is discussed in the report).
- Produce a report (this document) that:
  - Outlines the methods used to determine suitable rehabilitation batter designs;
  - Identifies materials required to be used to achieve an erosionally stable landform design, and summarises the properties of these materials;
  - Provides the outcomes of the erosion modelling and landform evolution modelling;
  - Includes 3D design plans of the rehabilitation landform design;
  - Includes information of lining requirements;
  - Includes impacts of settling and subsidence on the final landform design;
  - Outlines interactions between the landform design and surface water and groundwater;
  - Outlines the methods of construction and QA/QC requirements;
  - Outlines field trial/monitoring methods to verify modelled performance of the final design; and
  - Discussed limitations and assumptions of the design.

3 BACKGROUND INFORMATION

3.1 Topography and existing land use

Poitrel is located in land that is generally of low relief dominated by gently sloping topography comprising of grazing lands. Poitrel straddles a low ridge line which runs roughly north-south and forms the catchment divide between New Chum Creek on the east and an unnamed creek to the west. New Chum Creek drains most of the Poitrel mining lease, with gently sloping drainage lines. Average slope on the site is 1.5%, towards the creeks and generally toward the south along the ridgeline. The average elevation is 230m Australian Height Datum (AHD) (BHP 2005).

Land use on the Poitrel is currently grazing. Surrounding land uses include grazing, cropping, and coal mining.

3.2 Post mining land use

Appendix A shows locations of the different proposed PMLUs across the Project. The PMLUs include:

- Cattle grazing;
- Dryland cropping (not considered applicable);

- Woodland habitat;
- Water Storage (stock use); and
- Watercourse.

This landform design report will focus on land to be rehabilitated to cattle grazing and woodland habitat PMLUs. Cattle grazing is to be used for spoil dumps with pasture vegetation (<15% slope). Woodland habitat is to be used for spoil dumps with native vegetation (>15% slope).

3.3 Geology

PTM has three separate rock units: Permian Rocks, Tertiary Sediments and Post-Tertiary Sediments. The deposit occurs in the Late Permian Rangal Coal Measures in a drag syncline within the Burton Range fault system (BHP Billiton 2005).

A number of geological units occur across Poitrel:

- Quaternary-aged channel and flood plain alluvium; gravel, sand, silt and clay, located around Isaac River in the southern portion of the site, along with a tributary of Isaac River in the western corner of the site;
- Quaternary-aged sand plains along the southern boundary of the site;
- Quaternary-aged colluvium and/or residual deposits; boulder, gravel, sand, located in the central portion along with the north-eastern and south-eastern corners of the site;
- Triassic-aged Rewan Group consisting of lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone located in the centre and northern portions of the site;
- Permian-aged Blackwater Group consisting of sandstone, siltstone, shale, mudstone, coal, tuff, conglomerate located in the eastern portion of the site; and
- Cretaceous-aged intrusive volcanics located on the southern boundary of the site.

The coal deposit occurs in a basin like structure with seams dipping gently to the west. Two major coal seams have been identified, the Leichhardt and Vermont Seams.

3.4 Waste materials

The waste materials consist of coal rejects, tailings and overburden/interburden materials (spoil). Tailings are not characterised in this report as they are not currently considered as a rehabilitation resource.

A summary of key chemical and physical properties is presented in Table 1. Additional waste characterisation testing is in progress at PTM. Initial results indicate similar results to those outlined above. However, if this more recent report indicates different ranges to those outlined in Table 1, those more recent results would supersede the ranges outlined in Table 1.

Table 1: Summary of key chemical and physical properties for spoils at Poitrel.

Analysis	Spoil Material	
	Permian Overburden	Weathered Sediments and Clay Interburden
pH_w (pH units)	Moderate to strongly alkaline (8.0–9.5)	Neutral to strongly alkaline (7.0–9.0)
$EC_{1:5}$ (dS/m)	Low to moderate (0.18 – 0.82)	Moderate to high (0.51 – 1.20)
ANC (H_2SO_4/t)	High (20–30)	High (20–50)
PAF	No	No
ESP (%)*	Non-sodic to strongly sodic (5–27)	Sodic to strongly sodic (6–24)
Metals	Comparable to background levels	Comparable to background levels
Clay content (%)	<25	>35
Rock content (%)	>30	<20
Slake durability (%)	Moderate (50–75)	Low (<50)
Dispersion (EAT)	Dispersive (2)	Dispersive (2)

3.4.1 Spoils

3.4.1.1 Overburdens

Characterisation of the overburdens was undertaken as part of the EIS (BHP Billiton 2005) and throughout the life of the mine, subsequent analysis of overburdens has been conducted by BHP (the previous owner). Broad overburden characteristics were found to be similar across all studies and identify two spoil management groups:

- Permian spoil (overburden); and
- Weathered sediments and clay spoil (interburden).

Both spoil management groups have identical properties to spoils characterised at the nearby Daunia Mine. Therefore, it is assumed erodibility properties of Poitrel overburdens can be inferred from the testing conducted by Landloch in 2017 on Daunia.

Generally, Permian overburden is a rocky material consisting primarily of sandstone, siltstone, and claystone with clay content below 25%, resulting in low water holding capacity. It is generally grey or pale brown in colour. Permian overburden properties can vary depending on the strata location and degree of carbonaceous inclusions present. The materials are sodic and dispersive.

Fresh Permian is considered the most suitable option as a growth medium. Fresh or recently stripped Permian sandstone that has not be exposed to extended periods of weathering could be used in the upper growth media profile to greatly increase batter slope resistance to erosion while vegetation establishes.

3.4.1.2 Interburden

The weathered sediments and clay interburden is a highly weathered material containing portions of fragile rock and a clay content of >35%, resulting in moderate to high water holding capacity. It is typically pale orange to brown in colour. The materials are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Key chemical and physical properties are summarised in Table 1.

Placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended due its high erodibility. Consideration could only be given to use as a secondary growth medium on flat or very low gradient areas if the intended material has no chemical limitations to vegetation growth.

3.4.2 Coal rejects

Initial analysis of interburden material, representative of coal rejects for Poitrel, was completed as part of the Environmental Impact Statement (EIS) (BHP Billiton 2005). Over the life of the mine subsequent analysis of reject samples for acid/base and salinity characteristics has been conducted by BHP (the previous owner). The materials were found to have the following properties:

- Variable sulphur content, but low acid generating capacity;
- Strongly alkaline; and
- Low to moderate salinity.

The rejects are currently not being considered as a rehabilitation resource but can be considered a benign bulk fill material.

3.5 Soils

3.5.1 Regional soils

Soil mapping of the region identifies two broad soil groups across the project area (State of Queensland (Department of Resources), 2021) These include Ro9 – Sodosols, and MM7 – Friable earths. Relevant details of these soil types are provided in Table 2.

Table 2: Summary details of regional soils in the Study Area.

Soil Landscape Code	Description	Associated Australian Soil Classification (ASC)
Ro9	Sodosols. Dominant soils are hard alkaline duplex brown soils.	Sodosol
MM7	Chief soils are neutral dark and yellow friable earths with friable brown soils.	Vertosol, Dermosol

3.5.2 Recoverable soils

Pre-mining soil and land suitability assessments of the region, that included the study area, was completed by CSIRO (Story *et al.* 1967) and agricultural management units were described by Bourne and Tuck (1993). Both surveys produced land and soils information at a scale of 1:500,000.

A more detailed soil survey was conducted as part of the EIS (BHP Billiton 2005) and approximately 203 survey sites at a scale of 1:25,000. Across all surveys, 13 soil mapping units (SMU) were identified, including 3 variants. A summary of all SMUs, including associated Australian Soils Classifications (ASC) and Agricultural Management Units (AMU) is provided in Table 3.

3.5.3 Stockpiled soils

Information on stockpiled soils and their location was provided by BHP (the previous owner). The approximate total volume of available stockpiled soil is 2,793,354m^3. Locations of soil stockpiles on PTM are presented in Figure 2. Soil stockpile characterisation occurred in 2022 (Landloch 2023). A total of 84 samples were collected from 21 locations within soil stockpiles. Stockpiled soils were named and categorised into two groups:

- Red/Brown Clays; and
- Red/Grey Loams.

Red/brown clays are the dominant soil stockpiled at Poitrel. In general, they are dark brown, brown, or reddish brown in colour with textures of clay loam to medium clay. Gravel content is generally <10%, although sometimes gravel content of up to 20% is present. All red/brown clays were non-sodic and generally stable. Erodibility studies conducted on a similar clay topsoil at an adjacent mine site indicate these soils are comparable to the most stable clay topsoils available for rehabilitation in the region.

Red/grey loams form a minor portion of stockpile soils at Poitrel. Less than 15% of samples collected are characterised as loams. In general, they are pale red, pale grey, or grey in colour, with textures of sandy loam to sandy clay loam. Gravel content is 10—20%. All red/grey loams were non-sodic but susceptible to slaking and dispersion.

A summary of key chemical and physical properties of these soils is given in Table 4.

Table 3: Summary details of the SMUs developed in the previous soil assessments for the mine site (BHP Billiton, 2005)

SMU	Soil Concept	Description	ASC	AMU
A1	Alluvial – deep Isaac sands	Alluvial soils adjacent to the Isaac River which are either uniform deep coarse sands or duplex with coarse loamy sands extending past 50 cm. River red gum and Moreton Bay ash.	Arenic Rudosol	Isaac
A2	Alluvial – Sandy hard duplex	Hard setting sandy loam duplex soils alongside New Chum Creek often with bleached A2 over hard, coarse structured, medium yellow clay, often heavily mottled. Poplar box mixed woodlands with associated brigalow and blackbutt.	Brown Sodosol	Lascelles
A3	Alluvial – Uniform Brigalow clay	Deep, generally alkaline with carbonate nodules, possibly bleached A2 horizon, uniform medium sandy clay which is non-cracking. Brigalow, blackbutt and Bauhinia.	Brown Dermosol	Rolleston
B1	Red/Brown deeper uniform clay undulating plains	Undulating plains up to 3% gradient of mostly cleared brigalow, blackbutt and Bauhinia. A firm to hard-setting sandy surface, often gravely, overlies stiff medium sandy clays which are neutral and red to brown coloured. Weathered parent material or gravels generally predominate by 80 cm depth.	Red Dermosol	Glengallan
B2	Gravelly clay on ridgelines	Relic ridgelines and scree slopes associated with residual mesas. Uniform non-cracking clay and thin duplex with hard-setting sandy clay surface with strong gravel layer starting from 10-15 cm depth, underlying light clay is pale to red coloured. Mostly cleared of original brigalow, blackbutt with minor poplar box.	Petroferric Red Chromosol	Glengallan / Highlands
B3	Uniform Brigalow grey/brown clays	Generally non-cracking uniform grey/brown clay but includes areas of normal gilgai (up to 40 cm deep) which may crack. Also includes isolated areas of B4 (melonholes) in lower slope positions.	Brown Dermosol	Rolleston
B3v	Melonholed brigalow clay lowlands	Approximately 50% or more of land surface is melonholed (40-100 cm deep) with deep grey cracking clay.	Brown Dermosol	Lonesome
B4	Friable brigalow scrub soil	Deep well-structured black cracking clay with granular surface mulch.	Black Vertosol	Picardy
B4v	Variant to B4	Fine granular non-cracking red/brown brigalow scrub soil.	Brown Dermosol	-
B5	Linear gilgai brigalow	Dark cracking clay in association with red non-cracking clay in linear gilgai complex.	Crusty Black Vertosol	Rolleston
E1	Sandy duplex plains with poplar box	Undulating plains of poplar box and blackbutt with very uniform duplex soils with 30-40 cm sandy clay loam over hard yellow/brown clays, often with a bleached A2.	Brown Sodosol	Lascelles
E2	Residuals (mesas)	Mixture of outcropping rock, skeletal and shallow, gravelly duplex soils with a range of vegetation. Includes mesa tops and rugged margins.	Sodosol	Highlands
E3	Texture contrast soil	Duplex soils with thin sandy loam A horizon.	Brown Chromosol	Lascelles

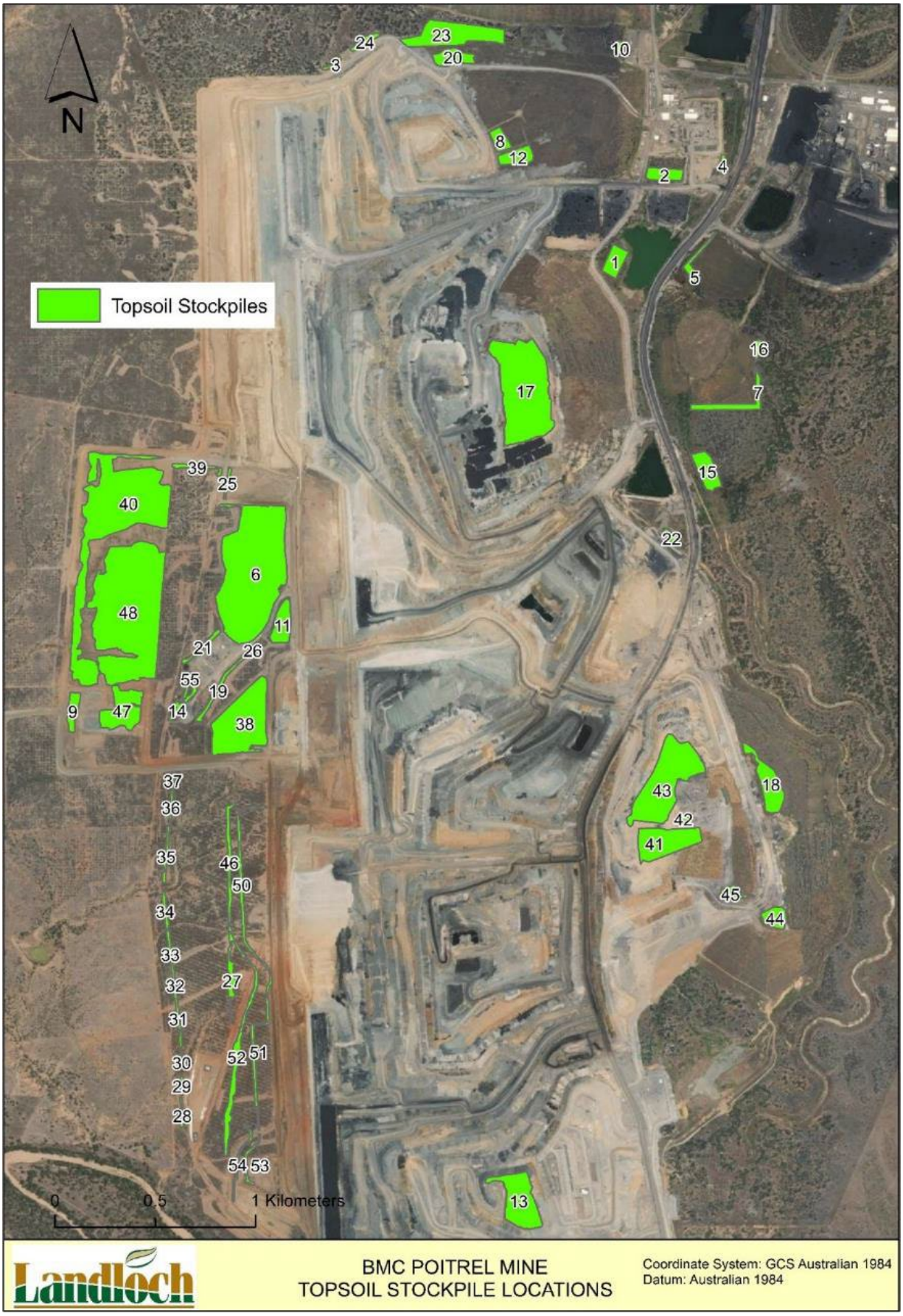

Figure 2: Stockpiled topsoil materials across Poitrel.

Table 4: Summary of key chemical and physical properties for stockpiled soils.

Analysis	Red/Brown Clay	Red/Grey Loam
pH_w (pH units)	Neutral to strongly alkaline (7.1–8.5)	Neutral to strongly alkaline (6.9–8.5)
$EC_{1:5}$ (dS/m)	Low to moderate (0.9–0.28)	Low (0.12–0.14)
ESP (%)	Non-sodic (1.2–4.9)	Non-sodic (2.8–3.5)
Total N (mg/kg)	Low the moderate (270–1,384)	Low (396–471)
Available P (mg/kg)	Low (4–16)	Low (4–14)
Available K (mg/kg)	Low the moderate (76–364)	Low the moderate (124–222)
Organic C (%)	Low to moderate (0.57–1.82)	Low (0.29 – 0.83)
Clay content (%)	>30	<30
Rock content (%)	<20	10 – 20
Dispersion (EAT)	Slightly dispersive to stable (3b–7)	Slightly dispersive to slaking (3b–5)

Note: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed.

3.6 Surface water

Poitrel is located within the Isaac River Catchment which forms part of the Fitzroy River Basin. It is an ephemeral waterway that traverses the southern edge of Poitrel and is its main drainage feature. New Chum Creek runs near the south-eastern boundary of Poitrel and drains to the Isaac River. New Chum Creek rises about 8km north-north-west of the northern boundary of Poitrel. New Chum Creek drains from the nearby slopes south of the Peak Downs Highway. It first flows to the south-east, across the Millennium Mine site, then turns to flow south through the Red Mountain site and then Poitrel until it flows into the Isaac River at the southernmost point of the mine site.

Surface water associated from disturbed areas associated with pit progression is generally directed into the pits and pumped to mine water storages for reuse for dust suppression or process water. Runoff from undisturbed or rehabilitated areas is directed to sediment control structures. Poitrel currently has one pit sacrificed for water storage and four mine affected water dams.

The Southern Expansion Levee is a 3.95km levee and was constructed in 2018/2019 at the southern end of the mining lease on the northern bank of the Isaac River. New Chum Creek, which runs parallel to Poitrel along its eastern boundary has been diverted around the Poitrel mining area. Flood modelling of New Chum Creek (Engeny 2019) showed overtopping of the northern end of the diversion and potential inundation into future operational areas in the southern extent for a 1:1,000 AEP flood event. It is noted that the Southern Expansion Levee is to provide food protection in this area.

3.7 Groundwater

There are two distinct aquifers occur in the proximity of Poitrel, which are the Quaternary age alluvium unit, and the Permian age fractured rocks.

The Quaternary age floodplain alluvium unit consists of clay, silt, sand and gravel occurs in the south of Poitrel in association with the Isaac River. The deposits, associated with the river courses, are generally less than 20 m in thickness.

The Permian age Coal Measures underlie the Quaternary age alluvium unit and colluvium deposits (where present) and outcrops in the central and northern sections of the site. The unit consists of sandstone, siltstone, mudstone, shale and coal. In general, the formation does not yield significant volumes of groundwater.

3.8 Erosion potential of undisturbed land

The erosion potential of the Poitrel area was assessed using the Revised Universal Soil Loss Equation (RUSLE) (Renard *et al.* 1997). The RUSLE equation is:

$$A = R \times K \times L \times S \times P \times C \qquad 1)$$

where A is annual erosion (t/ha/y), R is annual rainfall erosivity (MJ.mm/ha/hr/y), K is soil erodibility (t.ha.hr/ha/MJ/mm), LS is the topographic factor (unitless), P is the practice factor (unitless), and C is the cover factor (unitless). Spatial layers developed by CSIRO (Teng *et al.* 2016) for each of the RUSLE parameters were used to generate an estimate for average long-term soil loss. The K factor from the spatial layer was cross-checked against the known particle size distribution data for Poitrel's soils using the equation provided in Rosewell and Loch (2002). The R, L, S, and C factors were cross-checked against the topographic and vegetation cover data for the Poitrel site in conjunction with the R, L, S, and C factors reported in Rosewell (1993). Cross-checking showed good agreement between the RUSLE factor values from the CSIRO spatial layers and those from other independent sources.

The long-term annual erosion (A-factor) was determined for a 15km x 15km areas centred on Poitrel. Based on this assessment, the long-term erosion for vegetated surfaces range from 0.3—7t/ha/y, with an average of 2t/ha/y and uncertainty of 0.3t/ha/y. The C-factor for the area from the spatial layer was ~0.03, consistent with 80% vegetative groundcover. For bare (0% cover), the average predicted long-term erosion for the same area is 77t/ha/y. For 50% cover, the average predicted long-term erosion for the same area is 12t/ha/y.

4 LANDFORM STUDY METHODS

4.1 Erodibility

The two categories of materials available for rehabilitation, characterised as part of this assessment, include stockpiled soil and spoils (Landloch 2023).

The soil stockpiles are representative of the material available for rehabilitation once soil is stripped and mixed. Stockpiled soils were categorised into two management groups based on texture:

1. Red/Brown Clays; and
2. Red/Grey Loams.

A summary of key properties of the soils is presented in Section 3.5. Clay textured topsoils are the dominant soil stockpiled at Poitrel. It occurs at approximately 85% of the sample sites. Loam soils account for approximately 15% of stockpiled soils at Poitrel.

Fresh Permian overburden was identified as a suitable waste for use with surface layers of rehabilitated areas at Poitrel. A summary of the properties of Fresh Permian is given in Section 3.4.1.

Based on this, erodibility was considered for the following materials:

- Clay topsoil; and
- Fresh Permian spoil.

Erodibility parameters are needed in order to complete long-term erosion modelling using the WEPP runoff/erosion model and the SIBERIA landform evolution model. The use of these models are detailed in Section 4. In brief, the WEPP model is used to generate the time-series runoff and erosion data required to parameterise the SIBERIA landform evolution model. WEPP requires values for the following parameters:

- Effective hydraulic conductivity;
- Interrill erodibility;
- Rill erodibility; and
- Critical flow shear stress for initiation of rilling.

The parameter sets for the 2 materials (clay soil and Fresh Permian waste) were sourced from previous erodibility testing conducted on the same materials at nearby Daunia mine These parameter sets were used to complete the WEPP modelling and the parameterise the SIBERIA landform evolution model. Flume studies that considered the soil overburden mixture were run with a 4:1 mix of D5:D1 (coarse waste:topsoil). Photographs of the soil and spoils tested are shown in Figure 3.

4.2 WEPP simulations

4.2.1 Slopes and materials

WEPP simulations were carried out for:

- Batter slopes 140 m high, at 15–25% gradients, surfaced with clay soil with vegetation cover levels of 0—90%.
- Batter slopes 140 m high, at 15-25% gradients, surfaced with a 4:1 blend of Fresh Permian waste and clay soil with 0—50% vegetation cover.

Despite this blending ratio being adopted for the modelling, other blending ratios could be considered in future modelling. It is possible that different blending ratios would also achieve acceptable long-term erosion rates.

Figure 3: Flumes showing application of flow to topsoil (left) and Permian overburden mixed with topsoil (right).

4.2.2 Vegetation impacts

Impacts of vegetation cover on infiltration rates were estimated using the relationship between vegetative cover reported by Kato *et al.* (2009), and direct impacts of cover on erosion rates were estimated using Cover (C) factors for the Revised Universal Soil Loss Equation (RUSLE) (Renard *et al.* (1993) listed in Rosewell (1993)).

A site inspection of Poitrel and a nearby mine site indicated that vegetative cover levels of over 90% are possible on rehabilitated sites (Figure 4). This is consistent with vegetation cover level for Poitrel used in the estimation of annual soil loss across Australia (Teng et al. 2016). Consequently, it was concluded that vegetative cover levels ≥80% are achievable on rehabilitation carried out on topsoil at Poitrel. For surfaces that contain lower fertility (overburden/soil mixtures), lower levels of cover can be expected to be maintained. Vegetation cover levels in the order of 30–50% have been observed by Landloch in rocky soils located in temperate climates (e.g. central QLD). On this basis, erosion simulations considered a cover level of 30–50% for materials of potentially lower fertility (overburden/soil mixtures) and 50—80% for more fertile soils.

Figure 4: Groundcover (grass) on a rehabilitated mining area near Poitrel.

4.2.3 Assumptions with respect to effects of cover on erosion

Two points should be noted:

a) In considering "vegetation cover" or "surface cover", this report specifically considers contact cover of vegetation on the soil surface. Practically, this means a combination of grass cover and anchored (not readily moved) surface litter.
b) Considerations of surface cover do not include rock. Where rocky materials have had erodibility measured experimentally and those parameters are used in WEPP simulations, then effects of the rock are already accounted for within the parameters used.

4.2.4 Climate

All simulations used a synthetic 100-year climate file prepared to match all relevant characteristics of the climate of Moranbah.

4.2.5 Key assumptions – landforms and vegetation

The simulations are based on two key assumptions:

a) There will be no uncontrolled discharge of runoff from landform tops onto outer batter slopes; and
b) The assumed vegetative cover levels will be achieved sustainably, with those levels being set as triggers for investigation and remedial action should monitoring indicate that they are not being achieved.

It should be recognised there are also underlying assumptions of good rehabilitation practice such that:

- There will not be discharges of concentrated flows onto any batter slopes at any point of their rehabilitation;
- Batter slopes will not be formed with flow-concentrating profiles (e.g. variations in surface elevation such that there is cross-slope concentration of flow into consistent depressions running downslope);
- Any cross-slope ripping will be carried out strictly on the contour; and
- Soil management (including stripping, stockpiling, replacement, amendment, and fertilisation) will be carried out effectively to maximise early and continuing plant growth.

4.2.6 Soil loss targets

This study used runoff, and erosion modelling to identify landform options that would erode at rates low enough to provide long-term stability. Effectively, the landforms are planned to be consistent with tolerable rates of soil loss. Wischmeier and Smith (1978) defined tolerable soil loss for cropland as "the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely."

A value of 11.2 t/ha/y averaged over an area of interest is often cited as a tolerable soil loss rate, but that value was derived by US soil conservation agencies for deep, fertile cultivated soils, and has little relevance to most rehabilitated minesites. Using similar criteria to those applied for crop land, a lower soil loss tolerance value of 4.5 t/ha/y was developed by US agencies for erosion of rangeland soils and shallow cultivated soils (Wight and Siddoway 1979).

Lower tolerance values are relevant to rangeland and minesite situations, as not only are the soils shallower and more susceptible to fertility decline, but the lack of regular tillage or disturbance means that any rills or points of scour that form are more likely to extend and develop into gullies over time. These are typically of concern for minesite landforms where there is no bedrock layer at depth to limit long-term depths of incision.

For that reason, a key priority in setting a tolerable erosion target is the prevention of significant rill or gully development. On that basis, for slopes where long-term erosion risk is considered high due to the height of the landform and the ability of generated sediment to be transported in surface water flows, then a maximum rate of erosion of 5t/ha/y at any point on the batter slopes being modelled has commonly been applied by Landloch - at that value - rilling is largely if not completely absent. This value is slightly lower than the maximum soil loss rate for undisturbed soils near Poitrel (7t/ha/y). For slopes where long-term erosion risk is considered lower due to the generated sediment being directed towards a final void, then a maximum erosion rate of 7t/ha/y at any point on the batter slopes being modelled was used. This is consistent with the maximum soil loss rate for undisturbed soils near Poitrel (7t/ha/y). For the purposes of modelling, these values are considered appropriate.

The elimination of rilling greatly reduces the potential for channelised flow to form gullies, and experience to date with a large number of waste landforms designed by Landloch has shown that the target soil loss values adopted have achieved acceptable levels of stability to erosion.

4.3 Derivation of SIBERIA parameters

To run SIBERIA, the parameters β_1, m_1, n_1, β_3, and m_3 are usually needed. However, if the batter area to be modelled is identical to the batter for which erosion data are available for calibration, m_3 and β_3 can be taken as 1.0 (Willgoose, pers. comm.), and a value of n_1 = 1.5 can be adopted for situations where slope gradient does not affect slope erodibility (Willgoose, pers. comm.). Therefore, the two key parameters that require derivation are β_1 and m_1.

Effectively, the β_1 parameter could be described as a "rate parameter", as it primarily controls the rate of sediment movement. The m_1 parameter could be considered as primarily controlling slope length responses. However, in practice, there is interaction between all of the parameters with the result that an almost infinite number of parameter sets will all show the same rate of erosion though some aspects of the pattern of erosion that is predicted will vary. It is for this reason that, where possible, fixed values of n_1 and m_3 are adopted – thereby reducing the difficulty of deriving parameter values.

Input parameters for SIBERIA are typically derived by fitting the various model equations to time series data of runoff and erosion. To generate the necessary data, Landloch has developed method that involves:

- Run the WEPP model to generate data sets of runoff and erosion for slopes consistent with the proposed landforms and for materials of interest using site specific climate data.
- Analyse the WEPP output to derive the required SIBERIA input parameters.

This approach ensures that SIBERIA parameters are effectively benchmarked to the WEPP output, and thereby, effectively based on measured erodibility parameters for site materials and on-site climate.

4.4 SIBERIA simulations and outputs

SIBERIA modelling was undertaken for the rehabilitation landform design with:

- The vegetated clay soil applied to the grazing PMLU areas; and
- The vegetated clay soil mixed with Permian waste was applied to Woodland PMLU areas.

The following erosion statistics were produced for each SIBERIA simulation:

- Outputs at year;
- Average erosion in t/ha/y for each output year; and
- Depth of gully formation at each output year. A minimum depth of 0.3m is used to define a gully.

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 the erosion and deposition on the modelled surface are given with scaling to show:
    - erosion/deposition ±0.3m in green;
    - deposition >0.3m in blue; and
        - erosion >0.3m in red.
- Visuals of erosion rates on the modelled surface are given with scaling to show long-term average annual erosion rates:
    - <5t/ha/y in green (low erosion);
    - 5–10t/ha/y in yellow and orange, consistent with average erosion rates in the natural environment; and
    - >10t/ha/y in purple, consistent with the higher erosion rates likely to occur in the natural environment.

Some portions of the landforms may be modelled as having elevated erosion potential due to the quality of the underlying

4.5 Risk assessment

A risk assessment considered the risks to achievement of the landform design. The risk assessment was based on the method outlined in the Integrated Mine Closure Good Practice Guide (ICMM 2019). It is based on the Australian Standard risk management guideline (AS ISO 31000:2018). Terms used in the risk assessment include:

- Risk – Effect of uncertainty on objectives. Risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood.
- Residual risk – The remaining risk after management actions have been implemented to reduce the initial risk.
- Latent risk – Those risks that are unknown or that are not imminent.
- Likelihood – The chance of something happening. In risk management it may be measured or determined objectively or subjectively, qualitatively or quantitatively, and described in general terms or mathematically.
- Consequence – The outcome of an event affecting objectives.
- Event – The occurrence or change of a particular set of circumstances.
- Control – Measure that maintains and/or modifies risk.

Likelihood and consequences scales (environmental type consequences only) are given in Tables 5 and 6, respectively. The risk matrix used to define risk as 'low', 'medium', 'significant' or 'high' is given in Table 7.

Table 5: Likelihood rating of the risk occurring (adapted from ICMM 2019).

Rating	Description
Almost certain (5) >90%	Has happened, will probably happen during the mine life and there is no reason to suspect it won't happen.
Likely (4) 30-90%	This consequence is not uncommon in the mining and metals industry/area.
Possible (3) 10-30%	There is a possibility of this risk occurring as it has occurred before (albeit infrequently) in the mining and metals industry/area.
Unlikely (2) 3-10%	There are no specific circumstances to suggest this could happen.
Improbable (1) <3%	It would require a substantial change in circumstances to create an environment for this to occur, and even then, this is a rare occurrence.

Table 6: Consequence rating of the risk occurring (adapted from ICMM 2019).

Rating	Description
Major (5)	Permanent impact; affecting area on a whole basin or regional scale; receiving environment classified as highly sensitive natural habitat with very high biodiversity value.
High (4)	Lasting years; affecting area on sub-basin scale; receiving environment classified as having sensitive natural habitat with high biodiversity value
Moderate (3)	Lasting months; affecting extended area (kilometres); receiving environment comprising largely natural habitat and moderate biodiversity value
Minor (2)	Lasting weeks; affecting limited area (hundreds of metres); receiving environment altered with little natural habitat and low biodiversity value
Insignificant (1)	Lasting days or less; affecting small area (metres); receiving environment altered with no sensitive habitats and no biodiversity value (e.g. urban/industrial areas)

Table 7: Risk matrix.

Rating	Consequence				
	Insignificant	Minor	Moderate	High	Major
Almost certain >90%	11 (Medium)	16 (Significant)	20 (Significant)	23 (High)	25 (High)
Likely 30-90%	7 (Medium)	12 (Medium)	17 (Significant)	21 (High)	24 (High)
Possible 10-30%	4 (Low)	8 (Medium)	13 (Significant)	18 (Significant)	22 (High)
Unlikely 3-10%	2 (Low)	5 (Low)	9 (Medium)	14 (Significant)	19 (Significant)
Improbable <3%	1 (Low)	3 (Low)	6 (Medium)	10 (Medium)	15 (Significant)

5 RESULTS OF WEPP SIMULATIONS

5.1 Grazing PMLU with vegetated topsoil

Simulations considered a batter height of 140m and slope gradients of 15%, 20%, and 25%. The target erosion rate for modelling outer batters was a maximum of 5t/ha/y at any point on the batter slope.

Simulations indicate that 140m high batter slopes on gradients of 15% (the current PMLU gradient for grazing) will be erosionally stable provided a vegetative cover level of ≥80% can be sustainably achieved (Figure 5). For gradients of 20% (steeper than currently planned for the grazing PMLU), a 140m high slope will also be erosionally stable provided a vegetative cover level of ≥80% can be sustainably achieved (Figure 6). For gradients of 25% (also steeper than currently planned for the grazing PMLU), a 140m high slope will be stable provided a vegetative cover level of ≥90% can be sustainably achieved (Figure 7).

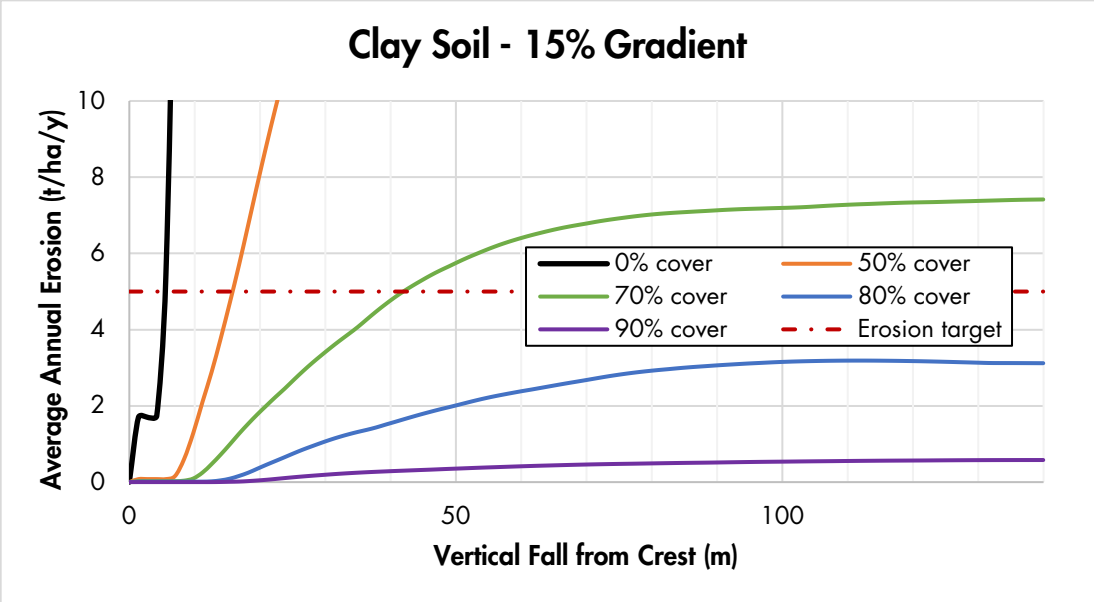

Figure 5: Predicted erosion rates along 15% gradient batter slopes with clay soil surface and 0%, 50%, 70%, 80%, and 90% vegetation cover.

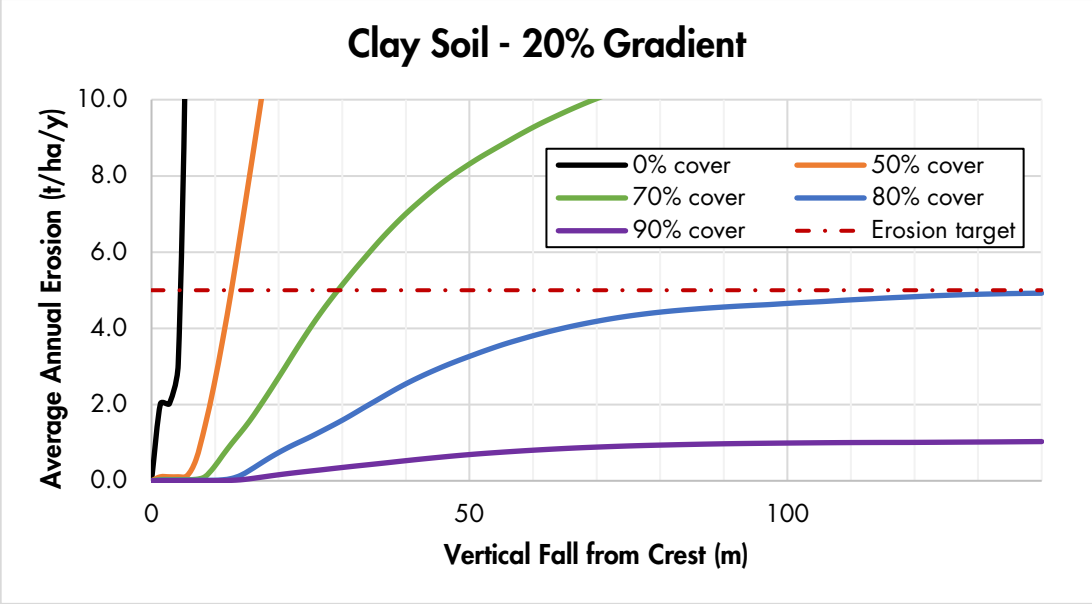

Figure 6: Predicted erosion rates along 20% gradient batter slopes with clay soil surface and 0%, 50%, 70%, 80%, and 90% vegetation cover.

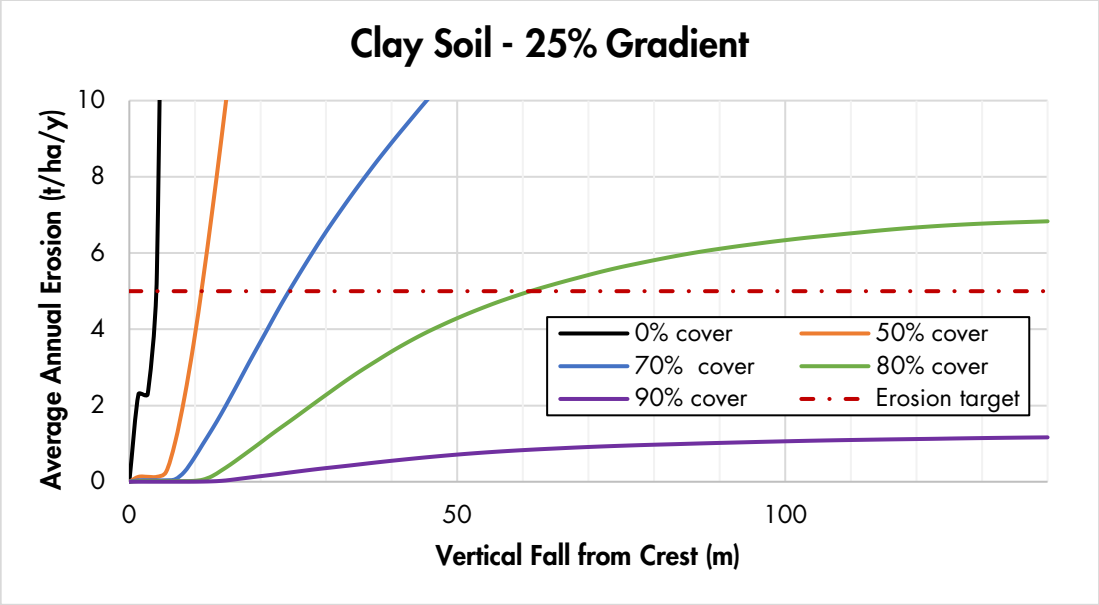

Figure 7: Predicted erosion rates along 25% gradient batter slopes with clay soil surface and 0%, 50%, 70%, 80%, and 90% vegetation cover.

5.2 Woodland PMLU with vegetated soil rock mixture

Simulations considered a batter height of 140m and slope gradients of 15%, 20%, and 25%. The target erosion rate for modelling these batters was a peak of 7t/ha/y at any point on the batter slope. These results are shown in Figures 8–10.

Simulations indicate that 140m high batter slopes on gradients of 25% (the current PMLU gradient for woodland) will be stable provided a vegetative cover level of >30% can be sustainably achieved (Figure 10). At this level of cover, the entire length of slope is

predicted to have a long-term erosion rate <7t/ha/y. If a vegetation cover level of >50% is sustainably achieved (Figure 10), the entire length of slope is predicted to have a long-term erosion rate of <5t/ha/y. Lower gradients (Figures 8 and 9) are predicted to have long-term erosion rates even lower, and in some cases lower than the erosion rates of the surrounding undisturbed land.

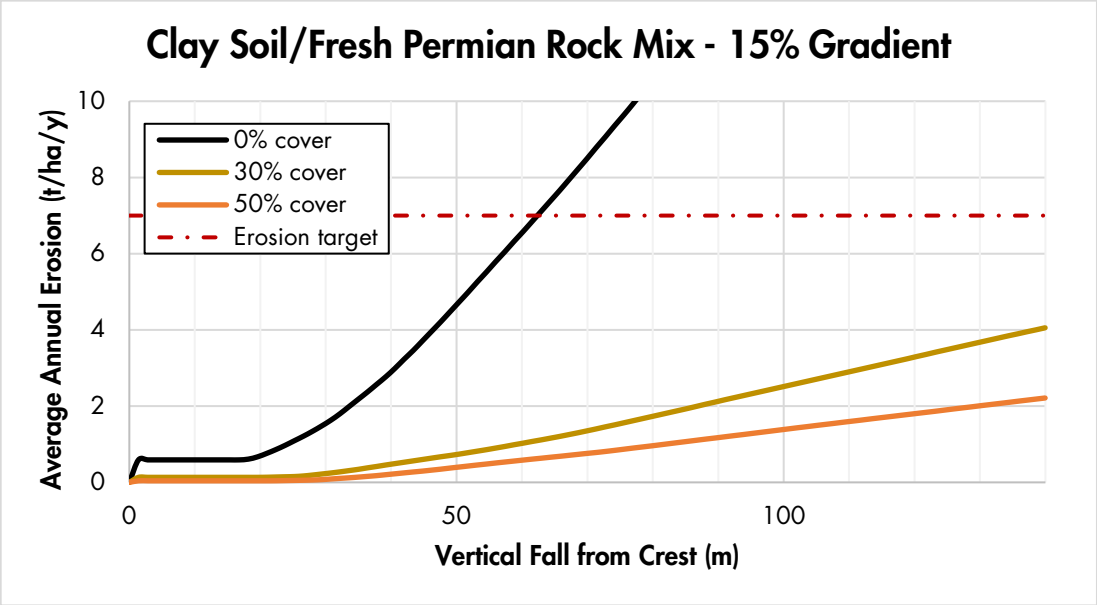

Figure 8: Predicted erosion rates along 15% gradient batter slopes with clay soil/Fresh Permian rock mix surface and 0%, 30%, and 50% vegetation cover.

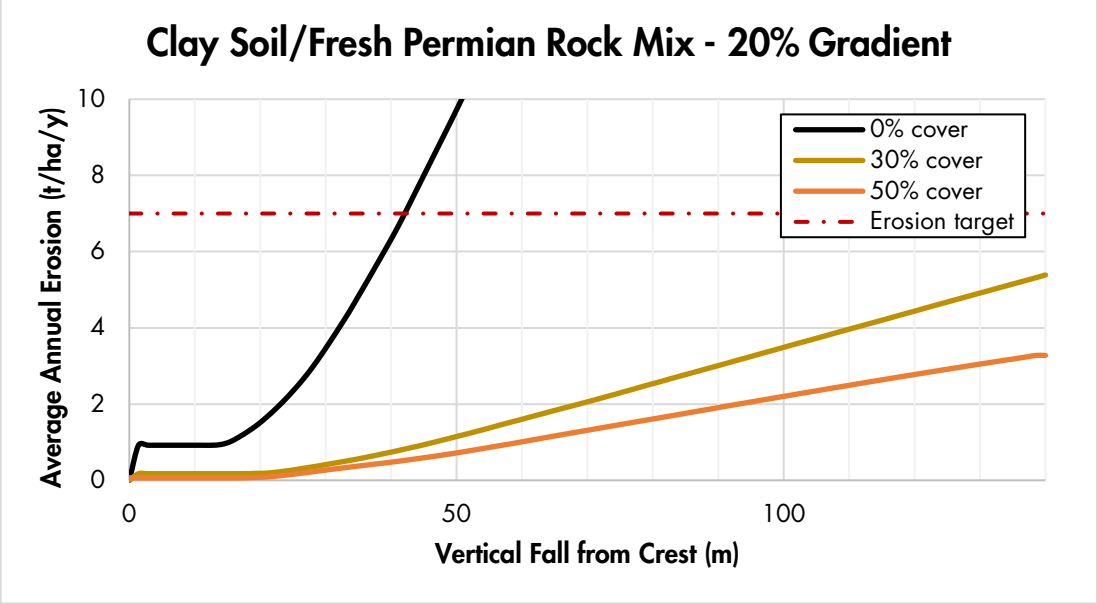

Figure 9: Predicted erosion rates along 20% gradient batter slopes with clay soil/Fresh Permian rock mix surface and 0%, 30%, and 50% vegetation cover.

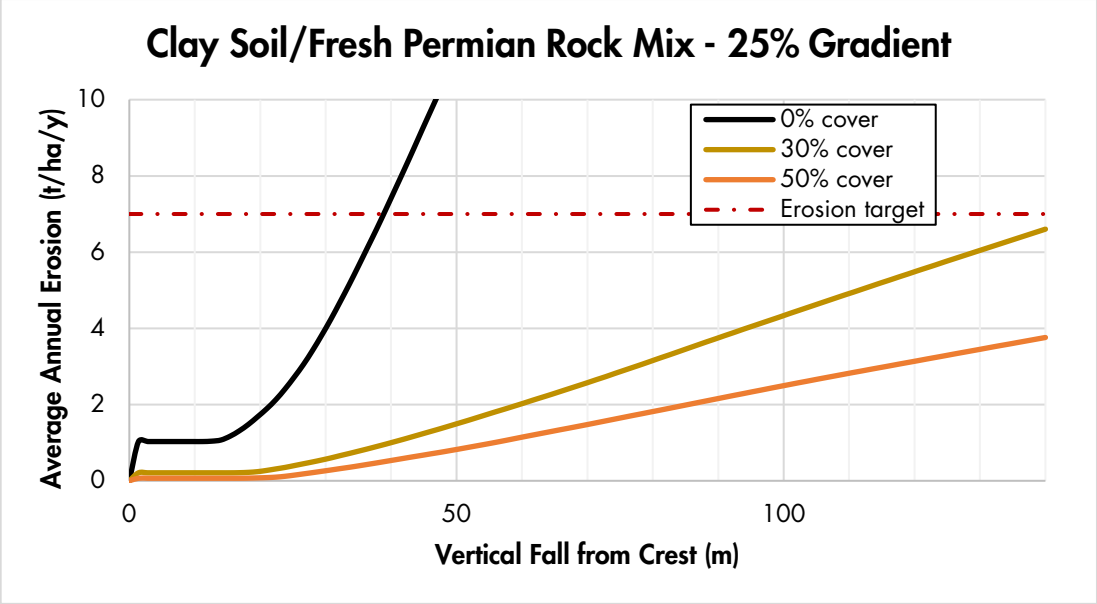

Figure 10: Predicted erosion rates along 25% gradient batter slopes with clay soil/Fresh Permian rock mix surface and 0%, 30%, and 50% vegetation cover.

5.3 Rehabilitation landform shape

Based on the WEPP simulations, the materials proposed for use in the final landform and for the landform evolution modelling are:

- Clay topsoil with 80% vegetation will be used for grazing PMLU area; and
- Clay soil mixed into Fresh Permian rock with 50% vegetation will be used for woodland PMLU areas.

Despite this blending ratio being adopted for the modelling, other blending ratios could be considered in future modelling. It is possible that different blending ratios would also achieve acceptable long-term erosion rates.

A landform shape was supplied to Landloch that represented a dozer push plan to a final rehabilitation shape. As such, the design is not representative of a final design in that there are sections that will likely be modified as further design work and refinement occurs. However, the landforms have the overall conceptual 3D rehabilitation shape and modelling of long-term erosion of this design is useful insofar as it:

- Assesses the suitability of the overall batter geometry being adopted; and
- Demonstrates aspects of the rehabilitation design that should be avoided in future refinement of the design.

The final landform will be overall water-shedding. However, specific surface water management features have not yet been integrated into the current design. It is expected that further refinements would need to include integration of those features.

The landform is not lined as the waste stored is considered geochemically benign.

Landloch completed modifications of the design shape provided 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 ±0.1m was also added to the DEM input to the SIBERIA model to reduce gridding artefacts and to provide a more realistic surface for modelling.

Further landform evolution modelling will be required in future iterations of the PRC plan as the rehabilitation landform design is refined. It is also noted that collection of site-specific erodibility data could be incorporated into future design refinement and landform modelling work.

The rehabilitation shape is shown in Figure 11 and the areas covered by the different PMLUs are shown in Figure 12.

6 LANDFORM EVOLUTION RESULTS

6.1 Parameter development

SIBERIA model parameters derived from WEPP simulations are shown in Table 8. Vegetation cover levels assumed in the modelling are conservative, with some variation to account for lower fertility of the wastes. The modelled vegetation cover level for the soil 80% and the 50% was used for the soil mixed with fresh Permian waste. It is noted that for the soil mixed with fresh Permian waste, the WEPP modelling showed that lower vegetation cover levels (30%) would achieve acceptable long-term erosion rates.

It should be noted that the method of deriving parameters attempts to ensure that the m_1 parameter is optimised so that SIBERIA simulations show a similar impact of slope length to that predicted by WEPP. However, because the two models use different methods to consider impacts of slope length, it is not reasonable to expect complete agreement between the two models over the full range of slope lengths considered.

Table 8: Estimated SIBERIA parameters

Material	Vegetation cover	m_1	β_1
Clay soil	80%	1.2735	0.0150
Clay soil mixed with Fresh Permian rock	50%	1.6923	0.000034

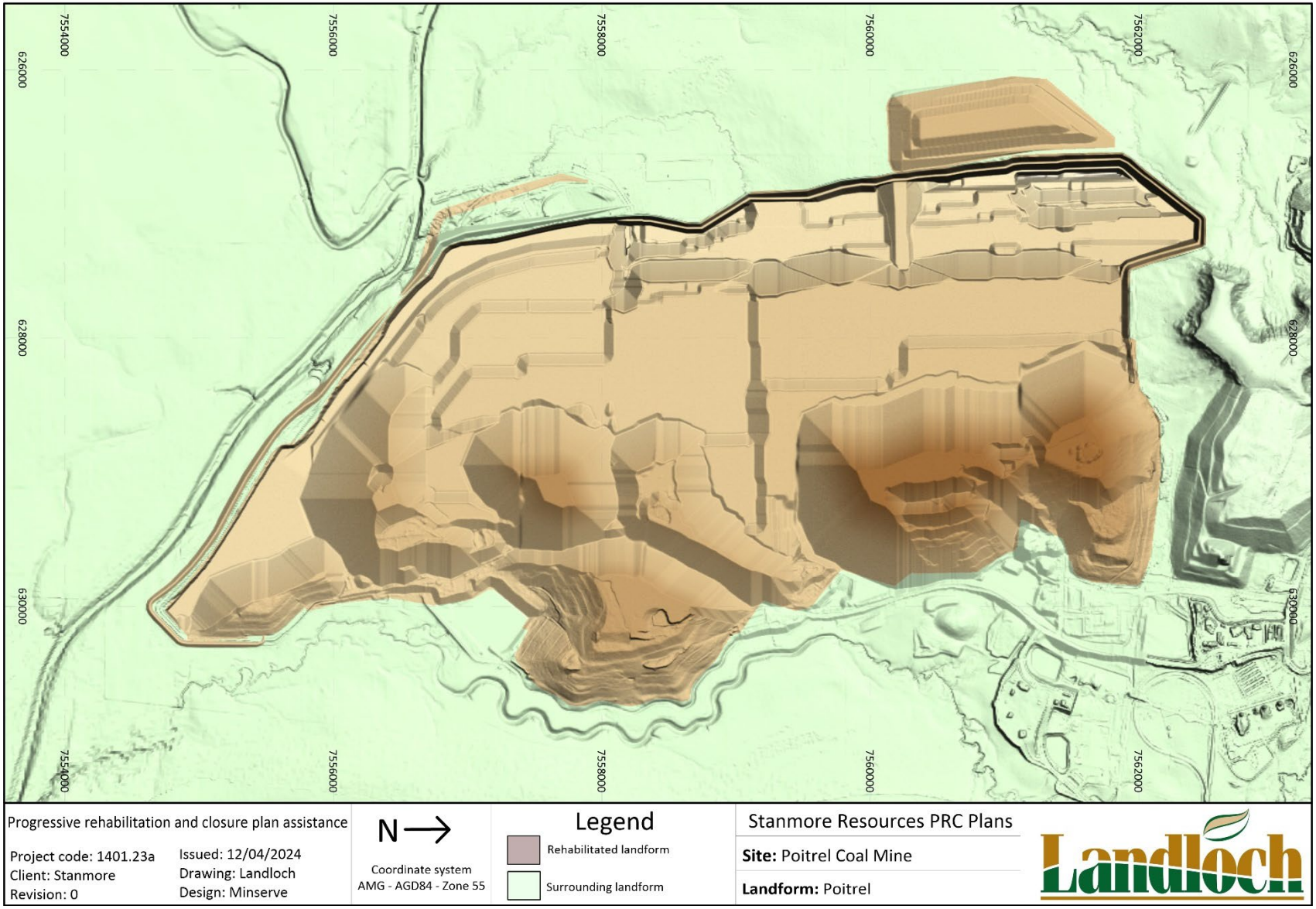

Figure 11: Poitrel 'dozer push' landform model used in SIBERIA modelling

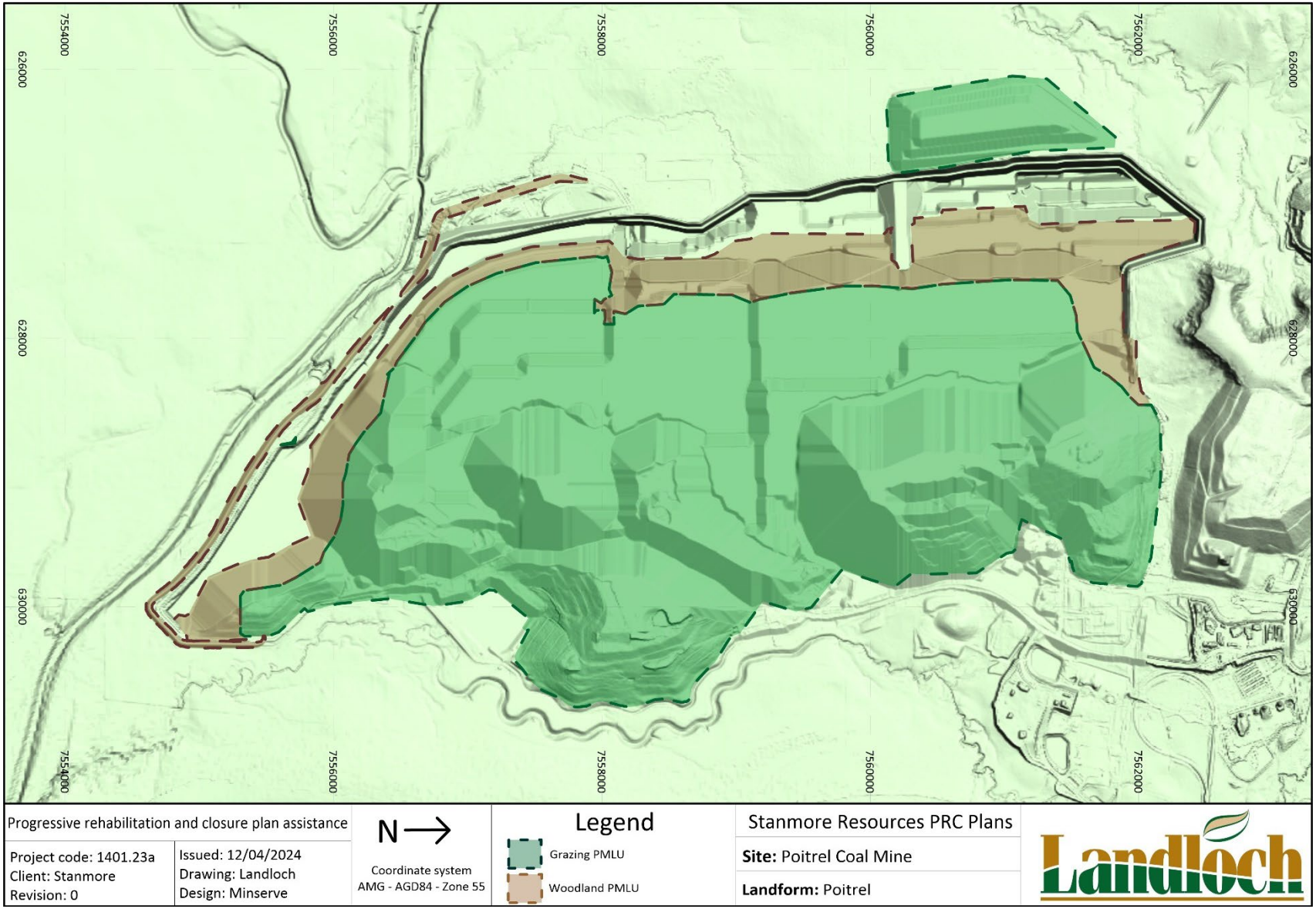

Figure 12: Poitrel 'dozer push' landform model used in SIBERIA modelling showing locations of the different PMLUs

6.2 Model outputs

Using input parameters derived for the materials, the SIBERIA model was run for 300 years, with outputs provided between 50 years and 300 years. At each output year, visualisations of the rate of erosion and gully development are provided, along with a table that includes rates for each material on the landform. Rates of gullying depth that exceeds 0.3m are highlighted in the visualisations. Erosion deaths and rates predicted by the SIBERIA landform evolution model for the proposed Poitrel landform are shown in Table 9. Figures 13 and 14 shows SIBERIA output after 300 years of simulation. All visualisations (50, 100, 200, and 300 years) are provided in Appendix B.

Table 9: Predicted erosion rates and gully depths for the grazing PMLU and woodland PMLU areas. Grazing PMLU batters are 15% gradient, sheeted in clay soil with 80% vegetation cover. Woodland PMLU batters are 25% gradient, sheeted in clay soil mixed with rock with 50% vegetation cover.

Simulation year	Maximum gully depth (m)	Average erosion (t/ha/y)	Cumulative erosion (mm)
Grazing PMLU Areas			
50	-	3.5	13
100	-	3.1	25
200	0.3	2.9	36
300	0.3	2.9	48
Woodland PMLU Areas			
50	-	3.5	13
100	-	3.0	25
200	0.3	2.8	36
300	0.5	2.8	46

Consistent with the WEPP simulations, the SIBERIA results indicate that:

- At a vegetative cover level of 80%, predicted erosion rates of the grazing PMLU areas capped with clay soil are below the target erosion level of 5t/ha/y.
- At a vegetative cover level of 50%, predicted erosion rates of the woodland PMLU areas capped with clay soil mixed with fresh Permian rock are below the target erosion level of 5t/ha/y.

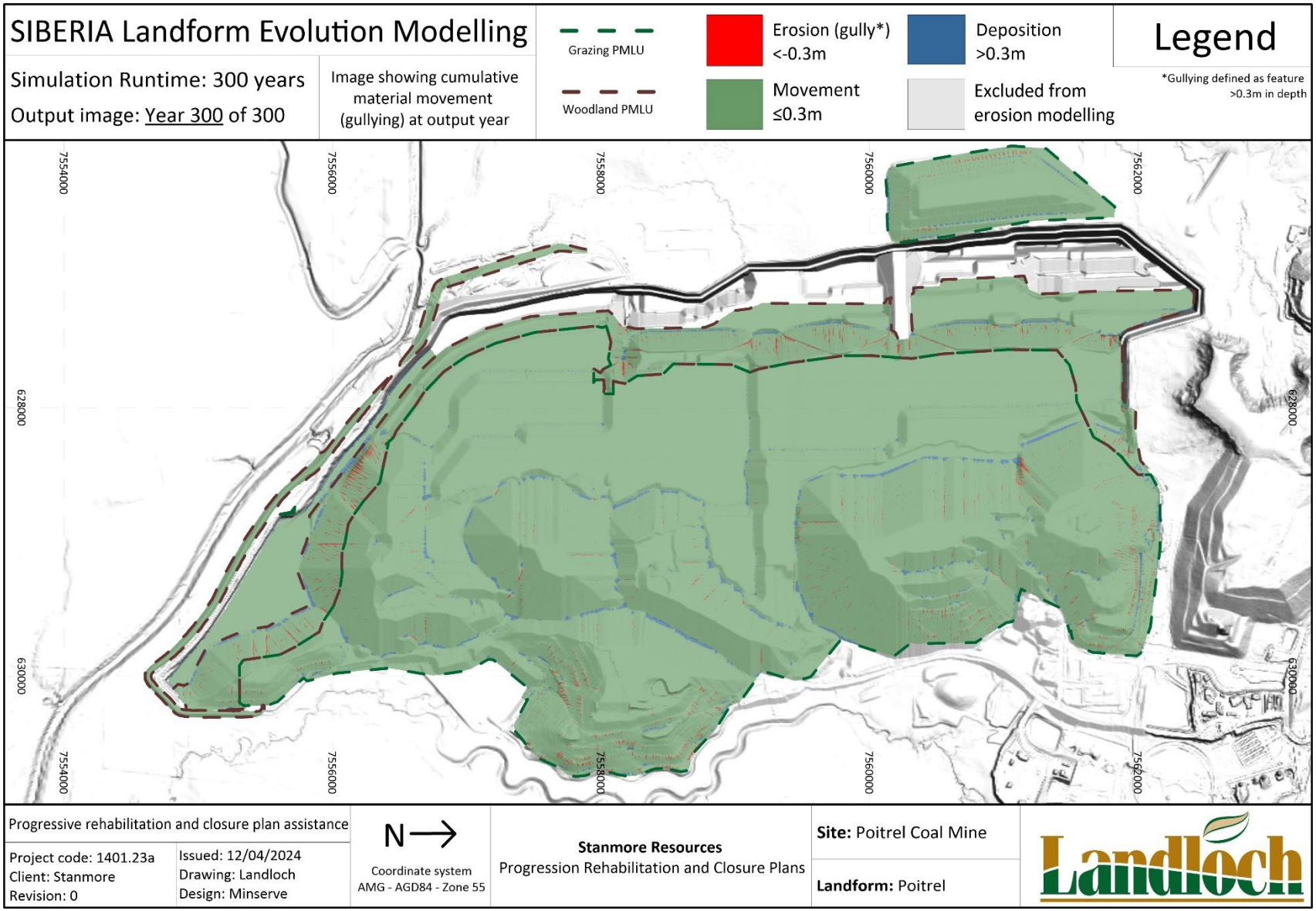

Figure 13: Predicted erosion and deposition depths of the Poitrel landform after 300 years

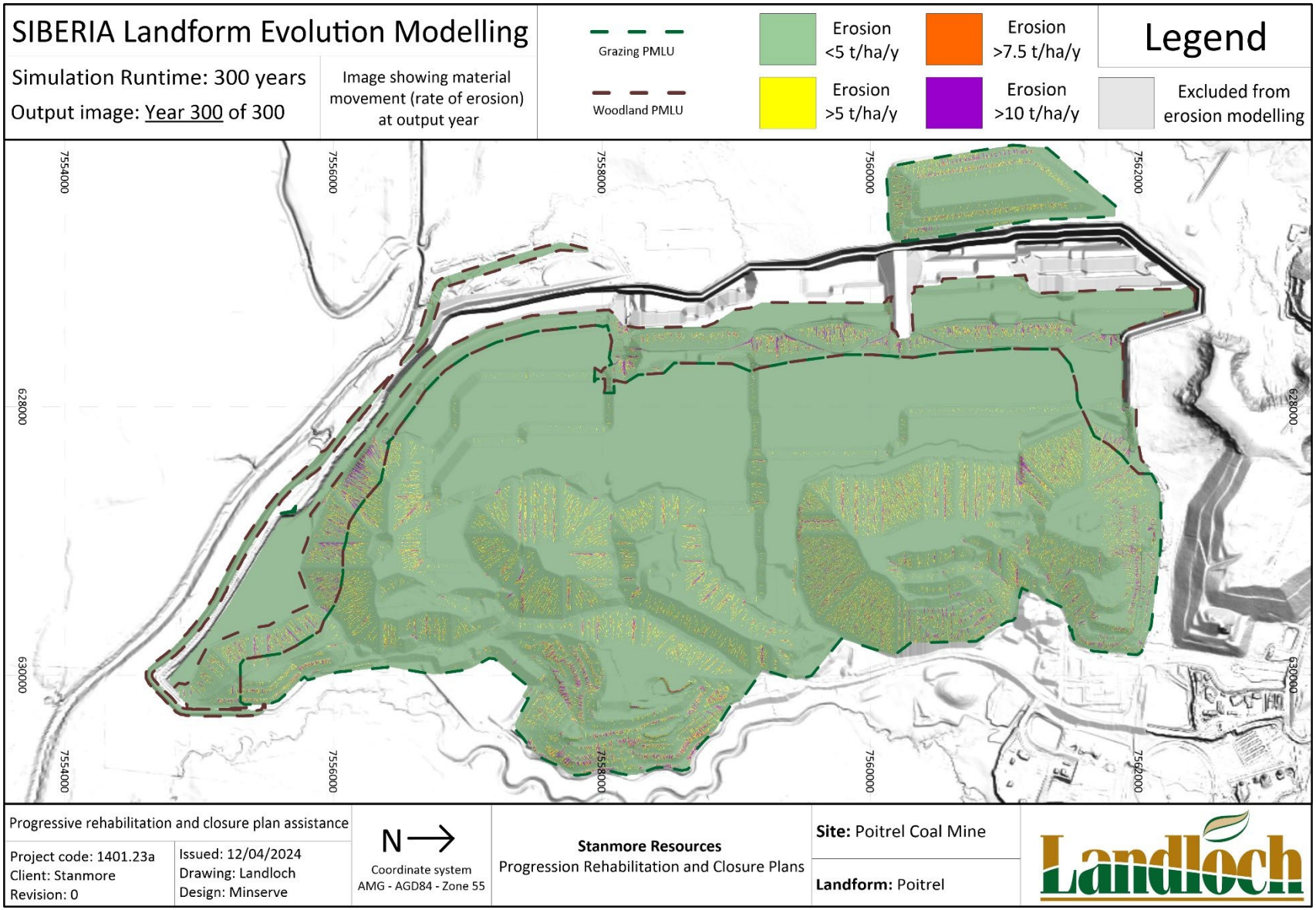

Figure 14: Predicted erosion rates of the Poitrel landform after 300 years.

7 RISK ASSESSMENT

The following risks to the achievement of the landform design were identified:

- Failure to achieve the required vegetation groundcover.
- Placement of spoils other than Fresh Permian overburden at at/near the rehabilitated surface.
- Non-conformance to design shape.
- Adverse climatic conditions (drought, heat, changing climate).

Table 10 details these risks, mitigation measures, and the residual risk, assuming the mitigation measures are adopted. Trials to address these risks are also detailed in Section 9. Key to the mitigation of risks associated with the rehabilitation landform design is the:

- Refinement of the dozer push design into a more fully worked rehabilitation design;
- Development of the revegetation plan; and
- Implementation of QA/QC as part of construction of the rehabilitation landform shape.

A revegetation plan has been developed as part of the PRC plan development (Landloch 2024). It includes QA/QC requirements. Further QA/QC information can be found in Section 8 of this report. Two medium risks remain (residual risks) and reflect unlikely events (no specific circumstances to suggest they could happen) with moderate environmental consequences (lasting months, affecting extended areas, receiving environment largely natural habitat with moderate biodiversity value).

Table 10: Risk assessment.

Risk	Mitigation measure	Likelihood	Consequence	Residual Risk
Failure to achieve the required vegetation groundcover.	Develop revegetation plan that considers vegetation suitability, seeding/planting methods, primary growth media suitability, and secondary growth media suitability. Plan is to include measurable rehabilitation milestones for landform design, growth media, and vegetation.	Unlikely	Minor	Low
Placement of spoils other the Fresh Permian waste at/near the rehabilitated surface.	Develop a revegetation plan that reduces the risk of poor vegetation establishment, and that outlines soil suitability indicators. Develop a revegetation plan that outlines remedial actions if these spoils are found within 2m of the surface. Incorporate QA/QC requirements in landform construction. Include erosion assessment as part of ongoing monitoring. Remediate areas performing poorly with respect to erosion (based on erosion monitoring data)	Unlikely	Moderate	Medium
Availability of sufficient quantities of fresh Permian overburden	Identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability. Development of processes by which future mining can segregate suitable wastes.	Unlikely	Major	Medium
Non-conformance to design shape.	Incorporate QA/QC requirements in landform construction and possibly into the works contract if contractors are used.	Unlikely	Moderate	Medium
Adverse climatic conditions (drought, heat, changing climate).	Develop revegetation plan that considers vegetation suitability to adverse climatic conditions. Monitor climate and plant responses as part of on ging monitoring.	Unlikely	Minor	Low

8 LANDFORM CONSTRUCTION AND QA/QC REQUIREMENTS

8.1 Reshaping

The constructed rehabilitation shape should achieve the design geometries ±0.2m vertical height measured over a maximum distance of 50m, allowing for some greater variation in microrelief caused by the blockiness of the spoils (i.e. some rocks or larger particles may protrude from an otherwise suitably level surface).

Simulations of runoff and erosion indicate that – once vegetation is established – there is no requirement for installation of berms or graded banks to reduce slope length and erosion risk. The berms that exist within the current design should be removed and additional erosion modelling of the refined shape should be carried out as part of future closure planning work.

It is anticipated that batter slope rehabilitation will be carried out progressively, working gradually up from the bottom of the slope, so that there will be increasing vegetation groundcover on lower sections of a slope as the works gradually (over a number of years) move towards the top of the landform.

8.2 Cover design

The geochemical assessment has shown that the wastes are not anticipated to pose a significant risk in terms of acid, neutral metalliferous, or saline drainage, or elevated metal and/or sulphate concentration in surface waters or groundwaters. As a result, a specific engineered cover design to address these risks is not required. Therefore, the intent of the cover design is to manage erosion risk and support vegetation growth.

The cover profile recommended to manage erosion risk and support vegetation growth is as follows:

- A topsoil surface layer with an average thickness of 0.10–0.15m placed on grazing PMLU area, to support ≥80% groundcover. This would overlie a ~2m thick layer of non-acid forming fresh Permian waste.
- A topsoil surface layer with an average thickness of 0.10–0.15m mixed with fresh Permian overburden at a ratio of 2–4 parts fresh Permian rock to 1 part topsoil placed on woodland PMLU area, to support >30% vegetation groundcover (>50% for improved performance). This would overlie a ~2m thick layer of non-acid forming fresh Permian waste.

Materials requirements, as supplied by Stanmore, are indicated below:

- Grazing PMLU:
  - Topsoil: 1,205,328m^3
  - Fresh Permian overburden: 28,626,540m^3
- Woodland PMLU:
  - Topsoil: 536,680m^3
  - 12,774550m^3

A total of 1,742,008m^3 of topsoil and 41,104,090m^3 of fresh Permian overburden is required. The approximate total volume of available stockpiled soil is 2,793,354m^3, sufficient to achieve the cover. It is likely that the volume of fresh Permian overburden at PTM is large. However, the source and availability of this material (beyond it being located within the current waste landform) is currently unknown.

More detail on the cover design can be found in Landloch (2024).

8.3 Surface ripping

It is critical that flow concentration on the batter slopes is minimised. Concentration of runoff can be prevented by minimising the size of cross-slope rip lines. Rip lines will be no deeper than 300mm from peak to trough of the rip line once settlement has occurred. To achieve this, an unconsolidated rip line ~500mm deep is recommended. Ripping will be desirable to reduce machinery compaction, remove track marks that are not on contour, and incorporate fertiliser to encourage repaid vegetation growth.

Equipment used for rehabilitation works should have precision guidance systems installed. Operators will be highly skilled and experienced. It is noted that rehabilitation earthworks are significantly different to earthworks typically conducted by mining staff and requires great precision and adherence to the specified designs if successful rehabilitation is to be achieved.

8.4 Ameliorants

Application rates for fertiliser and other ameliorants for soils are dependent on the intended PMLU for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus based ameliorants would be recommended for these areas. Further information of amendments can be found in the material characterisation report (Landloch 2022). A summary of the information is provided below.

8.5 Bunding

For the recommended design to be stable and sustainable, it will be critical that the crests of the rehabilitated landform tops be bunded. Uncontrolled discharge of concentrated flows over steeper batters is a very common cause of gullying and landform failure. The crest bunds must be designed to be high enough to contain extreme rainfall events while allowing some freeboard. A design storm with an Average Recurrence Interval of 2,500 years and duration of at least 9 hours is recommended.

The bunds are to be thoroughly compacted and constructed of stable (non-dispersive) material. They are to have their outer faces continuous with the outer batter profile and have the same surface treatments applied to it (e.g. soils). They are to have a width across the top of the bund of at least 2m and will have their inner face sloping gradually inwards at a gradient of 1V:10H. The gentle inward gradient ensures that any water that ponds will be ponded well away from the outer batter slope, thereby minimising the potential for any sinkhole that may form to reach the outer batter slope and create an "instant gully".

8.6 Lining

The landform is not lined as the waste stored is considered geochemically benign and the potential to adversely impact groundwater quality is considered low.

9 TRIAL RECOMMENDATIONS

Rehabilitation trials can improve the likelihood of achieving the PMLU by providing additional data on the suitability of the proposed rehabilitation strategies. Rehabilitation trials form part of the continual improvement process as rehabilitation at PTM progresses and the outcomes of the earlier rehabilitation works become apparent and inform future rehabilitation works. They are used to test design assumptions and to confirm completion criteria. Trial/study recommendations for PTM are detailed below.

9.1 Plant growth study

The baseline characterisation work undertaken for Poitrel has indicated that the soils have suitable fertility, but that the Permian overburden has low fertility. The erosion results indicate that establishment of healthy grass cover is critical to the overall stability of the remediated landforms. Therefore, it is critical to confirm that the growth media available can support a healthy and sustainable grass cover.

Trials should be established to demonstrate the ability of the proposed soils and soil/overburden mixtures to support the vegetation required of the grazing and woodland PMLU.

This could initially include the establishment of a small-scale pot trial in which growth media (soils and overburden) are assessed using different mixing ratios. The potential impact of fertilisation could also be addressed as part of this study. The results of this would establish the usefulness of the soils and overburdens, and the potential benefit of fertilisation to rapidly establish grass cover. From these results, larger scale field trials could be established to verify the results of the small-scale trial. Ultimately, the findings would support the closure strategies and closure cost estimates for Poitrel and also be useful in defining the need for ongoing soil amelioration (e.g. fertilisation) once the land is returned to its target PMLU.

9.2 Grazing pressure study

The PMLUs for Poitrel includes grazing. Grazing of the landforms post-closure is assumed and it going to be important that sustainable stocking rates are defined so that:

- Sufficient grass cover (>80% for the grazing PMLU and >30% for the woodland PMLU is sustainably achieved);
- Grass cover is not reduced through stock trampling and soil compaction; and
- Pathways used by livestock to access the pasture do not lead to unacceptable erosion.

A grazing study could be established with the aim of defining cover levels maintained when different stocking rates are used.

9.3 Material variability and quality studies

The erosion predictions are based on samples of waste that represent a very small proportion of the wastes that have been mined. Further characterisation of the overburdens should be completed that aims at defining the variability of these materials with respect to their erosion potential. On a broad scale, this can be usefully done using remote sensing techniques. An approach that could be considered is:

1. Determine the range of particle size distributions (PSDs) present within each of the material types identified.
2. Complete further erodibility testing of materials from the observed range of PSDs to determine whether this observed variation yields significant differences in long-term erosion performance.

9.4 Material mixing study

For surfaces where durable, erosion-resistant overburden is mixed with soils (i.e. woodland PMLU), the quality of material mixing will be important. Elevated erosion rates can result where poor quality material mixing occurs. In contrast, high quality mixing can yield excellent and consistent rehabilitation results.

A mixing trial could include:

- Identify an area of landform on which a trial can occur. This is a short term trial (taking only as long as it need to complete the ripping and gather data to compare the quality of mixing).
- Use the machinery available for rehabilitation to apply the mixes to the surface. A range of techniques have been used:
    - Mixing the materials at the base or crest of the batter and then spreading the mixed material to the surface;
    - Spreading the materials in separate layers and using cross-slope ripping to achieve the mixing, often with modified ripper tynes that encourage material inversion; or
    - Placement of windrows of different materials at the crest and pushing through the piles down onto the batter, using the act of pushing as the means of mixing.
- Assess the resultant quality of mixing using physical sieving techniques. Remote sensing techniques such as drone imagery are not likely to yield suitable data due to the high proportion of fines at the surface after ripping that will act to mask the rock that may be present just below the surface.

9.5 Climate change studies

Climate change has the potential to change (increase or decrease depending on the area) erosion potential over time as rainfall patterns change. The magnitude of the erosion potential change could be considered through additional runoff/erosion

modelling using climate sequences adapted to reflect climate change predictions. This study would broadly involve:

- Identifying whether climate change predictions are available for Poitrel, including rainfall totals, rainfall intensities, number of rain day per year, and probability of wet days following dry days and dry days following dry days.
- Use this information to modify the WEPP erosion model climate sequences to account for changes in rainfall patterns. WEPP has the ability to input modified variables for the rainfall totals, intensities, and probabilities outlined above.
- Use the WEPP model to predict long-term erosion under the changed climate scenarios.

10 ASSUMPTIONS AND LIMITATIONS

Assumptions and limitations relevant to the landform design include:

- The fresh Permian overburden is used as a cover over the less suitable Tertiary overburden.
- The fresh Permian overburden poses a low risk and acid, metalliferous and saline drainage, such that the intent of the cover is for management of erosion and promotion of vegetation growth.
- Fresh, benign, rocky Permian overburden can be sourced in sufficient quantities to achieve the required cover.
- The supply of fresh, benign, rocky Permian overburden is limited by the current site practice of not segregating wastes by their function/use for rehabilitation and closure. As a result, identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability will be required. Further, processes by which future mining can segregate suitable wastes is recommended.
- Vegetation groundcover levels of ≥80% can be sustainably achieved for the grazing PMLU.
- Vegetation groundcover levels of >30% can be sustainably achieved for the woodland PMLU.
- Vegetation groundcover levels specifically considers contact cover of vegetation on the surface. Practically, this means a combination of grass cover and anchored (not readily moved) surface litter
- Considerations of surface cover do not include rock. Where rocky materials have had erodibility measured experimentally and those parameters are used in WEPP simulations, then effects of the rock are already accounted for within the parameters used.
- The erosion modelling assumes:
    - No uncontrolled discharge of runoff from landform tops onto outer batter slopes.
    - That batter slopes will not be formed with excessive flow-concentrating profiles (e.g. variations in surface elevation such that there is cross-slope concentration of flow into consistent depressions running downslope).
    - Any cross-slope ripping will be carried out strictly on the contour; and

  - Soil management (including stripping, stockpiling, replacement, amendment, and fertilisation) will be carried out effectively to maximise early and continuing plant growth.
- Impacts of landform settlement has not been accounted for at this level of design, with final landforms not expected to be subject to significant areas of settling given uniformity of the properties of the overburden stored and the final cover treatment.
- Despite a blending 4:1 ratio being adopted for the modelling, other blending ratios could be considered in future modelling. It is possible that different blending ratios would also achieve acceptable long-term erosion rates.
- The landform shape supplied represented a dozer push plan to a final rehabilitation shape. As such, the design is not representative of a final design in that there are sections that will likely be modified as further design work and refinement occurs. However, the landforms have the overall conceptual 3D rehabilitation shape and modelling of long-term erosion of this design is useful insofar as it:
  - Assesses the suitability of the overall batter geometry being adopted; and
  - Demonstrates aspects of the rehabilitation design that should be avoided in future refinement of the design.
- The final landform will be overall water-shedding. However, specific surface water management features have not yet been integrated into the current design. It is expected that further refinements would need to include integration of those features.
- The landform is not lined as the waste stored is considered geochemically benign.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The results from the landform evolution modelling indicate that vegetated clay soils (>80% vegetation groundcover) and a vegetated mixture of clay soil and Fresh Permian overburden (>30% vegetation groundcover) can be used to create a rehabilitated landform that is erosionally stable in the long-term. Geometries of the rehabilitation surfaces used on the Poitrel landform are based on:

- Target erosion rates consistent with long-terms rates with a low tendency for rill and gully initiation;
- Erosion-related attributes of the target PMLUs (e.g. vegetation groundcover levels); and
- Suitability of the soils and fresh Permian overburden as primary growth media and the fresh Permian overburden as secondary growth media (underlying the primary growth media layer).

The clay soils were assessed as being suitable for use as a primary growth medium (i.e. at the surface of the rehabilitated landform). The fresh Permian overburden was also assessed as being suitable for use as a primary growth medium.

The potential for gully development on the batter slopes is predicted to exist but be low. The long-term erosion rates within the rehabilitation landform are predicted to be consistent with rates that show a low tendency to rill or gully.

The cover profile to manage erosion risk and support vegetation growth is as follows:

- A topsoil surface layer with an average thickness of 0.10–0.15m placed on grazing PMLU area, to support ≥80% groundcover. This would overlie a ~2m thick layer of non-acid forming fresh Permian waste.
- A topsoil surface layer with an average thickness of 0.10–0.15m mixed with fresh Permian overburden at a ratio of 2–4 parts fresh Permian rock to 1 part topsoil placed on woodland PMLU area, to support >30% vegetation groundcover (>50% for improved performance). This would overlie a ~2m thick layer of non-acid forming fresh Permian waste.

The revegetation plan (Landloch 2024b) addresses the plant growth needs of the surface layers of the rehabilitated landforms. More detail on the cover design can be found in (Landloch 2024a).

11.2 Recommendations

Adoption of a 2m thick cover is recommended to allow for erosion of the cover over time, and for some variation in the layer thickness actually applied by machinery during the rehabilitation. This thickness of cover could include the soil layer (0.1—0.15m thick) overlying a suitable fresh Permian overburden.

The weathered sediments and clay interburden is a highly weathered material containing portions of fragile rock and a clay content of >35%. They are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended.

The supply of fresh, benign, rocky Permian overburden is limited by the current site practice of not segregating wastes by their function/use for rehabilitation and closure. As a result, identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability will be required. Further, processes by which future mining can segregate suitable wastes is recommended.

Application rates for fertiliser and other ameliorants for soils are dependent on the intended PMLU for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus based ameliorants would be recommended for these areas.

Gypsum has been recommended for sodic/dispersive materials or where calcium is low. It should be applied during soil preparation stages, in a manner that allows for as

thorough mixing as is practicable of the surface materials. Gypsum should be applied prior to seeding and fertilising. The depth to which sodicity is ameliorated should be dependent upon erosion risk/gradient. Details of this are provided in Section 8.4.

A balanced NPK fertiliser such as Crop King (CK) 55 (N: ~13.5%, P: ~15 %, K: 12.5%) and slow-release nitrogen source such as coated urea (N: ~46%) or organic compost is recommended to provide a balanced source of nutrients to plants during rehabilitation. Any composted material, if used, should comply with the Australian Standard for Composting (AS4454-2012). Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. More detail is provided in Section 8.4.

The supply of fresh, benign, rocky Permian overburden is limited by the current site practice of not segregating wastes by their function/use for rehabilitation and closure. As a result, identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability recommended. Further, processes by which future mining can segregate suitable wastes is recommended.

The current landform design is not representative of a final design in that there are sections that will likely be modified as further design work and refinement occurs. The design also does not currently include all surface water control features that may exist in the rehabilitation design (e.g. crest bunds). Continued landform design work to refine and improve the rehabilitation design is recommended.

Recommendations for rehabilitation trials are outlined in Section 9.

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APPENDIX A: POST MINING LAND USE MAP

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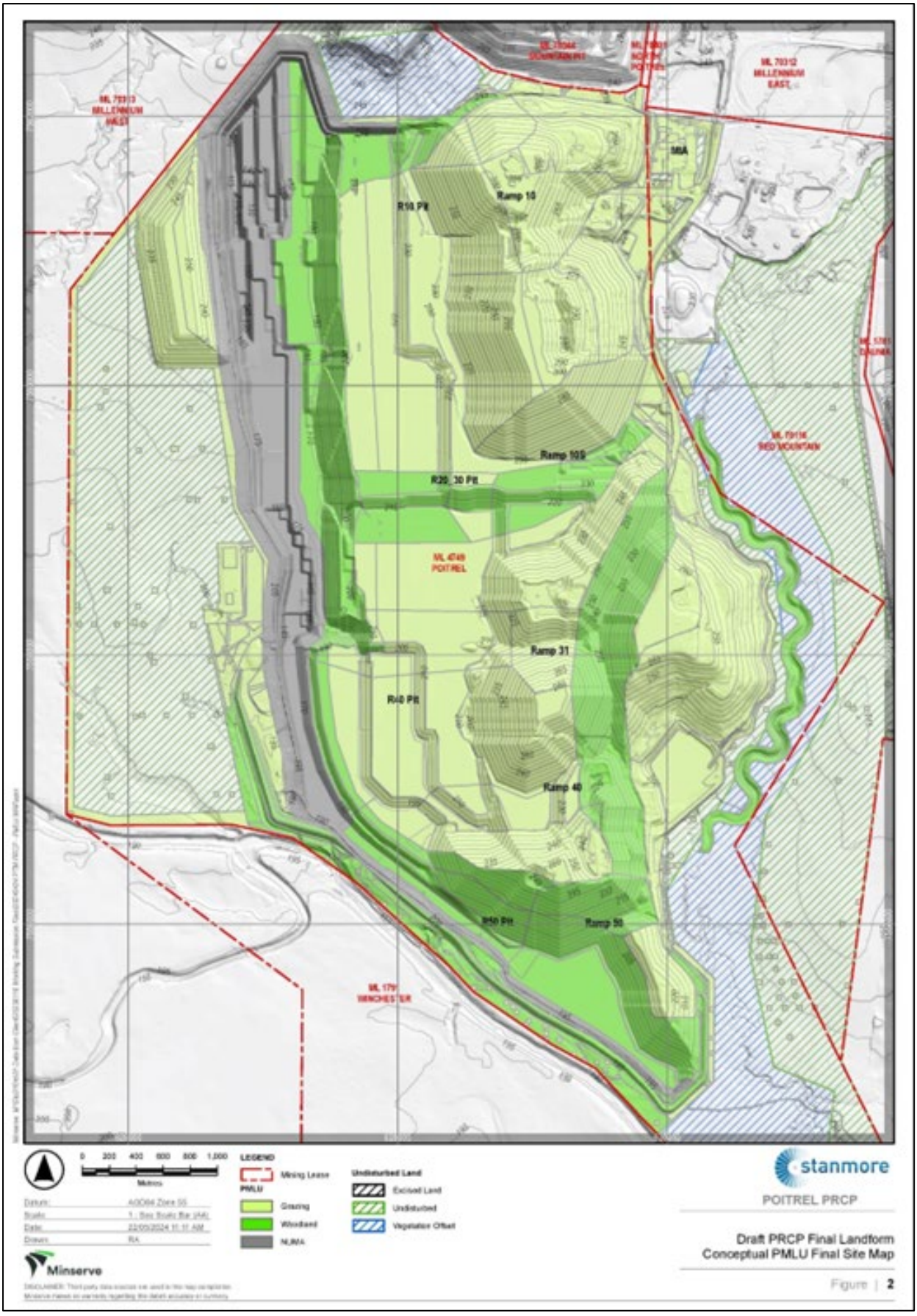

Figure A-1: Proposed PMLU mapping at PTM.

APPENDIX B: SIBERIA MODEL OUTPUTS

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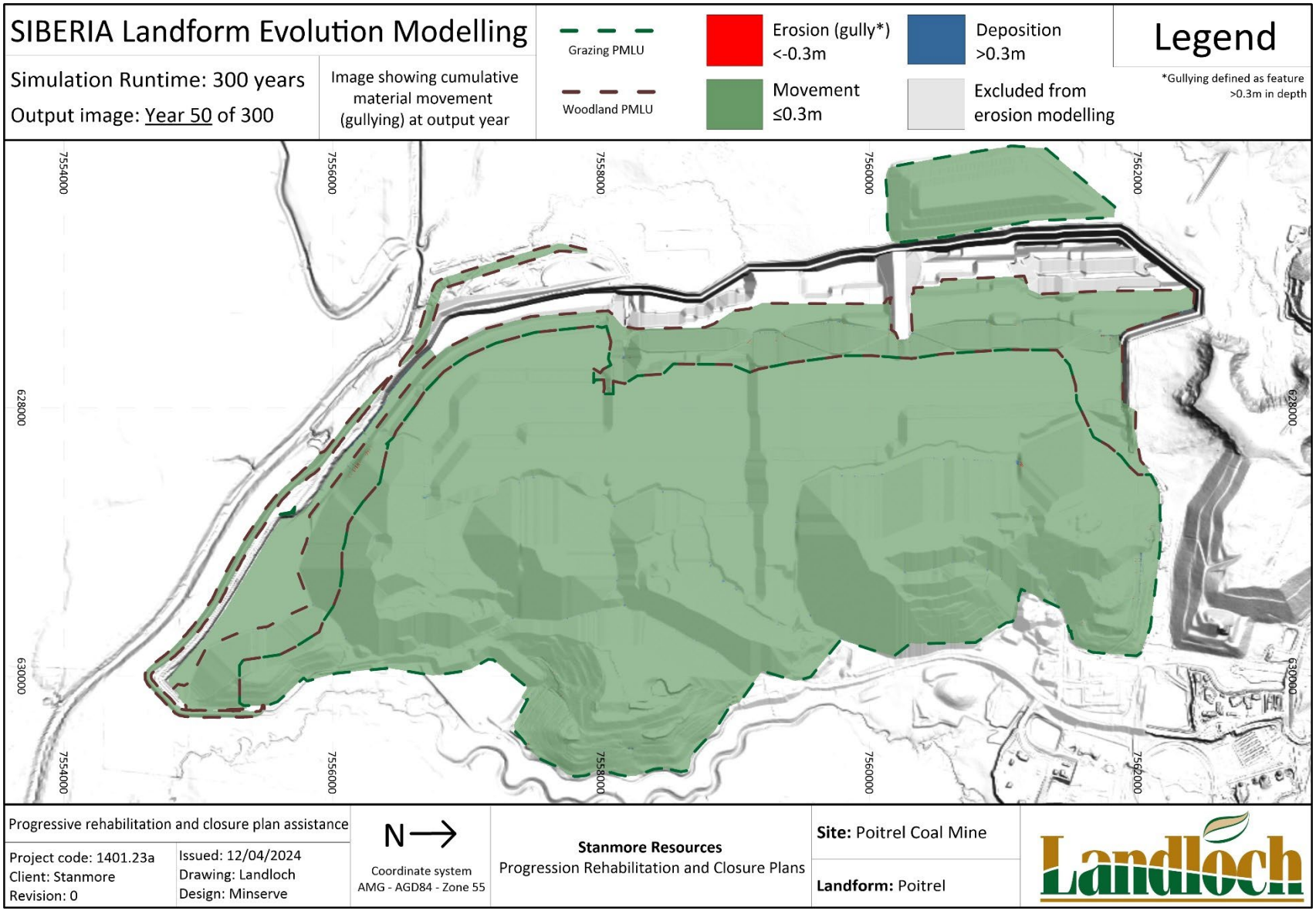

Figure B-1: Predicted erosion and deposition depths of the Poitrel 'dozer push' landform after 50 years.

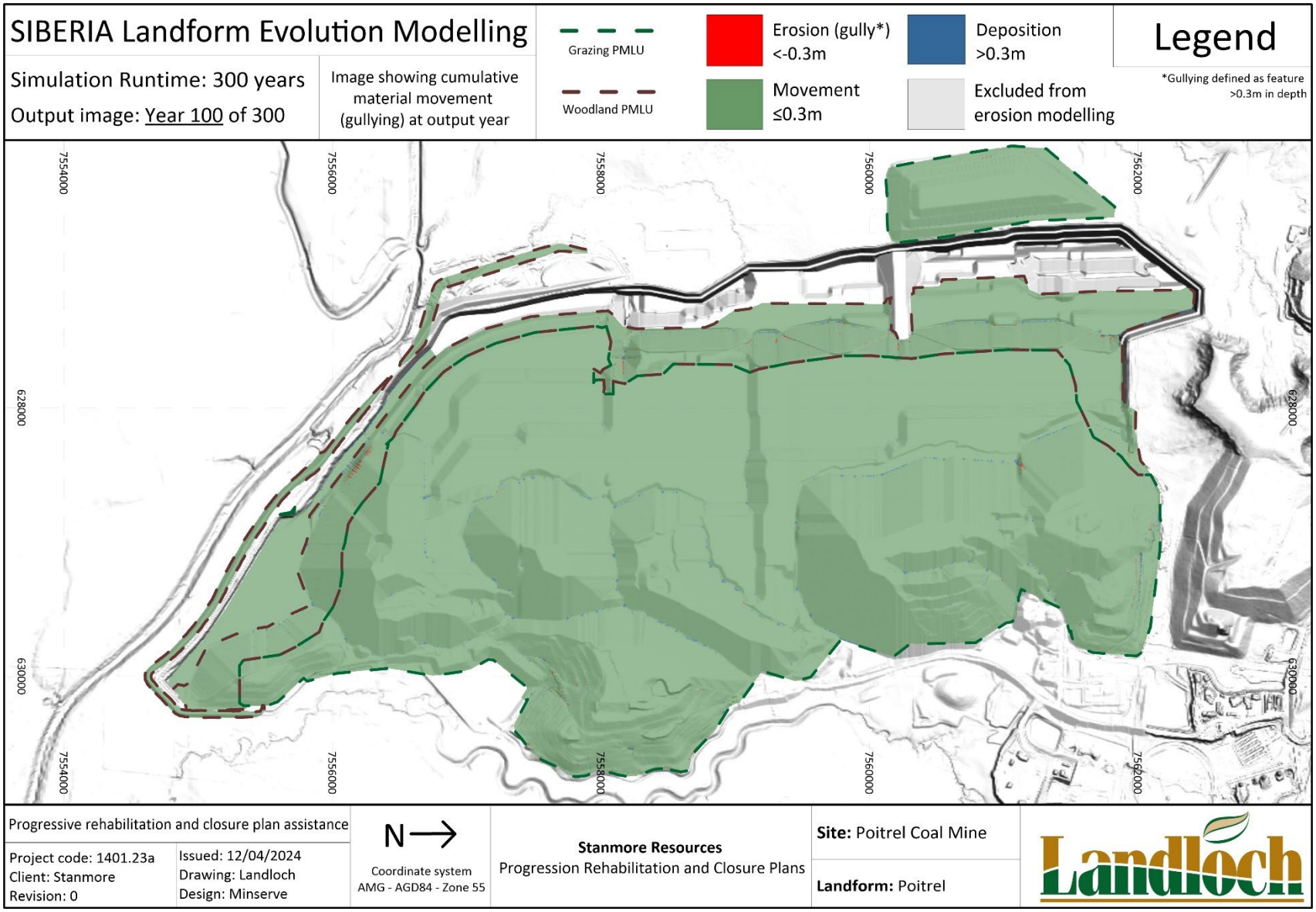

Figure B-2: Predicted erosion and deposition depths of the Poitrel 'dozer push' landform after 100 years.

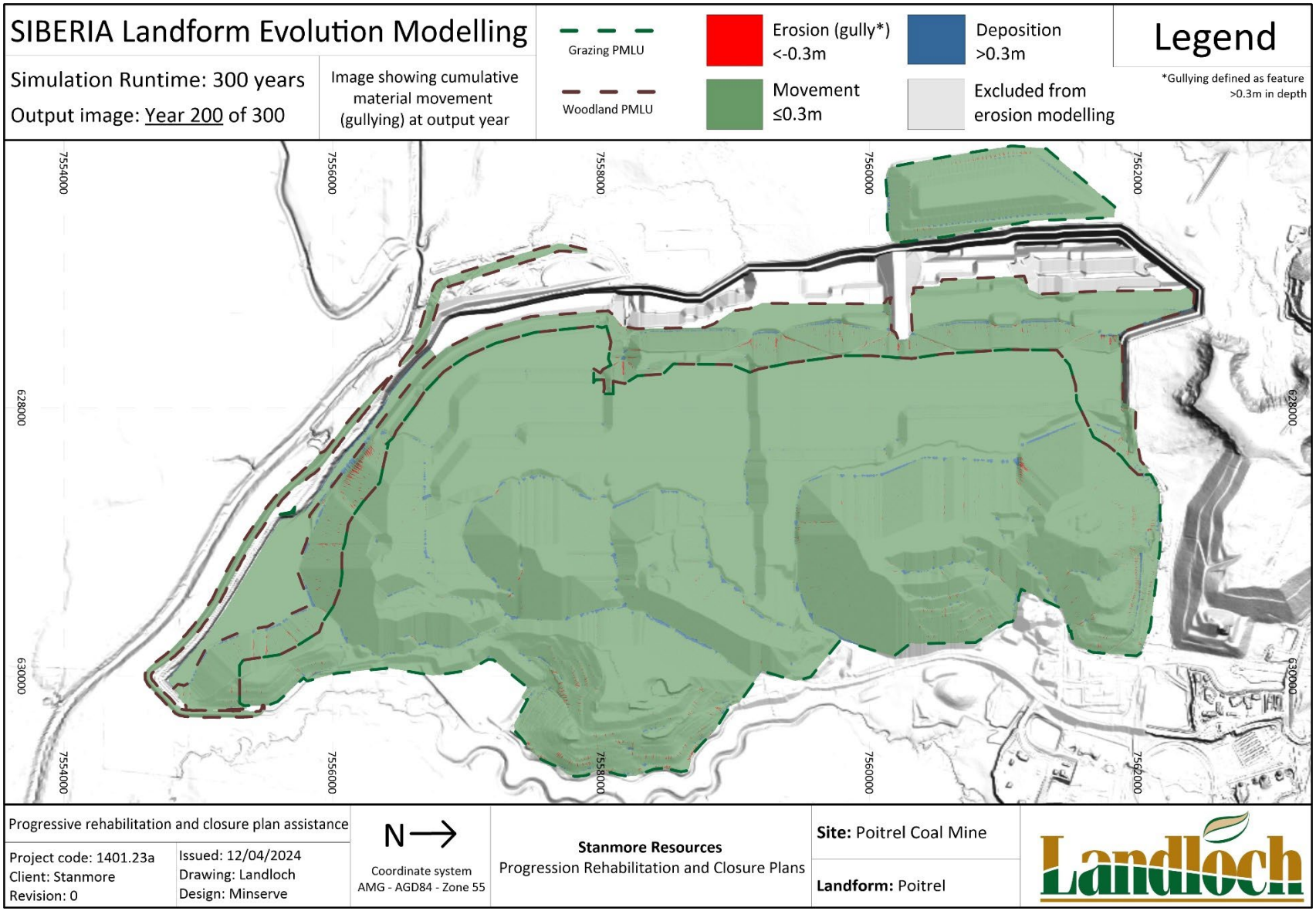

Figure B-3: Predicted erosion and deposition depths of the Poitrel 'dozer push' landform after 200 years.

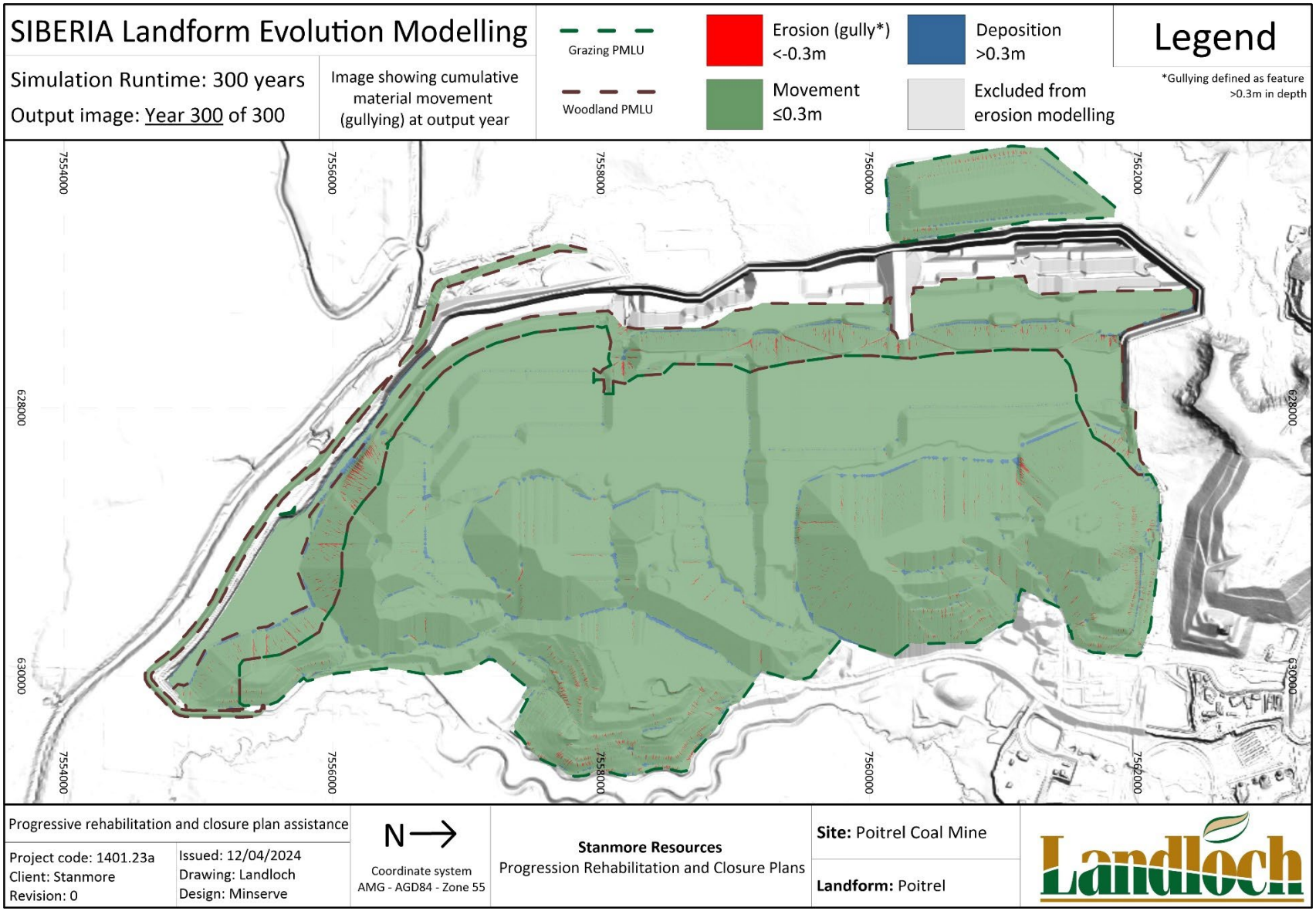

Figure B-4: Predicted erosion and deposition depths of the Poitrel 'dozer push' landform after 300 years.

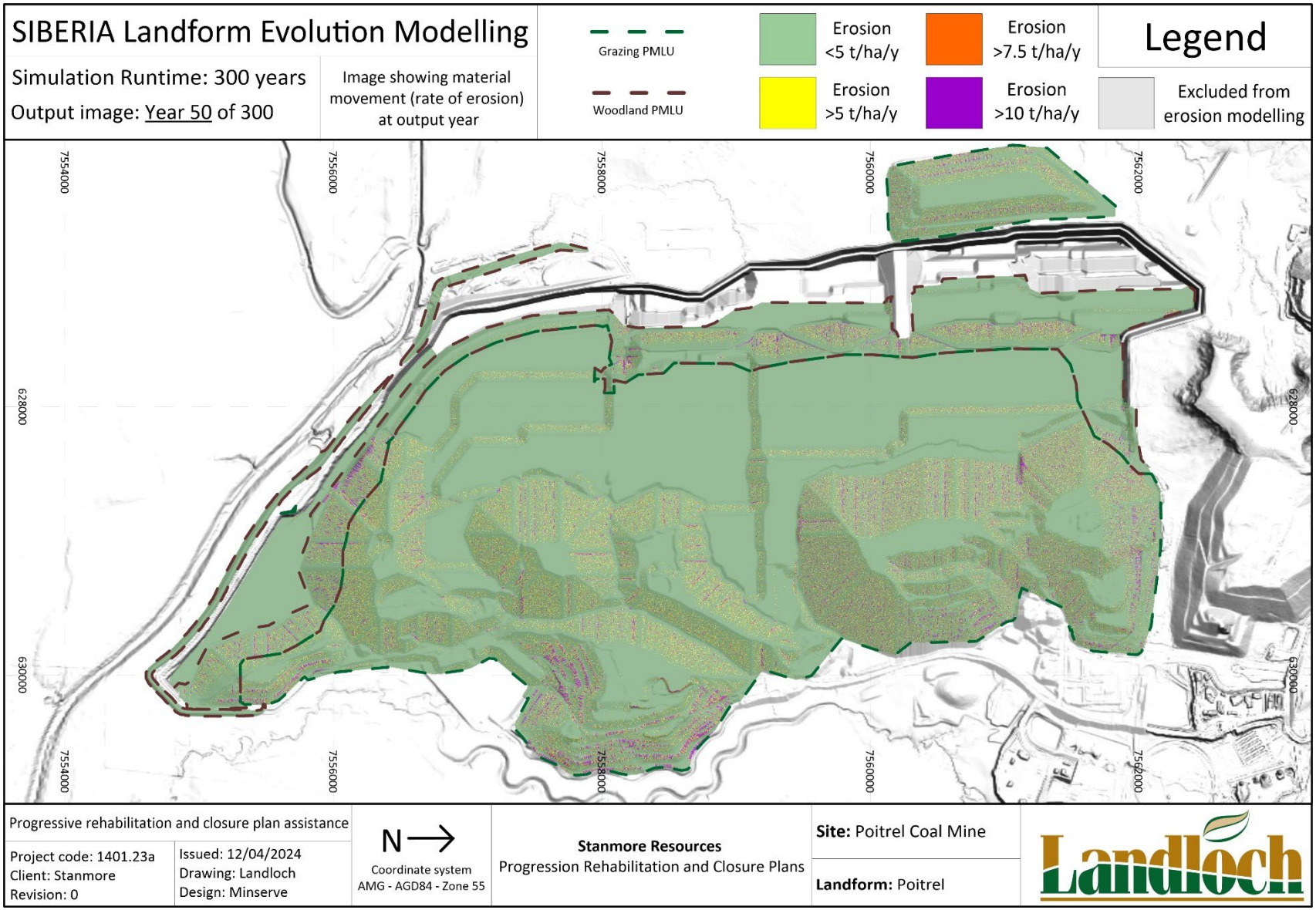

Figure B-5: Predicted erosion rates of the Poitrel 'dozer push' landform after 50 years.

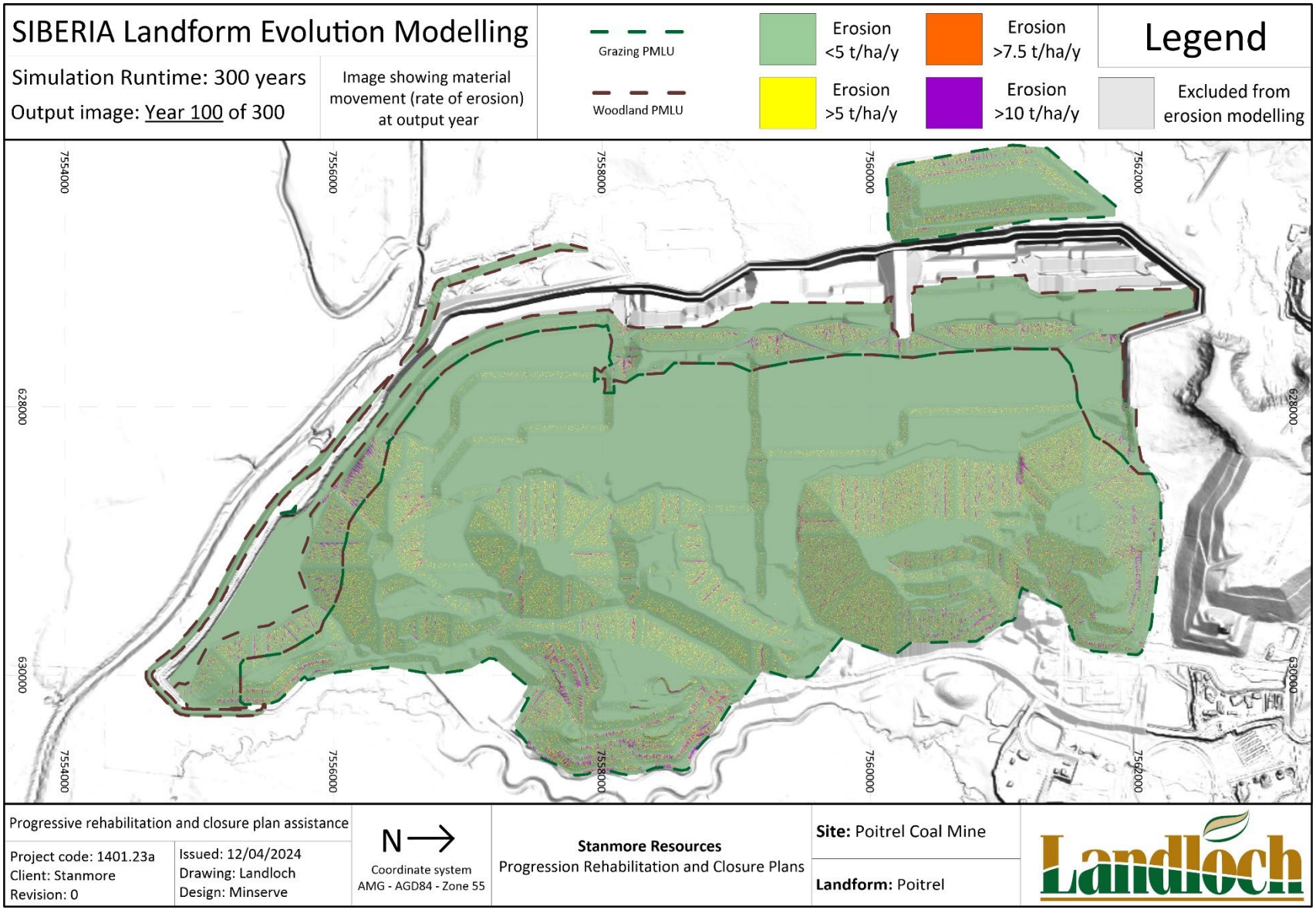

Figure B-6: Predicted erosion rates of the Poitrel 'dozer push' landform after 100 years.

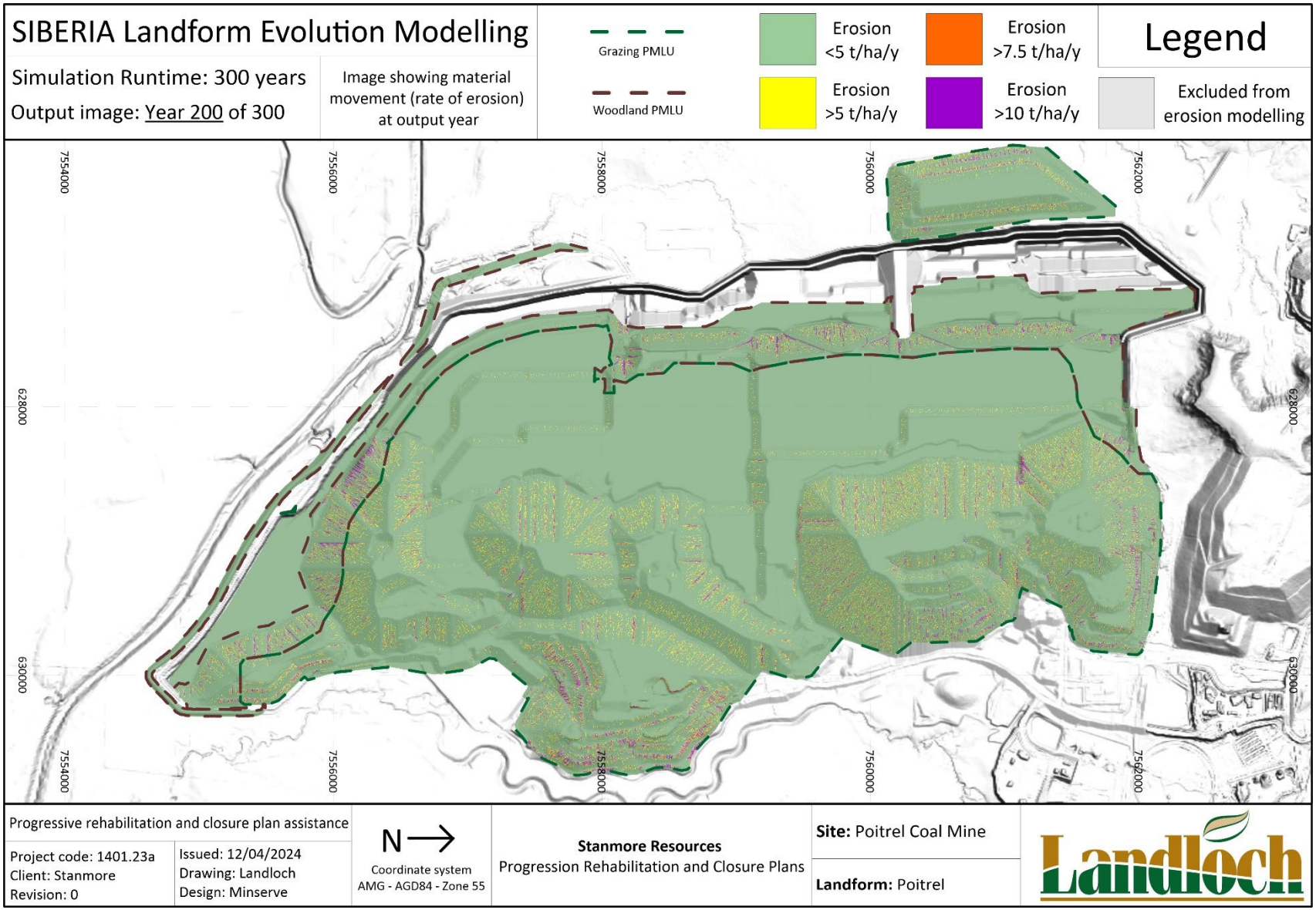

Figure B-7: Predicted erosion rates of the Poitrel 'dozer push' landform after 200 years.

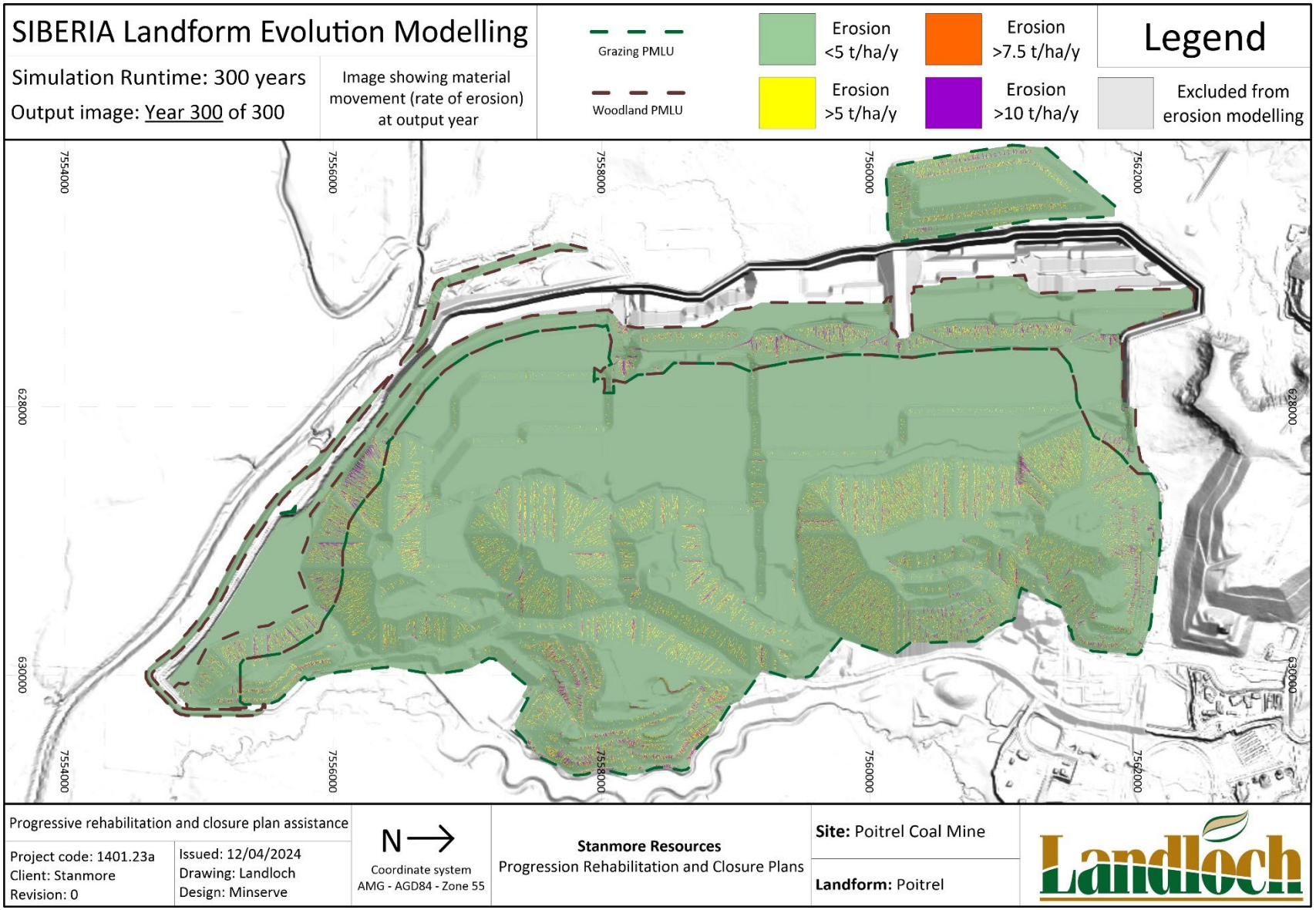

Figure B-8: Predicted erosion rates of the Poitrel 'dozer push' landform after 300 years.

Appendix 8 Void Closure Plan (1 July 2024)

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Void Closure Plan

Poitrel Mine

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Rev	Date	Details
A	24/05/2024	Draft for client review
B	24/06/2024	Draft for client review (high-wall geotechnical stability section updated)
B1	26/06/2024	Draft for client review (updates to flooding section)
0	28/06/2024	Final for submission
1	10/09/2024	Final for submission (update following not properly made notice)

	Name	Date	Signature
Prepared by:	Luke Johnston	10/09/2024	
Reviewed/approved by:	Raina Hattingh	10/09/2024	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

This document may contain confidential and legally privileged information, neither of which are intended to be waived, and must be used only for its intended purpose.

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Abbreviations

AEP	Annual exceedance probability
AHD	Australian height datum
AWBM	Australian water balance model
CHM	Conceptual hydrogeological model
CHPP	Coal handling and processing plant
CO_2	Carbon dioxide
CWS	Climate warming sensitivity
DBCT	Dalrymple Bay Coal Terminal
DES	Department of Environment and Science (now known as Department of Environment, Science and Innovation – [DESI])
EA	Environmental authority
EC	Electrical conductivity
ET	Evapotranspiration
FoS	Factor of safety
GCM	Global climate models
GDE	Groundwater dependent ecosystem
GW	Groundwater
ML	Mining lease
ML	Megalitre
NUMA	Non-use management area
PMF	Probable maximum flood
PMLU	Post mine land use
PRCP	Progressive rehabilitation and closure plan
PTM	Poitrel Mine
RCM	Rangal coal measures
RCP	Representative concentration pathway
RFC	Representative future climate
RMI	Red Mountain Infrastructure
ROM	Run of mine
TDS	Total dissolved solids
WBM	Water balance model
WBNM	Watershed bounded network model
WQO	Water quality objectives

1 Introduction

Stanmore SMC Pty Ltd, a subsidiary of Stanmore Resources Limited (Stanmore), owns and operates the Poitrel Mine (PTM), an open-cut coal mine in the central Queensland Bowen Basin. The mine is situated approximately 35 kilometres (km) east of the township of Moranbah, Queensland. PTM operates under Environmental Authority (EA) EPML00963013 on mining lease (ML) 4749 and ML70116.

Holders of an EA are required to submit a progressive rehabilitation and closure plan (PRCP) that meets requirements under the *Environmental Protection Act 1994*. A transition notice was issued to BHP Mitsui Coal Pty Ltd (as the previous owners of PTM) by the then Department of Environment and Science (DES)[1], requiring that Stanmore (as the current owners of PTM) submits a transitional PRCP for PTM. The date by which the transitional PRCP was required to be made was extended to 1 July 2024.

This void closure plan presents the outcomes of technical studies completed to support closure planning and achievement of a safe, stable and non-polluting residual void at PTM – specifically the residual void associated with the mining pits of Ramp 10, 20, 30, 40 and 50. This void closure plan is an appendix to the PTM PRCP and is required by the DES *Progressive rehabilitation and closure plan guideline* (version 3.0), hereafter referred to as the '*PRCP Guideline'*, dated 4 April 2023.

The technical studies, including the water balance and hydrogeology modelling, have been undertaken through an iterative approach with the development of the mine closure landform design. These iterations have resulted in a mine closure landform that includes residual void partial backfill and catchment reduction. This void closure plan documents how these refinements contribute to minimising environmental harm, as it related to the post-closure residual void.

It is also noted that Condition E7 of the EA requires the site to complete an investigation into residual voids, including at least the assessments provided in Table 1.1.Although the void closure plan does not constitute a record of compliance with Condition E7 of the EA, the supporting documented studies address the requirements of this condition. Management measures for the residual void are also identified to manage the closure of the voids in a way that does not cause environmental harm beyond the area of the relevant resource tenure (as required in Condition E6).

Table 1.1 Investigations required by Condition E7 of the EA and where they are addressed in the void closure plan

Investigations required by EA Condition E7	Section(s) in this void closure plan where addressed	Comments
— E7(a): A study of options available for minimising final void area and volume.	Section 2.2 Post-mining residual void optimisation	The five operational mining pits have been consolidated into one final residual void that is being transitioned as a pre-approved NUMA.
— E7(b): A void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long-term.	Section 3 Void water balance Section 5 Groundwater Section 7 Geochemical stability	-

[1] Now referred to as the Department of Environment, Science and Innovation (DESI).

Investigations required by EA Condition E7	Section(s) in this void closure plan where addressed	Comments
— E7(c): A pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events.	Section 6 Geotechnical stability	-
— E7(d):A study of void capability to support native flora and fauna.	Not applicable.	The proposed residual void is being transitioned as a NUMA.
— E7(e): A proposal(s) for end of mine void rehabilitation success criteria and final void areas and volumes.	Section 2.2 Post-mining residual void optimisation (final void dimensions). Section 5 Void water balance (final void water volumes).	Milestone (success) criteria are included in the PRC Plan and PRCP Schedule.

1.1 Scope and objectives

The PTM proposed mine closure landform design includes seven mining pits consolidated into one final residual void – Ramp 10/20/30/40/50 (herein referred to as the PTM residual void). Post-closure, this residual void is pre-approved as a non-use management area (NUMA).

The objective of this void closure plan is to document the rehabilitation and management approach showing how Stanmore will achieve safe, stable, and non-polluting residual void at closure. This void closure plan will also aid in:

- Minimising risk of the residual void and surrounding areas within the NUMA extents.
- Minimising active management of the residual void post-closure.
- Avoiding unmitigated access to the NUMA by humans and livestock.

The following sections present information as required by Sections 3.4 and 3.6.3 of the *PRCP Guideline*, specifically:

- Section 2.2: Post-mining residual void
- Section 3: Groundwater
- Section 4: Flooding assessment
- Section 5: Void water balance
- Section 6: Geotechnical stability
- Section 7: Geochemical stability
- Section 8: Residual void management

1.2 Applicable legislation and guidelines

The following applicable legislation and guidelines have informed the development of this void closure plan:

- *Environmental Protection Act 1994* (QLD).
- EA (EPML00963013) dated 1 March 2024.
- *PRCP Guideline* (version 3.0) dated 4 April 2023.

2 Site overview

2.1 Mining operations

PTM is open-cut coal mine in the Bowen Basin, located approximately 35 km east of the township of Moranbah, Queensland.

PTM targets the coal seams of the Rangal Coal Measures (RCM) via removal and stockpiling of topsoil, drilling, and blasting of overburden/interburden and stripping of overburden/interburden via excavator and truck/shovel to expose the coal seams. The overburden/interburden is placed back into the previously mined voids.

Run-of-mine (RoM) coal is transported to the Red Mountain Infrastructure (RMI) Coal Handling and Preparation Plant (CHPP) located on the adjoining ML70312 (which is operated under a separate EA - EPML0081911). Product coal is transported by rail to the Dalrymple Bay Coal Terminal (DBCT) for export. Coarse and fine rejects from the RMI CHPP are disposed of within the mining spoil within previously mined voids.

Mining construction/operations commenced in 2006. There are five mining pits that make up the mining operation - Ramp 10, 20, 30, 40 and 50. The current locations of these pits, overlain on the conceptual mine closure landform are depicted in Figure 2.1.

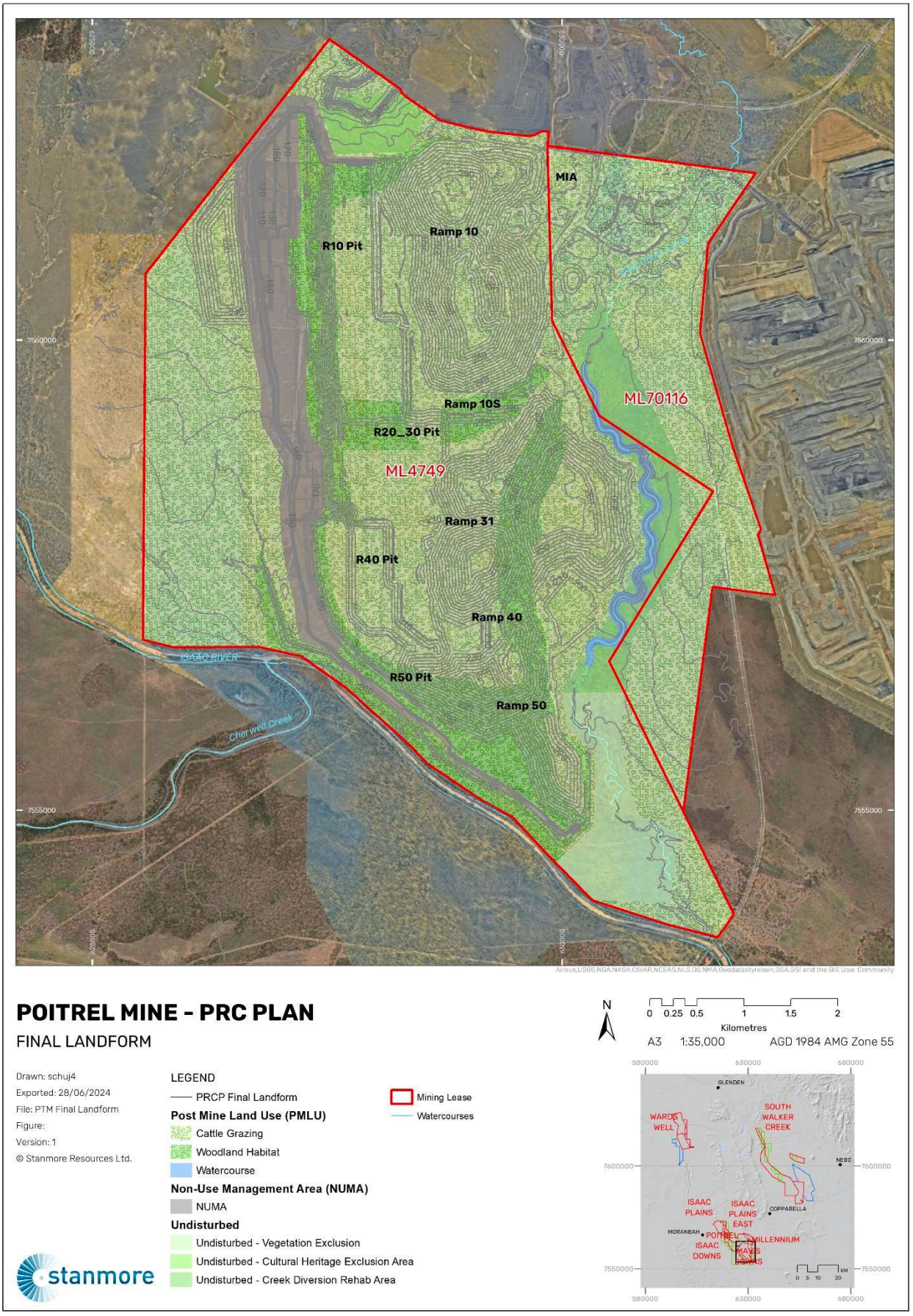

Figure 2.1 Location of current PTM pits in the mine closure landform (Stanmore, 2024)

2.2 Post-mining residual void optimisation

2.2.1 Context

Based on the final mine closure state topography, the five mining pits at PTM have been consolidated as part of PTM's mine closure landform into one residual void - Ramp 10/20/30/40/50 residual void. Consolidation into a single residual void was determined through an iterative process that considered:

- Current and comprehensive mine scheduling to optimise the life-of-mine and minimise the extent of the final void as a NUMA.
- Surface water catchment areas of the residual void and the resultant establishment of void lakes (Section 5).
- Groundwater modelling including the post-closure recovery of groundwater levels and void lake interaction with groundwater (Section 3).
- Geotechnical stability and any required set-back distances to achieve a physically safe landform (Section 6).
- The financial and environmental implications of achieving the final mine closure landform including resultant delays to timing of when areas may become available for rehabilitation (this section).

2.2.2 Base case

Based on the current mine plan, the closure year for the PTM residual void is 2036.

The presence of a residual void at PTM is authorised under Schedule E (Condition E6 and E7) of the EA and is being transitioned as a pre-approved NUMA in the PTM PRCP.

To optimise resource extraction planning, a base case life-of-mine plan was developed that represented the maximum efficiencies with respect to removal, loading and hauling of overburden material to an optimal location to gain access to the coal resource (Figure 2.2). This base case mine plan also considered the geological models (for overburden quantification) and current coal quality, both of which are subject to ongoing update as further drilling and coal sampling is undertaken.

The base case offered the preferred outcome for Stanmore as it:

- Minimises waste material re-handling and bulk push requirement following removal of the final coal, This subsequently reduces potential environmental impacts (such as additional carbon dioxide (CO_2) emissions) and accelerating areas available for rehabilitation.
- Is expected to result in similar environmental outcomes as the PRCP-proposed residual void option.
- Offers the highest Net Present Value (NPV).

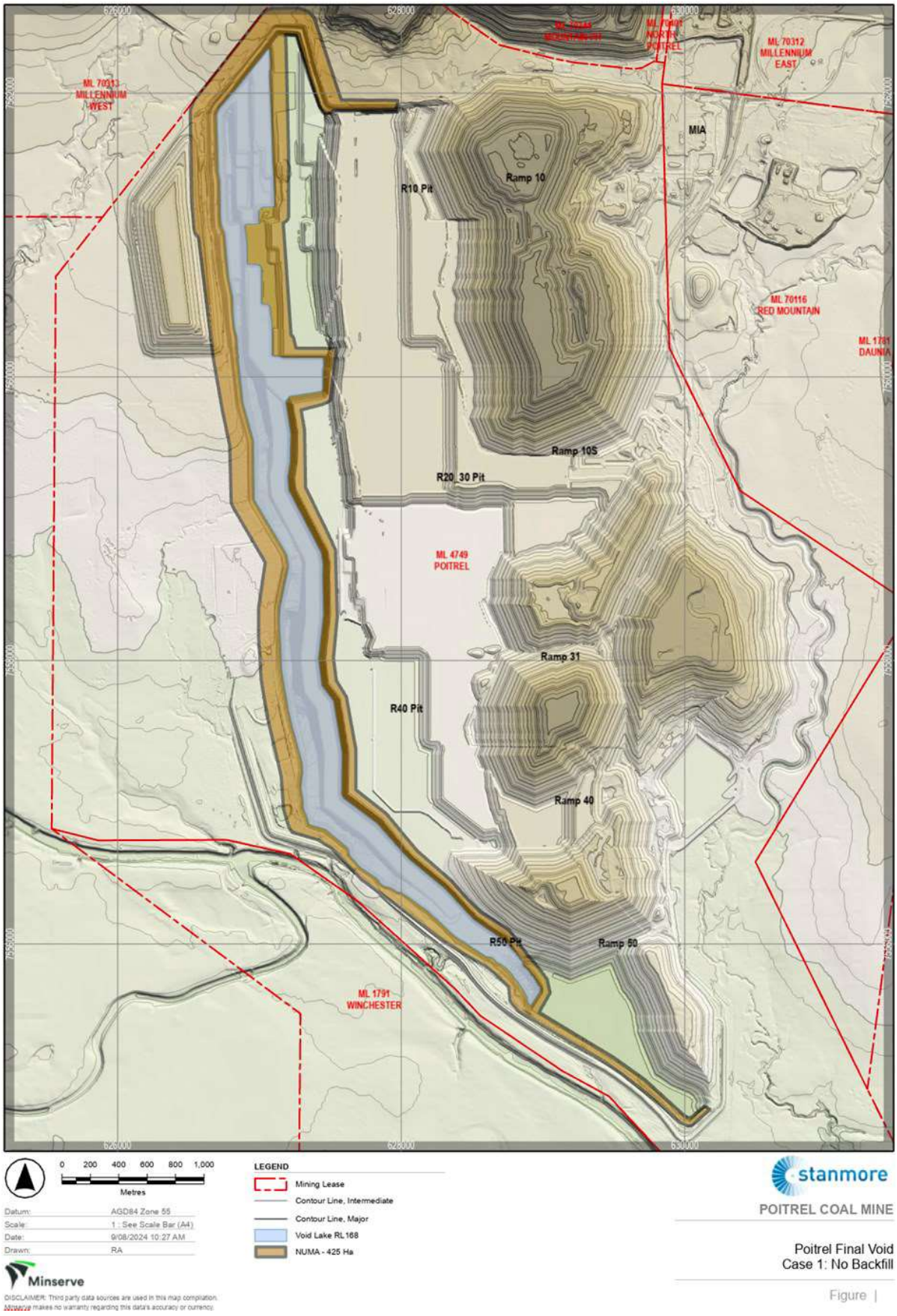

Figure 2.2 Base case life-of-mine plan void option for Poitrel mine (Minserve, 2024a)

2.2.3 Extent optimisation

Refinements to the base case were then considered necessary due primarily to the proximity of the proposed NUMA to the Isaac River in the south. An option to backfill the southern portion of the void (the R40 and R50 pits) was investigated, including a design where the southern voids adjacent to the Isaac River were backfilled to create a free-draining landform suitable for a PMLU (Figure 2.3). However, the following constraints were identified:

- Due to the topography and altered landscape from mining activities, this landform continued to drain to the remaining residual void. The resultant reduction in void volume and retention of catchment area from this landform option indicated, through the WBM, that the void lake levels would establish at a level where there could be interaction between void lakes and groundwater with the potential for environmental harm.
- The southern void section backfill option also resulted in a shortfall of material in the north of the mine with a final (extended) residual void area of 399 hectares (ha). To further reduce the void size for this option, re-handling of large amounts of waste material would be required. This material would need to be sourced from previously deposited material in existing dumps and most likely from material deposited earlier in the mine life, resulting in several hundred hectares of spoil not being available to be progressively rehabilitated until completion of the mine life. The availability of this area for rehabilitation could conceivably be a considerable amount of time after it would typically have become available for rehabilitation if not utilised for backfilling a pit at end-of-mine life. Due to increased haul distances required, this landform design would extend the mine life outside of currently feasible planning boundaries.
- The landform design could potentially sterilise available coal reserves.

Based on the above constraints, this option was not deemed viable for Stanmore's future mine planning or long-term management of environmental harm.

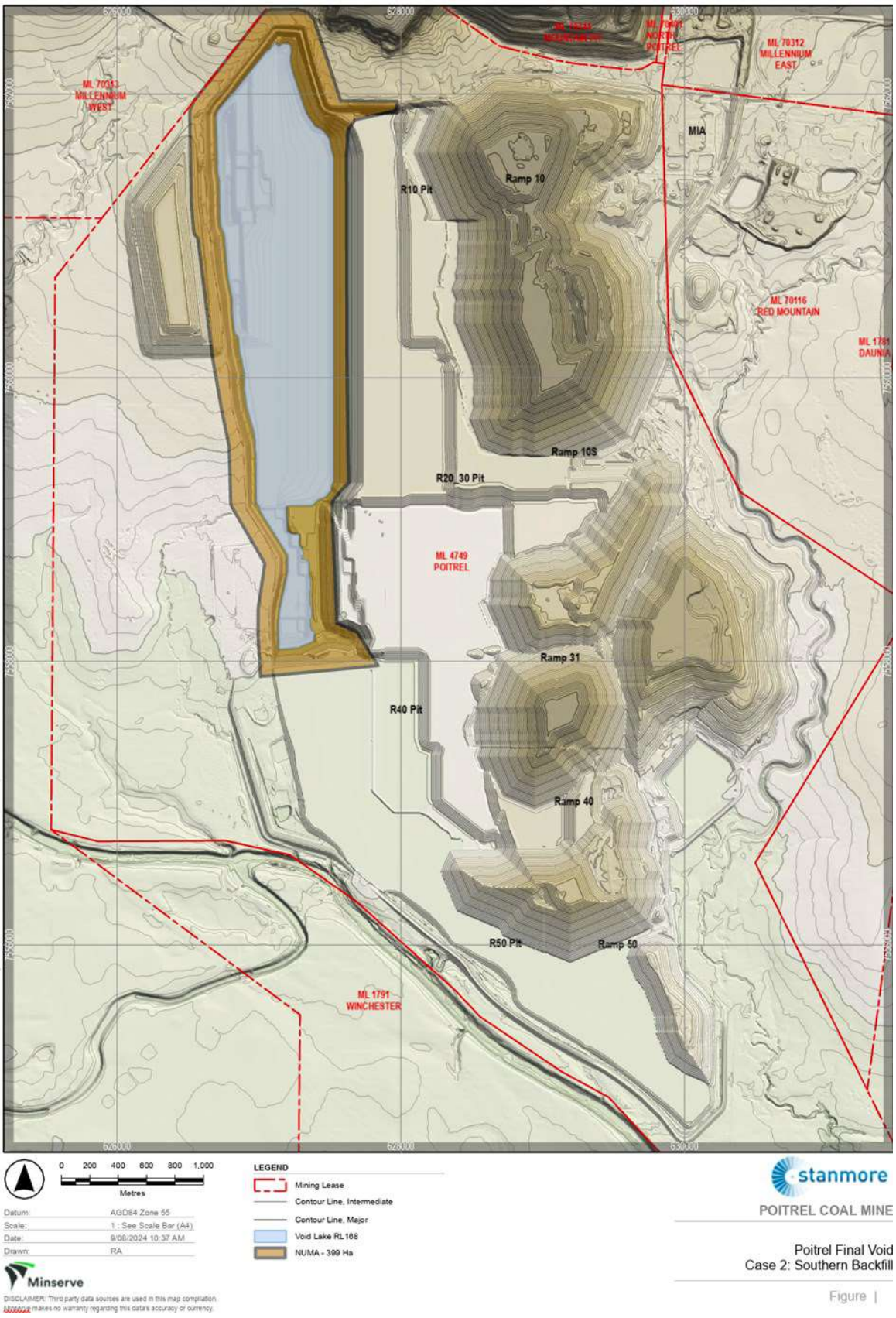

Figure 2.3 Southern void section backfill option for Poitrel mine (Minserve, 2024b)

2.2.4 Optimised residual void design

A summary of the various residual void options assessed and their resultant NUMA areas are presented in Table 2.1.

Table 2.1 Summary of residual void minimisation options for Poitrel mine and resultant NUMA areas

Residual void options considered	Resultant NUMA area (ha)
Base case	425
Southern backfill	399
Partial backfill	316

Based on the above, the planned closure landform for the mine pits includes provision for partial backfilling with spoil. Partial backfilling, spoil placement and drainage design will minimise the extent of the residual void, reduce the catchment area and assist with flood protection such that the potential for inundation of the residual void from floodwaters is greatly reduced (refer to Section 4). The level of backfill within the southern void section was informed by the groundwater assessment (Section 3) and water balance modelling (Section 5), aimed at designing a closure landform that:

- Reduces the likelihood for groundwater interaction with backfilled material in the void; and/or
- Avoids formation of a lake on top of the area where rejects are stored, thereby generating a hydraulic head and creating a likely source of contamination to the groundwater.

The residual void that was designed in the mine closure landform, and that has been included as the proposed option within the PRCP and the studies within this void closure plan has been developed through the above iterations, supported by the technical studies within this void closure plan, and achieves the following:

- Backfilling of the southern void section to a level (including capping considerations of reject material) where groundwater interactions are not expected to occur.
- Maximising the area allocated as a PMLU (adjacent to the NUMA extents) while factoring in slope safety and achievement of milestone criteria of the PMLU adjacent to the high-, end- and low-walls.
- Minimising the height and length of the remnant high-wall adjacent to the Isaac River.
- Establishing a residual void that behaves as a groundwater sink in the closure landform.

Due to the long-term closure timeframes, exploration drilling, coal quality and future coal prices will influence the dimensions and final locations of the pits and hence the final mine closure landform. Refinements to geotechnical stability assessments as the mine draws nearer to closure may also result in a reduction in NUMA areas, through refinement of safe set-back distances.

Indicative dimensions for the proposed residual void are presented in Table 2.2. A three-dimensional (3D) void design plan for the residual void, including equilibrium mean void lake level, is presented in Figure 2.4.

Table 2.2 Indicative maximum dimensions of the residual void at PTM

Residual void	Indicative maximum width (m)	Indicative maximum length (m)	Indicative maximum depth (m)
Ramp 10/20/30/40/50	795	12,000	145

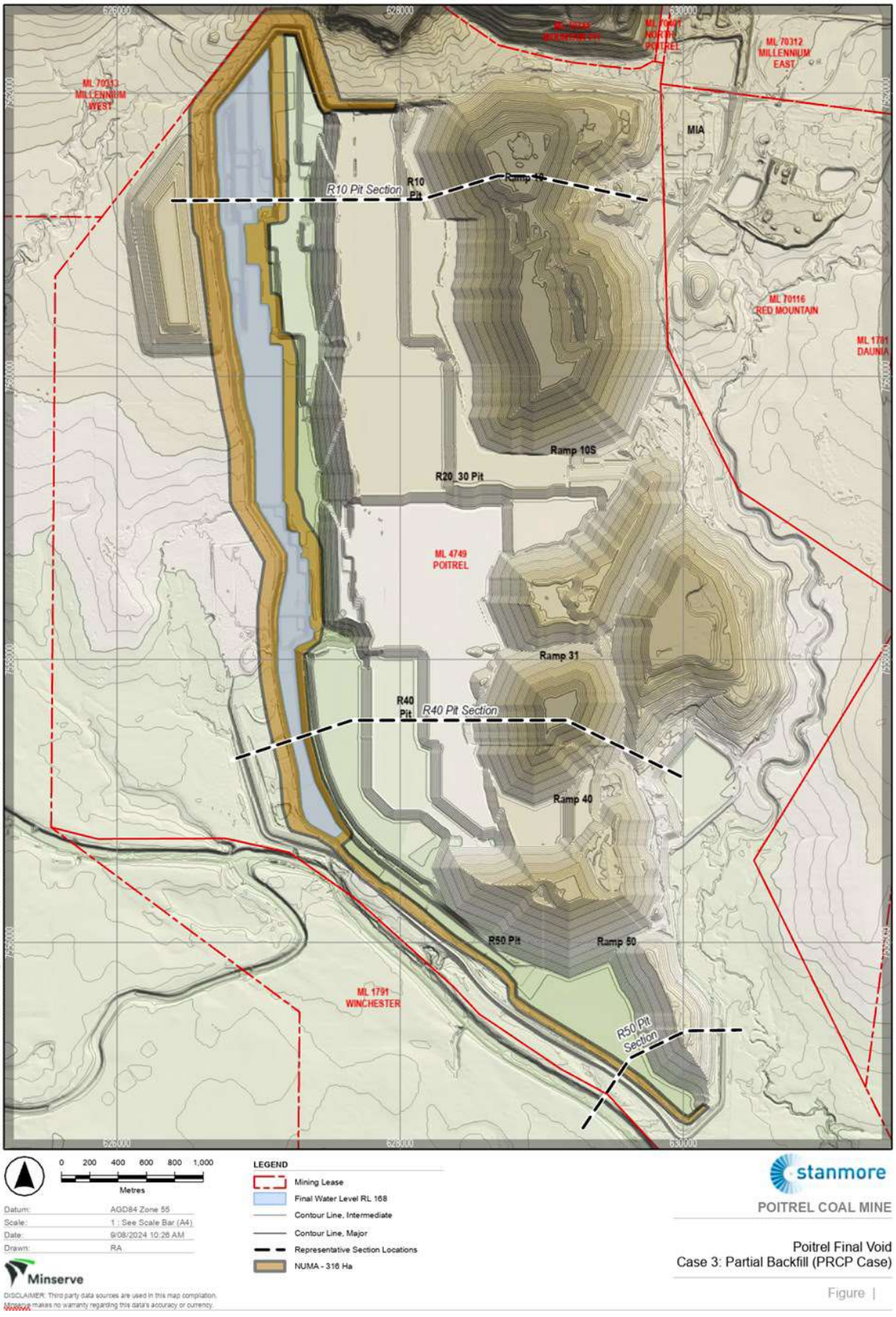

Figure 2.4 3D depiction of PTM residual void and indicative post-mining mean lake levels (Minserve, 2024)

3 Groundwater

A hydrogeological assessment was completed that included conceptual and numerical modelling to understand groundwater interactions with, and the potential for contaminant transport from the PTM residual void (SLR, 2024).

The complete hydrogeological assessment report - including details of the model set-up, calibration, and results is provided as an attachment to the PRCP. This section summarises the relevant context from the hydrogeological report relevant to required rehabilitation and management approaches to achieve safe, stable, and non-polluting residual void at closure.

A post-closure conceptual hydrogeological model (CHM) was developed depicting the groundwater interactions with the mine closure landform including the residual void. A visual representation is presented in Figure 3.1. The CHM key findings, relevant to post-mining groundwater impacts from the closure state landform, are as follows (SLR, 2024):

- Formation of a residual void lake was predicted, with lake water levels stabilising below both pre-mining groundwater elevations and shallow post-Permian strata including the base of surficial weathering and shallow hydrostratigraphic units (i.e., alluvium, Tertiary units and weathered regolith).
- Inward hydraulic flow gradients towards the residual void will be maintained within the RCM upon stabilisation of groundwater and residual void lake levels. This is driven by evaporative losses from the void lake, with no outflows of water to the surrounding hydrostratigraphic units predicted to occur.
- Infiltration of rainfall through in-pit spoil emplacements will continue to be captured in the residual void or remain within the spoil.
- There will be little to no impact on surficial aquifers, including alluvial aquifers beyond what has already been predicted at the time when mining is anticipated to end.
- There will be little to no impact on environmental or anthropogenic receptors.

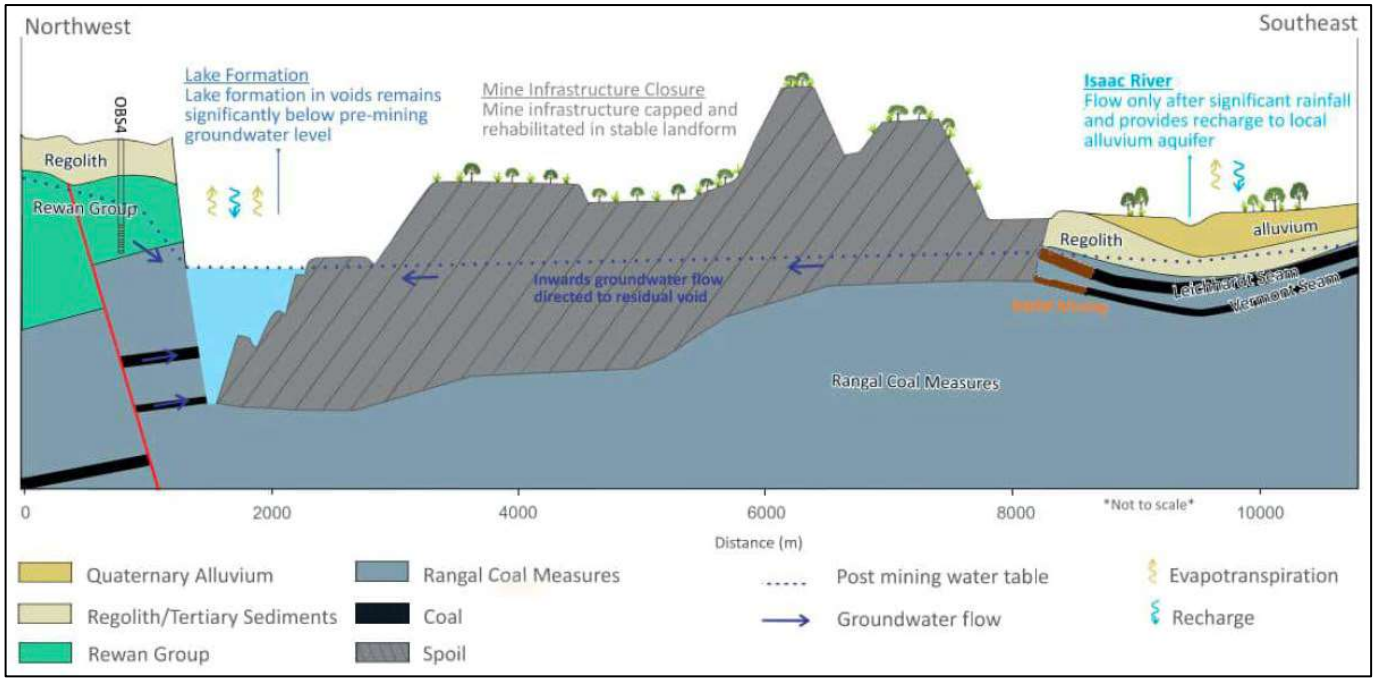

Figure 3.1 Post-closure conceptual hydrogeological model for PTM (SLR, 2024)

Calibrated numerical groundwater modelling and flow path simulation was undertaken to evaluate the potential groundwater-related impacts of the mine closure landform, including the residual void. The objectives of this modelling and simulation were as follows:

- Simulate the water level and rate of recovery of the residual void lake, and the water level and rate of recovery from mining-related groundwater drawdown in the groundwater system surrounding the void.
- Assess groundwater inflow to the final residual void.
- Identify areas of potential environmental or anthropogenic risk, such as impacts to private water supply bores or groundwater dependent ecosystems (GDEs), where groundwater impact mitigation/control measures may be necessary post-closure.
- Assess the potential for migration/flow pathways for contaminants and residual void water through particle tracking.

The proposed mine closure landform was replicated in the model, including the PTM residual void and spoil emplacements that will form part of the landform. The predicted end-of-mining groundwater head levels were applied as the starting head levels for the post-closure simulation. The model simulation period commenced at the end-of-mining and ran for 2309 years, with a total of 82 stress periods.

Climate-related boundary conditions for recharge and evapotranspiration (ET) were set constant for the duration of the model simulation period. Recharge and ET were not applied in the numerical groundwater model to the residual void itself as the water balance model (as described in Section 5) accounts for these boundary conditions.

There are periods of variability in inflows and outflows of groundwater predicted by the groundwater model for the PTM residual void over approximately the first 50 years post-mining. During this initial 50-year period, groundwater levels in the spoil and natural geological formations are recovering from mine dewatering activities and remain below the residual void lake level, as predicted by the WBM (see Section 5). Over this time, modelled groundwater fluxes to the residual void are largely controlled by the difference between the modelled residual void lake level and predicted groundwater levels in the spoil. The void lake levels rise and fall periodically according to the climatic simulation applied to the WBM, as well as how the daily timestep water balance results are translated to the comparatively simplified stress periods set up in the groundwater model.

Model results indicate that over this initial period, outflows derived from rainfall captured in the residual void flows to the in-pit spoil surrounding the residual void lake. This occurs as the groundwater levels in the surrounding in-pit spoil landform (and natural geological formations) slowly recover from mining activities. All predicted outflows from the residual void over this time occur to the spoil with no predicted outflow from the void to the natural geological formations or outside of the mine closure landform. By the end of the post-closure simulation, groundwater inflows and outflows to/from the residual void reach equilibrium (i.e. have stabilised to a constant value), with net inflows to the void occurring throughout the simulation period (Figure 3.2).

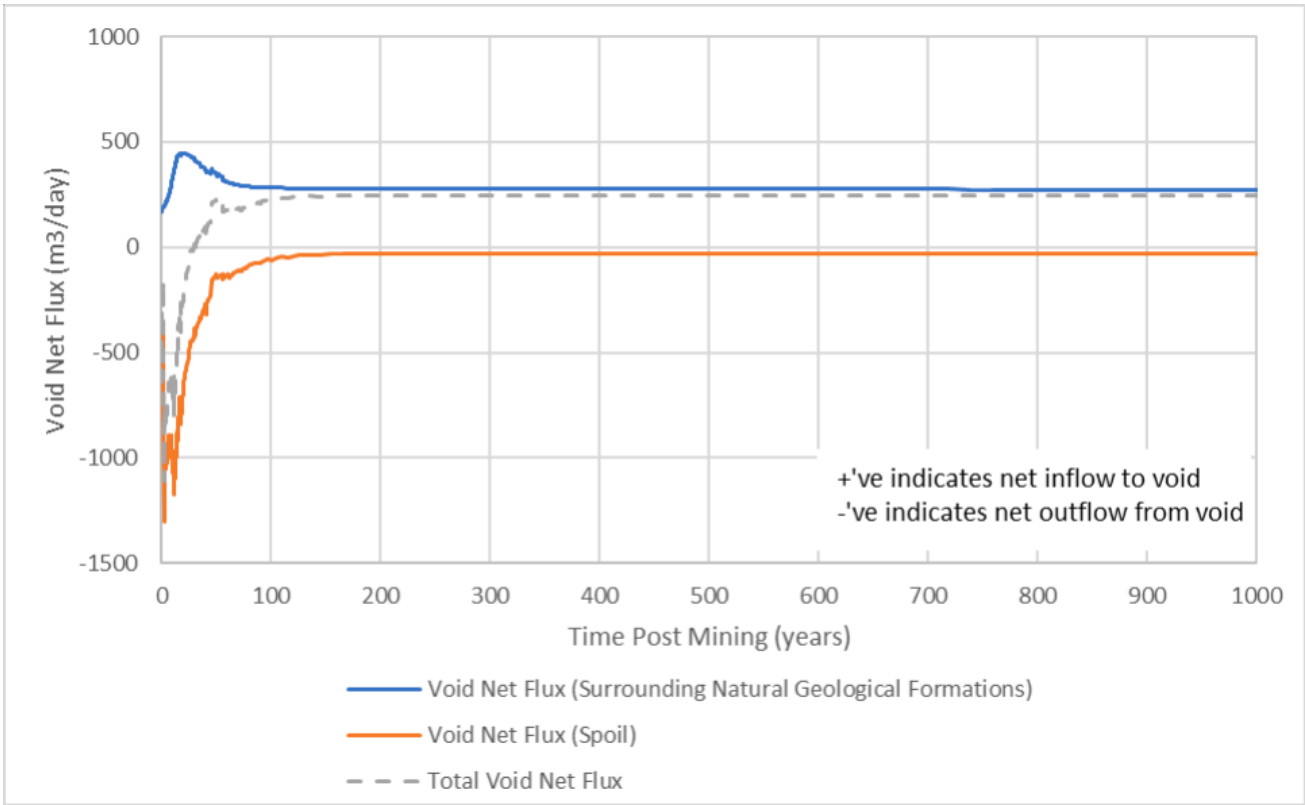

Figure 3.2 Predicted groundwater inflows to the PTM residual void (SLR, 2024)

Post-closure the water table is predicted to remain suppressed in the immediate vicinity of the residual void in the long term, except for the alluvium and regolith that are predicted to remain mostly dry (consistent with mining conditions), (Figure 3.3). Long-term groundwater flow gradients towards the residual void are maintained post-mining driven by the ongoing inflow of groundwater to the residual void lake and governed by the lake elevation itself. The groundwater hydraulic gradient towards the void is steep from the natural geological formations and relatively flat from the spoil towards the void. This is in part due to a larger residual head difference (<10 m) between groundwater in the natural geological formations and the residual void lake compared to the head difference between the spoil area and the residual void lake (<5 m). Hydraulic conductivities of the natural geology compared to the spoil are also lower, contributing to the steeper hydraulic gradient in the natural geological formations.

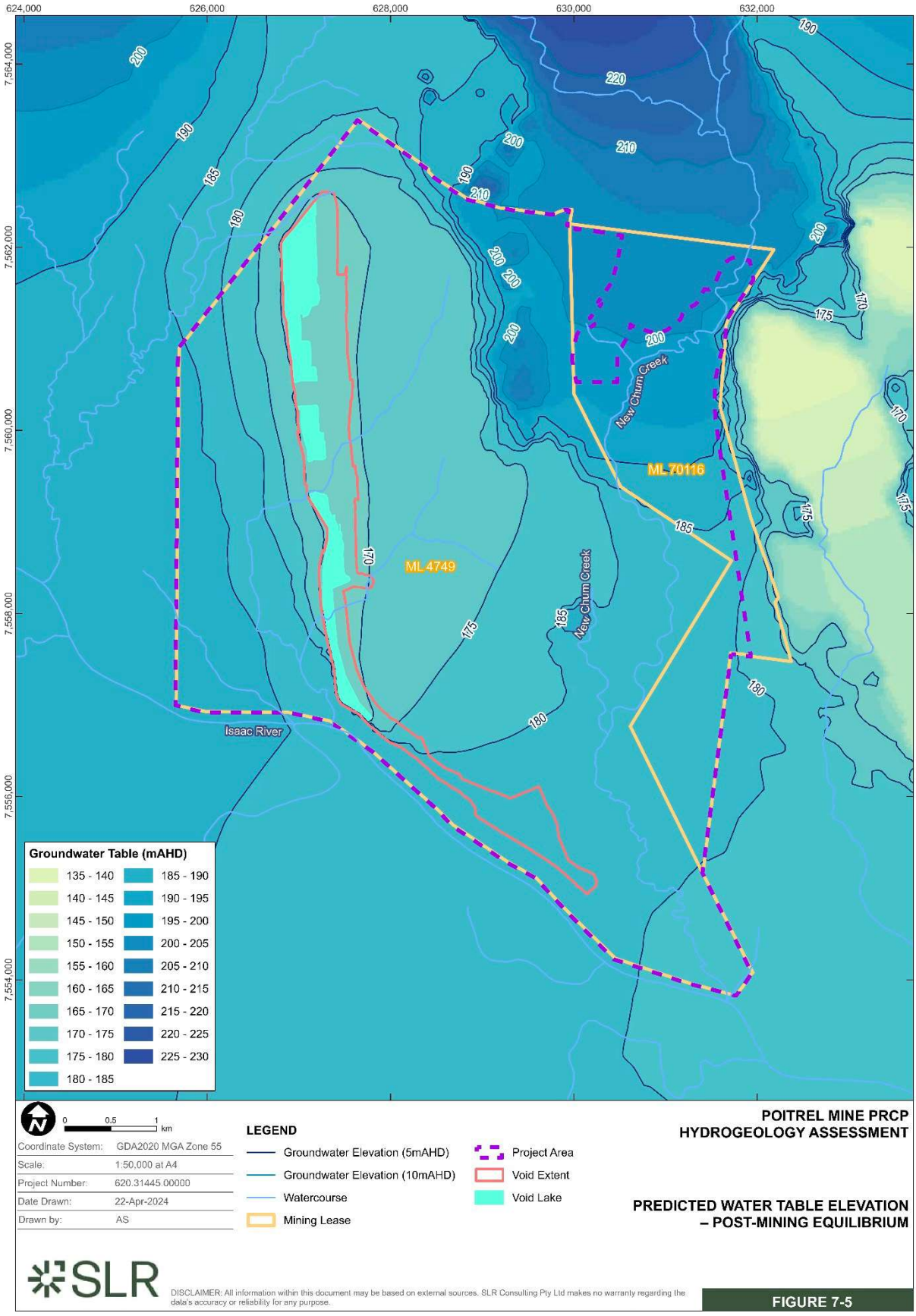

Figure 3.3 Predicted water table elevation at PTM – post-mining equilibrium (SLR, 2024)

Groundwater levels in the RCM are predicted to mostly remain below pre-mining conditions in the long-term; however, the post mining drawdown is not expected to be greater than that predicted during the operational mining period. Predictive hydrographs for the RCM seams in areas adjacent to the residual void show the change in groundwater levels over time (Figure 3.4 and Figure 3.5).

The hydrographs demonstrate that the vast majority of groundwater level drawdown in the RCM occurs as a result of operational mining activities with recovery of groundwater levels in the deeper coal seams (Vermont and Leichardt) adjacent to the PTM residual void occurring post-closure.

The predicted residual void lake level remains below the predicted groundwater levels for the duration of the modelled period indicating a low potential for outwards movement of void water to the RCM seams. The hydrographs also demonstrate very little effect on groundwater levels from the groundwater flow flux variability to the residual void in the initial 50-year period post-closure as discussed above.

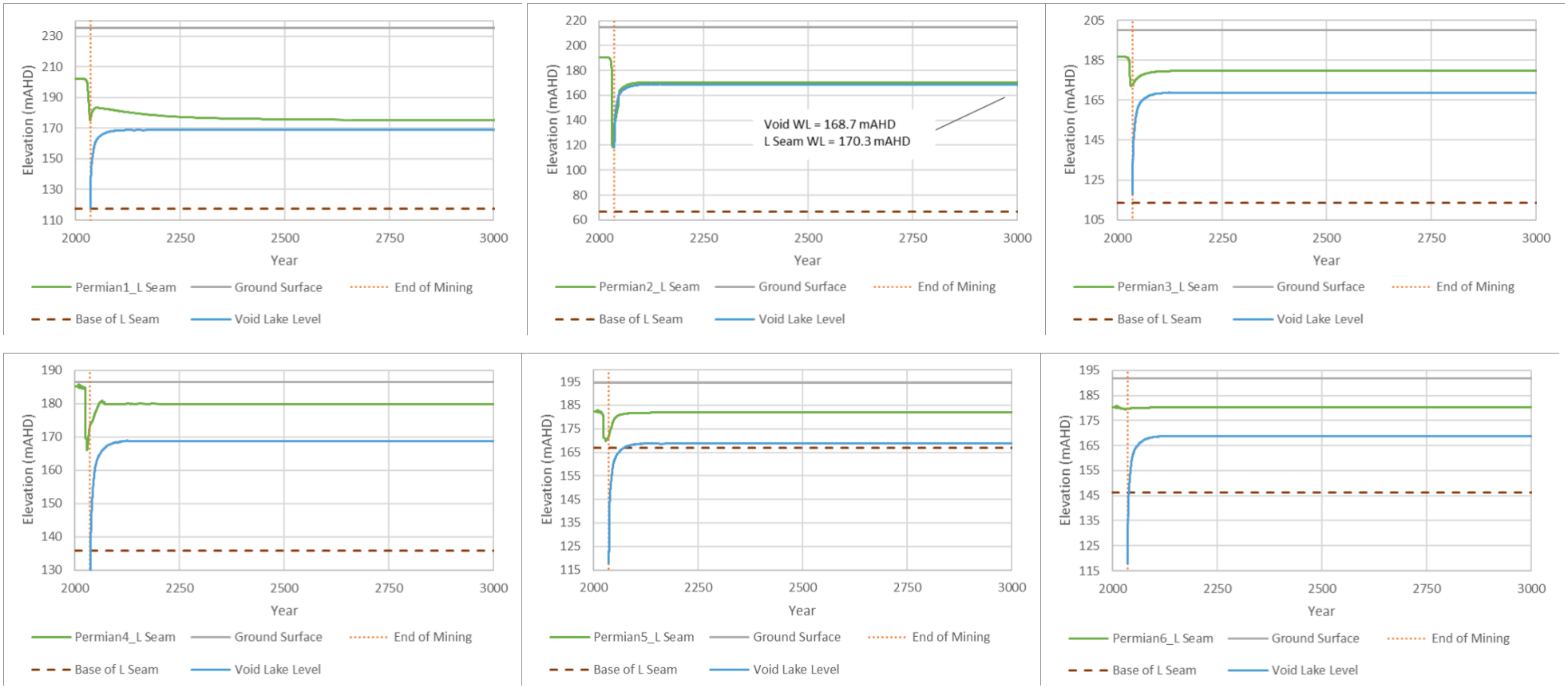

Figure 3.4 Predictive hydrographs for RCM Leichardt seam adjacent to the PTM residual void (SLR, 2024)

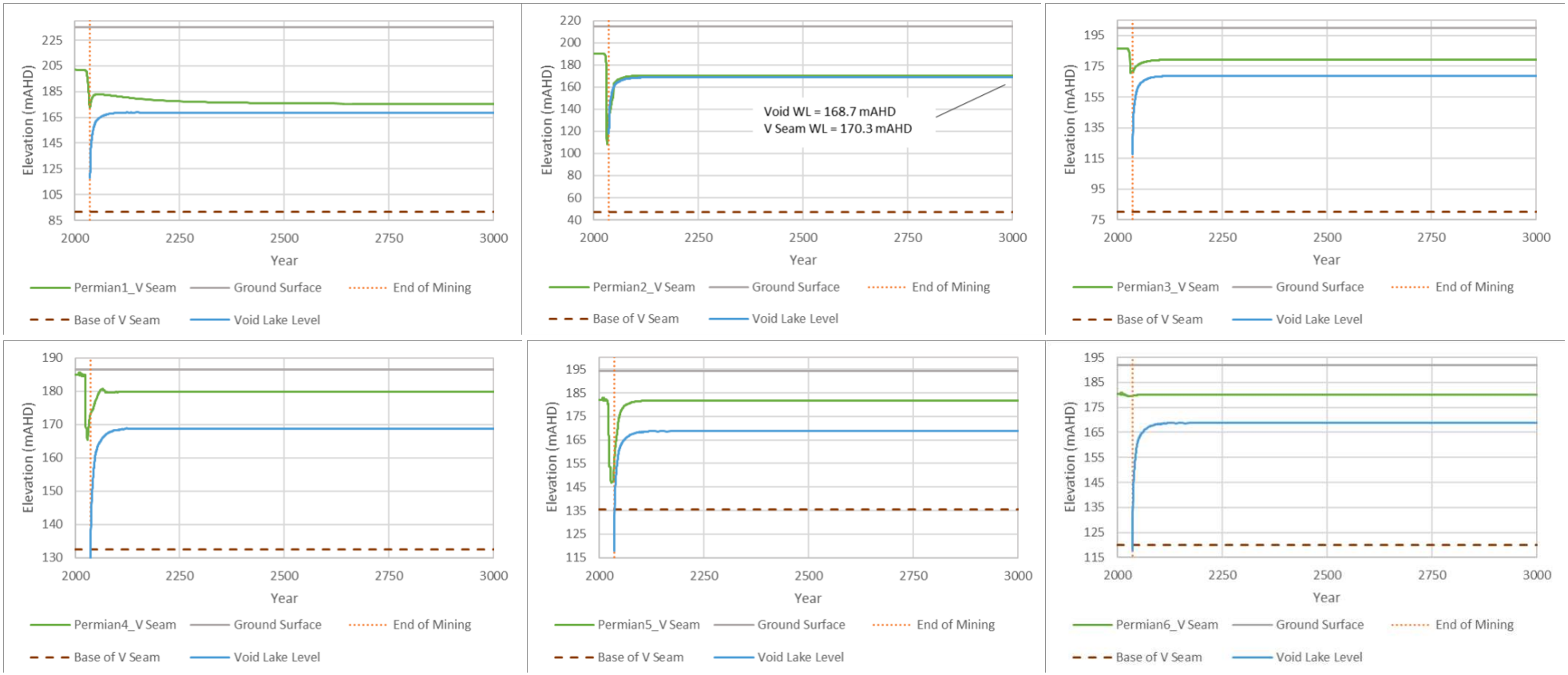

Figure 3.5 Predictive hydrographs for RCM Vermont seam adjacent to the PTM residual void (SLR, 2024)

Using the numerical groundwater model and the ‘mod-PATH3DU’ code, an analysis of the water movement within the mine closure landform was completed to simulate and assess the movement and fate of water particles through the groundwater system post-mining (SLR, 2024).

The particle movement simulation for particles placed within the residual void (Figure 3.6) indicated that groundwater at PTM will remain within the mine closure landform (i.e., rehabilitated in-pit spoil and residual void) in the long-term (SLR, 2024). This includes the modelled fluxes of water from the residual void to the in-pit spoil of the mine closure landform, with these particles returning to the residual void. The simulation also predicted that the void remains as a groundwater sink and the particles would not flow from the residual void off-site to the receiving environment. The particles placed outside of the residual void at the potential contaminant source, the MIA, are all captured within the residual void or remain within the mine closure landform for the duration of the post-mining simulation.

It is noted that the particle path lines generally follow predicted head gradients; however, at times they appear to be contrary to the head contours shown in the figure. The particle path lines are simulated from the start of the recovery simulation, yet the contours shown in the figure represent the head levels at the end of the recovery simulation period when groundwater levels have reached equilibrium. Hence, the figure shows the particles path during the transient head changes that are occurring throughout the recovery simulation period as void lake levels stabilise and the groundwater system partially recovers post-mining.

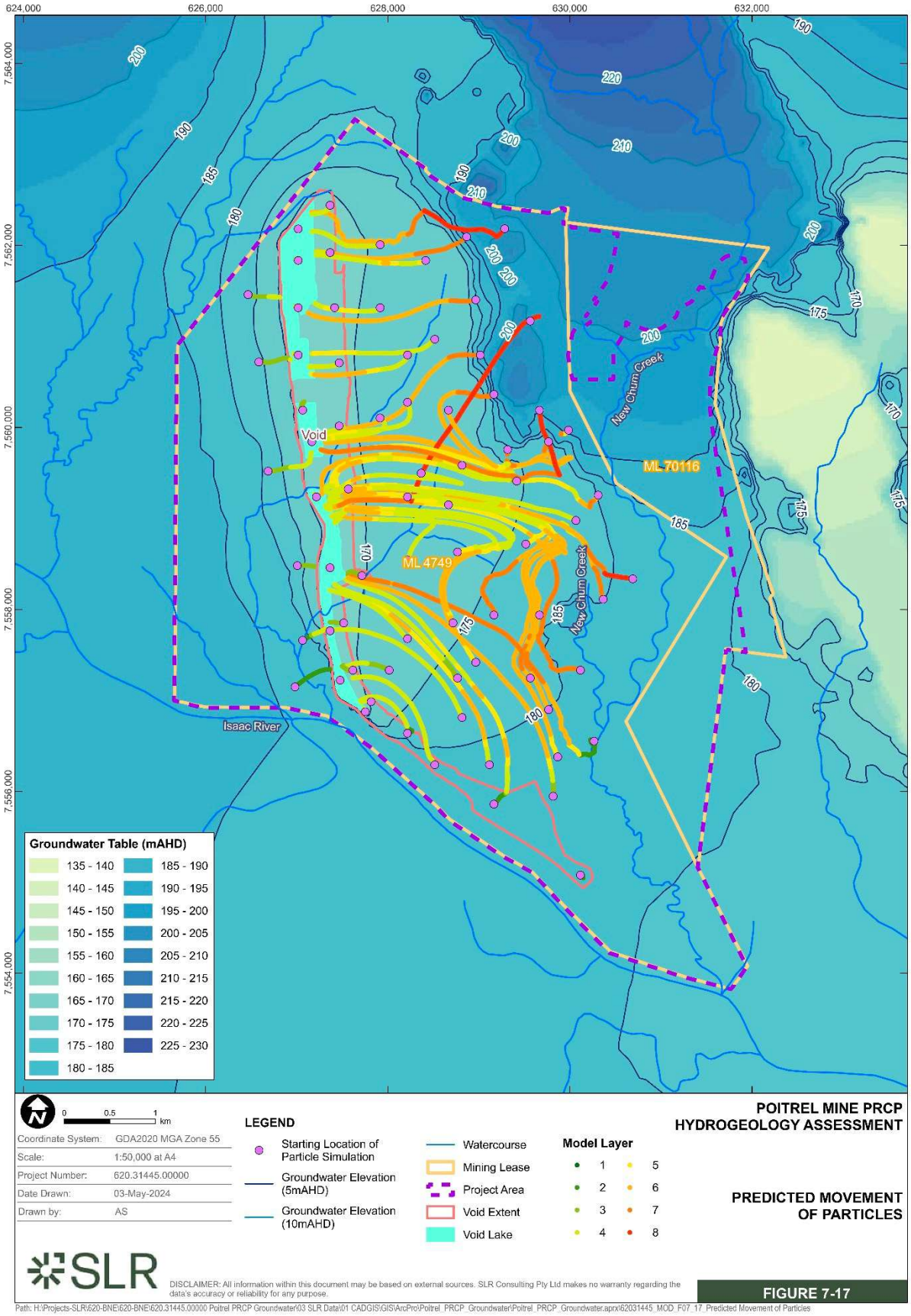

Figure 3.6 Predicted movement of particles from particle tracking simulation at PTM (SLR, 2024)

Although fluxes of rainfall-derived water captured in the residual void to the in-pit spoil is predicted to occur, no environmental harm is expected to result beyond that of the void itself from these minor outflows. This is due to the outflows to the in-pit spoil areas remaining within the spoil once groundwater levels and lake levels stabilise and net inward hydraulic gradients are predicted to prevail in the long-term.

This absence of environmental harm is supported by the groundwater modelling, particle tracking simulation, and the absence of third-party bores and GDEs within the spoil areas of the residual void. The water quality model (Section 7) also indicates that the water quality within the void is unlikely to establish acidic conditions, and the electrical conductivity (as Total Dissolved Solids (TDS)) for the residual void lake is not elevated above the EA trigger limit in approximately the first 150 years of the water quality model simulations. As such, any potential outflows to the in-pit spoil areas are considered to pose minimal risk to the environment if they were to eventuate as predicted. The predicted fluxes of residual void water to the in-pit spoil are also not expected to result in the milestone criteria of the spoil area post-mining land use (PMLU) not being achieved due to the expected depth from the spoil surface to the recovered groundwater level within the spoil.

Predictive hydrographs were derived from the groundwater model at the potential GDE sites identified within and adjacent to the PTM mining leases (Figure 3.7). The hydrographs (Figure 3.8) indicate that most water table drawdown in the vicinity of the potential GDEs is predicted to occur prior to the end of mining (i.e., associated with approved PTM mining operations). Any additional drawdown occurring over the post-mining period is predicted to be a result of continuing operational drawdown trends (i.e., a time lag from active mining), rather than new impacts caused by the mine closure landform design.

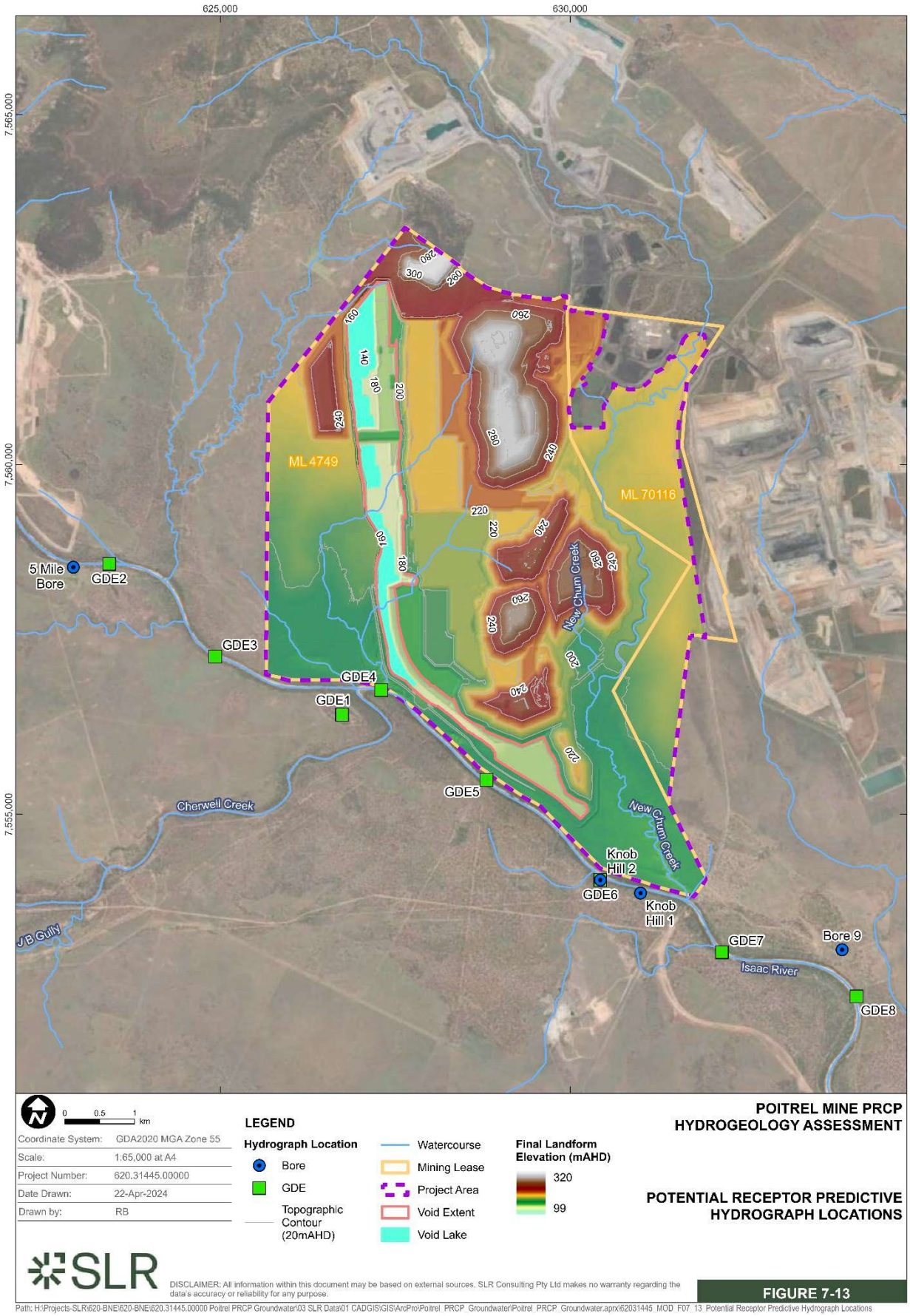

Figure 3.7 PTM predictive hydrograph locations of potential receptors (SLR, 2024)

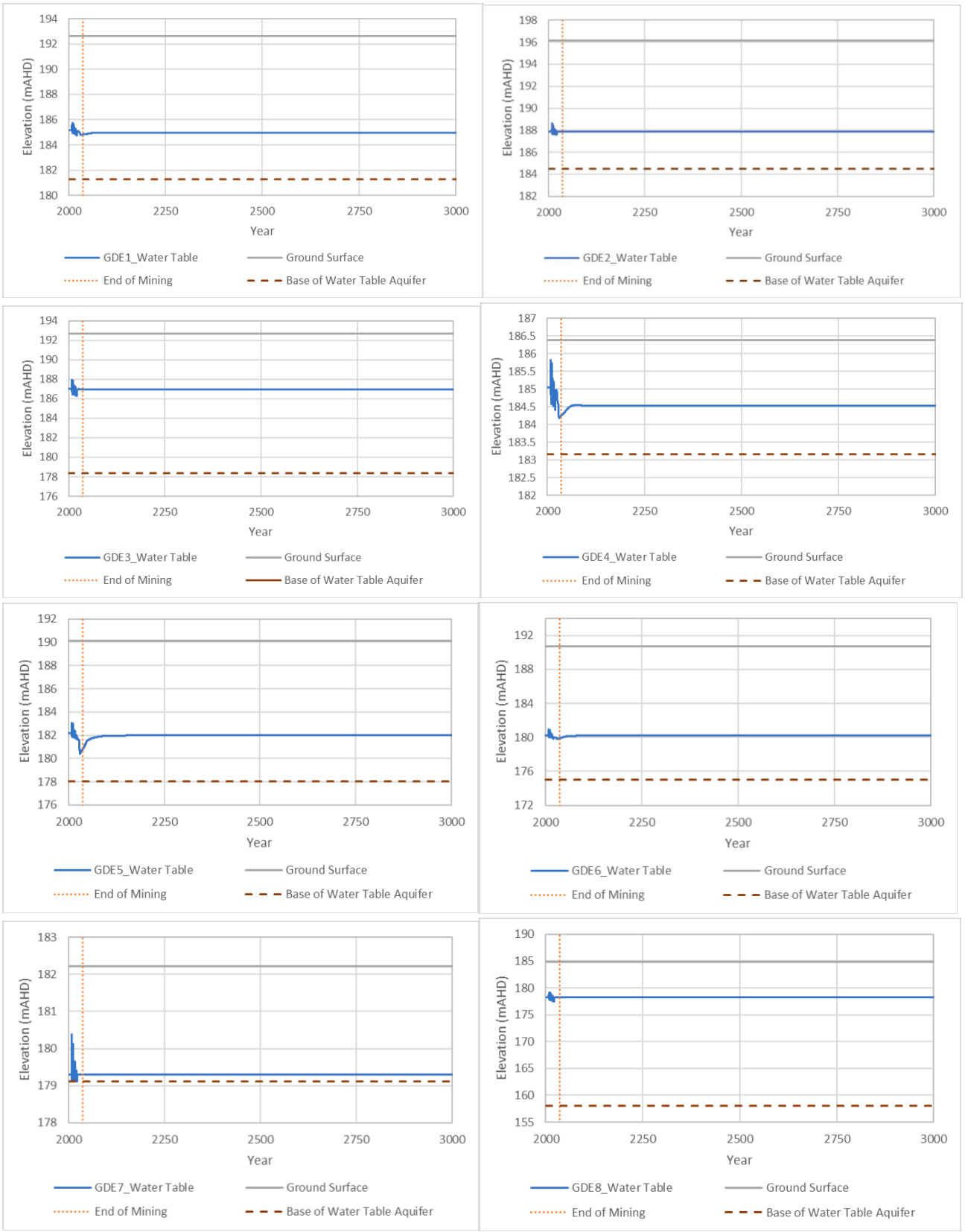

Figure 3.8 Predictive hydrographs for the potential GDE locations (SLR, 2024)

Predictive hydrographs were derived from the groundwater model for the four identified third-party water supply bores with sufficient information to attribute a source aquifer (Figure 3.7). The hydrographs (Figure 3.9) for all bores except 'Bore 9' show recovery of groundwater levels predicted in the post-mining period, i.e. there are no drawdown impacts attributable to the PTM mine closure landform. For 'Bore 9' there is predicted minor post-mining drawdown that is most likely related to continuing operational drawdown trends (i.e., a time lag following active mining ceasing) or regional-scale influences represented in the model (such as other third-party mining activities).

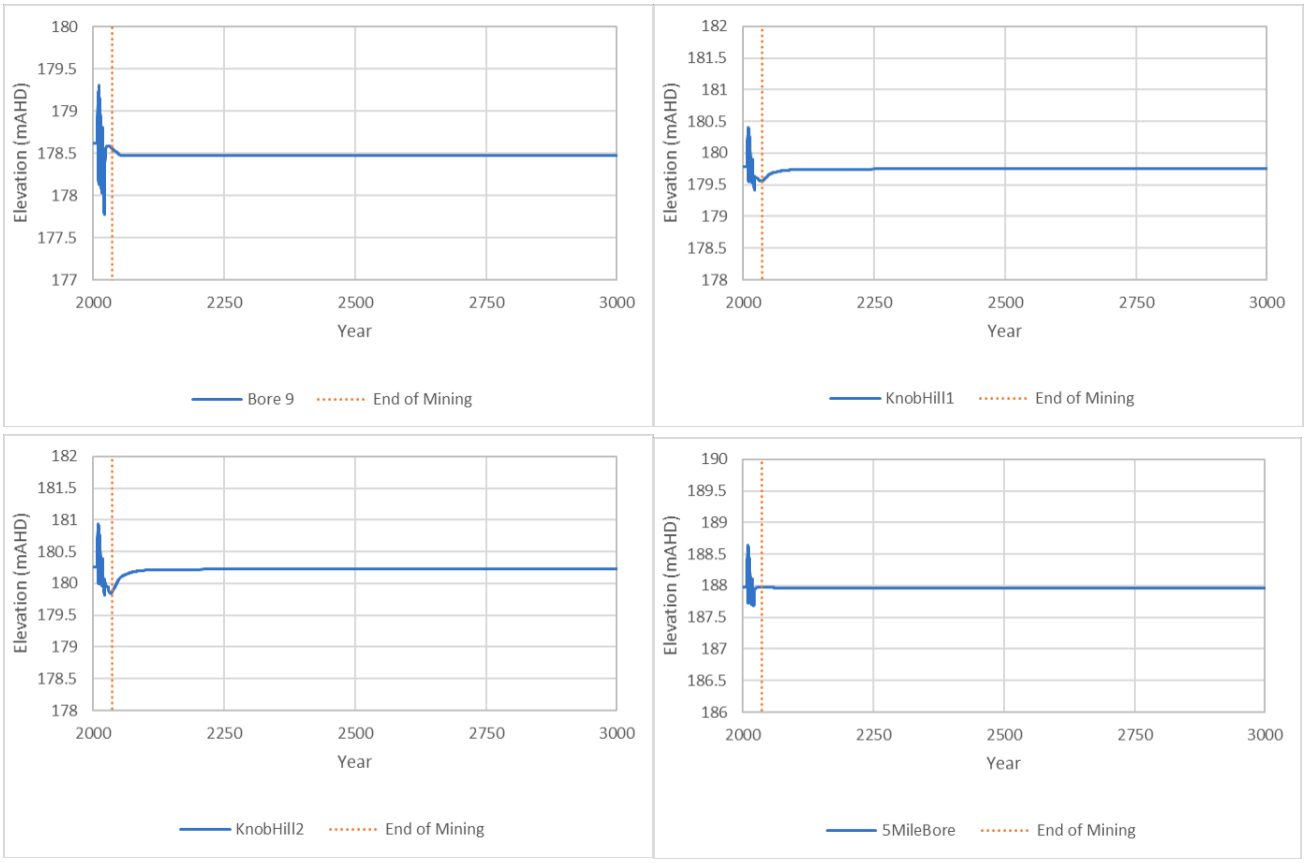

Figure 3.9 Predictive hydrographs for the potential GDE locations (SLR, 2024)

4 Flooding assessment

Flooding assessments were completed [(Engeny, 2024) (SLR, 2022)] to model the drainage and flooding behaviour of surface water in the vicinity of the PTM residual void (Ramp 10/20/30/40/50). This section presents the assessment findings, as relevant to void closure at PTM.

The complete flooding assessment reports - including details of the model set-up and results are provided as an attachment to the PRCP. This section summarises the relevant context from the flooding assessment reports relevant to required rehabilitation and management approaches to achieve safe and stable residual void at closure.

4.1 Voids in floodplains

In accordance with the DES PRCP Guideline transitional provisions, an assessment of voids in flood plains for the voids associated with the pre-approved NUMA of PTM was undertaken (SLR, 2022).

The floodplain assessment of the pre-mining landform identified that the pits would be located within the floodplains of the Isaac River (SLR, 2022).

For the mine closure landform, the extents of the residual voids modelled within the floodplain assessment will be reduced and refined through spoil placement, drainage design and placement of landforms/embankments to reduce the extent of void and flooding interactions.

4.2 Mine closure landform flooding

For the mine closure landform, rehabilitation flood modelling was undertaken on design storm events for a range of Annual Exceedance Probabilities (AEPs) including 1%, 0.1%, and Probable Maximum Flood (PMF) in accordance with the DES PRCP Guideline. This modelling and assessment predict the flood event inundation extent, depths and velocities for post-mining conditions.

Hydrographs generated from the hydrological model developed using Watershed Bounded Network Model (WBNM) were used to inform hydraulic modelling undertaken using TUFLOW software (Engeny, 2024).

The hydraulic modelling undertaken predicted the 1.0%, 0.1%, AEP and PMF event inundation extent, velocity, and depth of floodwaters within the mine closure landform (Engeny, 2024). The modelling has been interpreted to assess the flooding risk profile of the proposed mine closure landform.

Floodwaters from the Isaac River (to the west) as well as the approved New Chum creek diversion (to the east) are not modelled to interact with the current proposed mine closure landform associated with the residual void during a 0.1% AEP event. The flood assessment predicts that ingress of floodwaters is to occur into the southern end of the PTM residual void from the Isaac River (adjacent to the Ramp 40/50 pit) only during a PMF event (Figure 4.3) (Engeny, 2024). Floodwater ingress will require consideration during final design of exclusion bunding/embankments around the residual void high-walls in this location.

Flood velocities from the Isaac River floodwaters during PMF events that interact with the mine closure landform may contribute to scouring and/or erosion of the landform (Figure 4.4) (Engeny, 2024). Appropriate protection at locations where floodwaters of high velocities may interact with the mine closure landform will be considered and incorporated into the mine closure landform as the PTM residual void approaches closure.

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7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- >5.0

R	DETAILS	DATE
1	Final Issue	25-06-2024

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APPROVED	SB	DATE	25-06-2024

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0 1 2 km

Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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DATA SOURCE
QLD Government Open Data Source

ENGENY

stanmore

Figure 4.1 - Modelled peak flow depths for streams at PTM (0.1% AEP) (Engeny, 2024)

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-002

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7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

R	DETAILS	DATE
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Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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DATA SOURCE
QLD Government Open Data Source

ENGENY

stanmore

Figure 4.2 Modelled peak flood velocities for streams at PTM (0.1% AEP) (Engeny, 2024)

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-005

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7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- >5.0

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Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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Figure 4.3 Modelled peak flood depths for streams at PTM (PMF) (Engeny, 2024)

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-003

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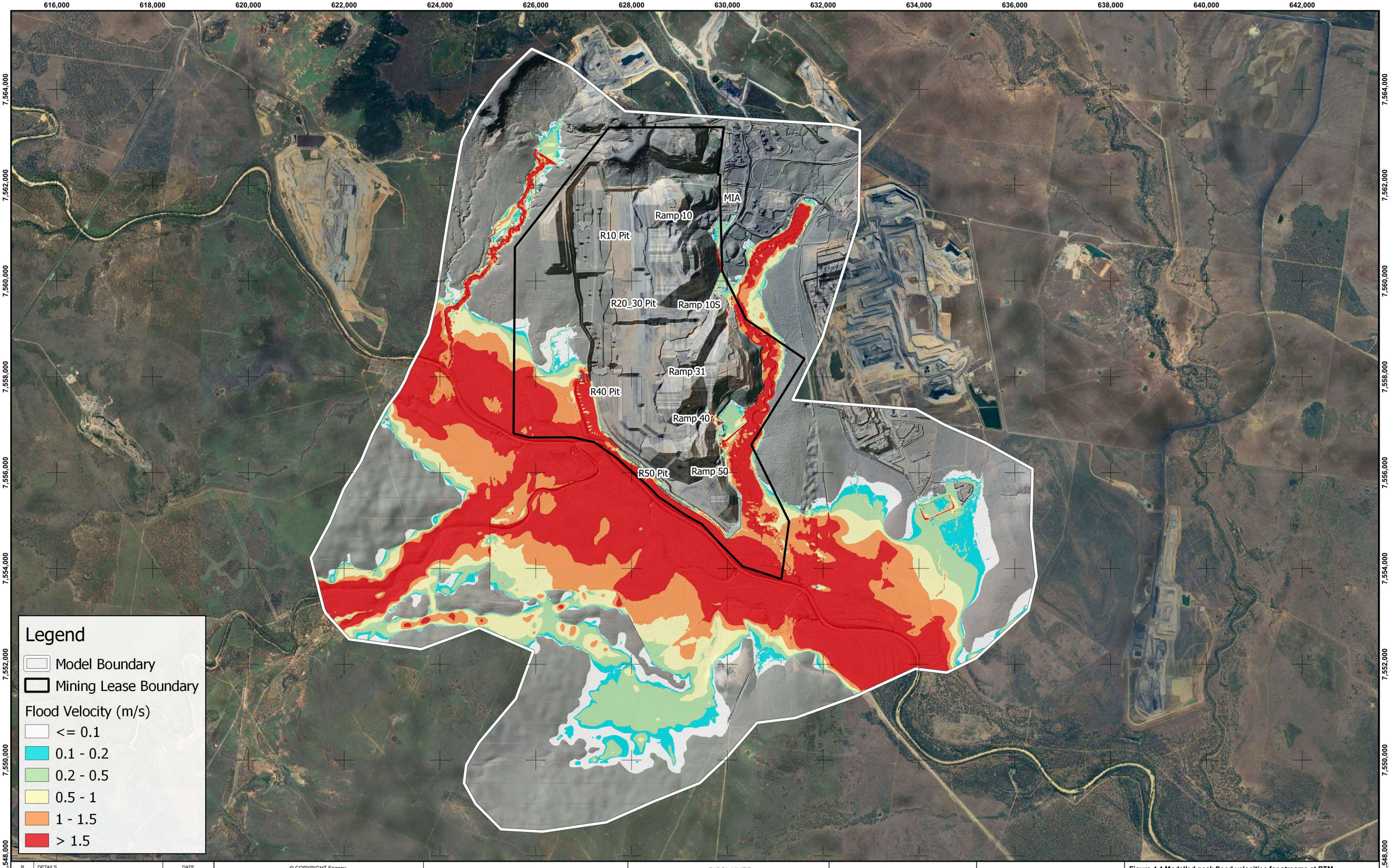

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Scale in metres (70,000 @ A3)
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DATA SOURCE
QLD Government Open Data Source

ENGENY

stanmore

Figure 4.4 Modelled peak flood velocities for streams at PTM (PMF) (Engeny, 2024)

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-006

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5 Void water balance

A water balance model (WBM) was completed by WSP to understand the possible hydrological closure risks associated with the PTM residual void. In accordance with the PRCP Guideline the WBM aimed to assess the following:

- Long-term water balance, formation of lakes, and predicted water levels in the residual void.
- Potential for residual void lakes to interact with regional groundwater aquifers (creating sources or through-flow systems).
- Potential for overflow from the residual void and subsequent release to surface water catchments.

The WBM also sought to inform separate assessments relating to geotechnical and geochemical stability of the residual void (findings from these separate assessments are presented in Sections 6 and 7, respectively).

5.1.1 Water balance model

The WBM was developed to estimate water volume fluctuation in the PTM residual void over time in response to changes in water inflows and outflows. Based on a conceptual understanding of the long-term hydrological behaviour of the residual void, possible water inflows were considered to include direct rainfall, surface water runoff and groundwater inflow (as either inflow or throughflow). Water outflows from the residual void included evaporation and outflows to groundwater.

The GoldSim software package was used to develop the WBM. The following conditions were included in the model set up:

- a daily time-step
- a model duration of 164 years (from 2036 to 2199)
- mine closure landforms achieved by end of 2035
- cessation of all mining operational processes (i.e., dewatering and pumping/transfers of water).

To estimate volumetric fluctuations in water in the residual void, the WBM adds all identified inflows and calculates the possible outflows for each time-step over the duration over the modelled period.

5.1.2 Catchment areas

Catchment areas were delineated for the PTM residual void (Figure 5.1) by generating elevation contours from the conceptual mine closure landform and calculating the drainage networks of each area. The selection of a single residual void was determined through the early stages of catchment delineation of the PTM mine closure landform. The smaller sections of the PTM residual void would spill to the other sections, hence forming one residual void at equilibrium.

Catchments for the residual void were subdivided into land use zones by analysing a slope map generated in the QGIS software package. The designated land use zones were as follows:

- ‘Natural’ zone: areas that will remain undisturbed throughout the mine life (based on the projected mine closure landform and the current topography of the area).
- ‘Void’ zone: the area of the residual void itself at the spill level (197 m AHD).
- ‘Rehabilitated’ zone: remaining catchment area for each residual void.

The resultant catchment areas are provided in Table 5.1.

Overtopping risk for the residual void was also assessed based on the generated elevation contours. The spill level of the PTM residual void is estimated as 197 m AHD.

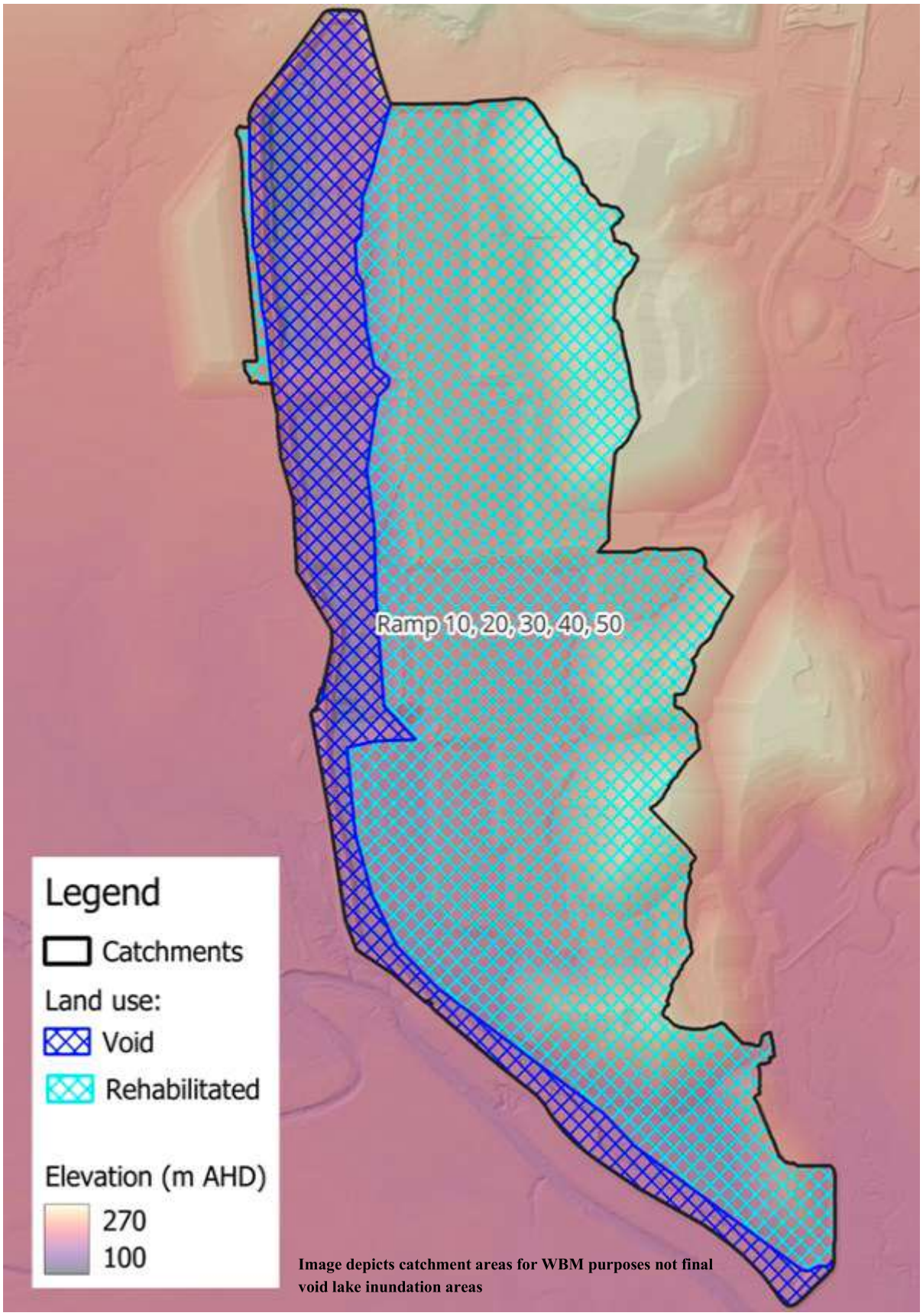


Figure 5.1 Catchment delineation for each land use zone applied to the water balance models for the PTM residual void catchment areas

Table 5.1 Catchment areas for each land use zone of the PTM residual void

Residual void	Natural (ha)	Void (ha)	Rehabilitated (ha)	Total catchment area (ha)
Ramp 10/20/30/40/50	0	333	1,109	**1,442**

Stage-storage relationships were derived using the mine closure landform to understand the correlation between the lake surface elevation and both storage volume and surface area of the residual void lake (Figure 5.2). Water levels in the residual void were assumed to be zero at the start of the simulations (i.e., dry conditions at cessation of mining). The results of this assessment were used in the WBM to estimate dimensions of the residual void lakes for each time-step modelled.

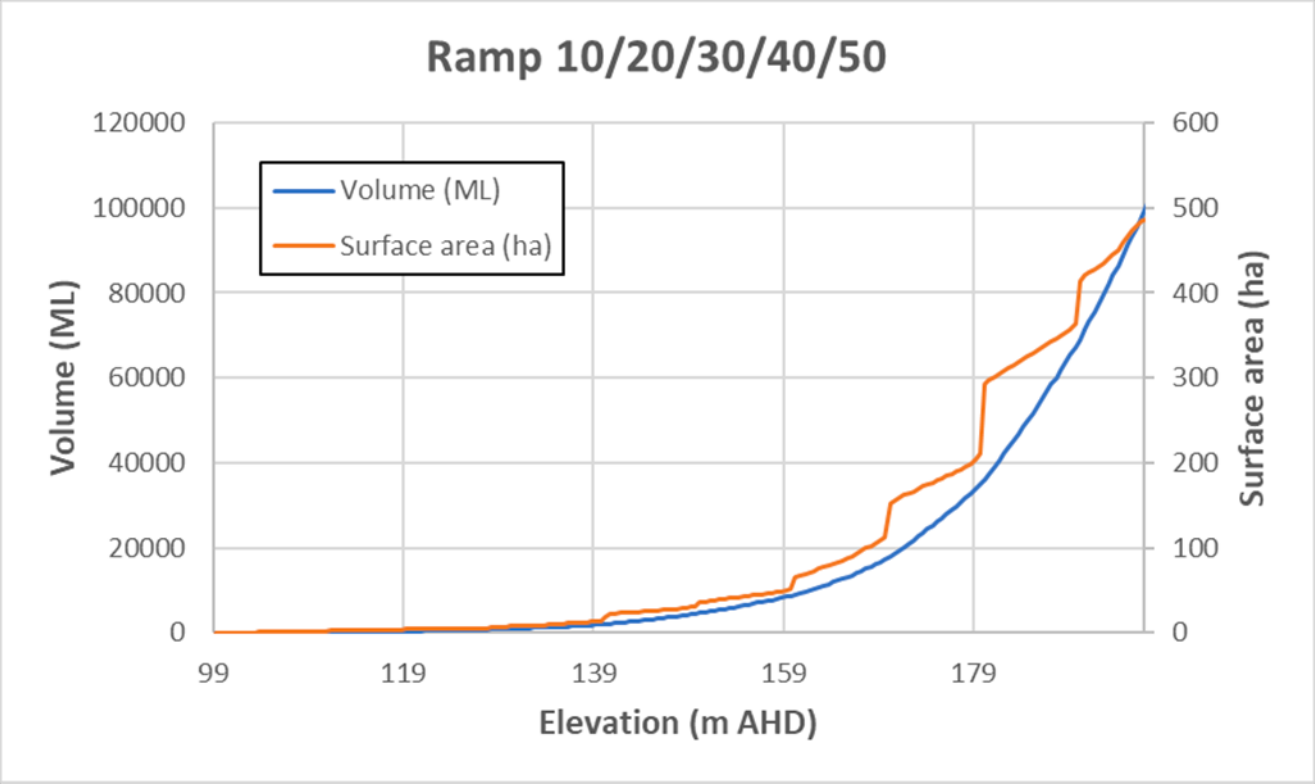


Figure 5.2 PTM residual void stage-storage relationship

5.1.3 *Surface run-off*

Runoff coefficients estimated from the PTM Australian Water Balance Model (AWBM) were used to understand the contribution of surface water runoff from each land use zone resulting from precipitation.

The runoff coefficients estimated from the AWBM are included in Table 5.2 as a percentage of rainfall.

Table 5.2 Runoff coefficients adopted in the WBM for the PTM residual void

Land use zone	Runoff coefficient (%)
Natural	15
Void	30
Rehabilitated	15

Surface water runoff does not include effects of high intensity and short duration events, and instead considers flows as daily average flows.

5.1.4 Climate change considerations

To enable a reasonable representation of future climate conditions, three synthetic climate projections were considered in the WBM, as follows:

- Representative Concentration Pathways (RCP): Projections of greenhouse gas and aerosol concentrations (pathways) and, together with land use change, are consistent with a set of broad climate outcomes adopted by the Intergovernmental Panel on Climate Change and used by the climate modelling community. RCP 4.5 and RCP 8.5 were considered.
- Global Climate Models (GCMs) grouped into four Representative Future Climate (RFC) categories: HI, HP, WI and WP, according to the global warming sensitivity and East Indian x West Pacific Ocean temperatures responses. The four RFC categories were considered for this analysis.
- Climate Warming Sensitivity (CWS): Estimates the sensitivity of the global temperature in response to carbon dioxide concentrations and are grouped into three ranges: Low (L), Medium (M) and High (H). All three ranges were considered.

Rainfall and evaporation time series data for the combination of the different climate projections were obtained from the Queensland Future Climate Portal (Queensland Government, 2023) for three pivotal projection years that were available at the time of the assessment (2030, 2050, and 2070). Historical data from 1960 to 2022 was also obtained.

The pivotal years represent the future average climate of a decade centred on the pivotal year - for example, the pivotal year of 2030 projects the climate from 2020 to 2039. As the data does not extend past the 2070 pivotal year, for the years from 2080 to 2199, the projections from the pivotal year 2070 were applied. The pivotal projection years were selected to project climate variation for the WBM simulation period.

The data presents the expected change in rainfall and evaporation based on the historical baseline period between 1960 and 2022. In total, combining the three different climate change considerations (RCP, GCM, and CWS), 24 scenarios for each pivotal year were assessed (total of 72 scenarios).

To simplify the WBM analytical processes, a single representative climate scenario for each pivotal year was identified. RCP8.5_M_HI5 was identified as the most representative of the 24 scenarios as the approximate middle point of the 24 available scenarios for each pivotal year.

Daily rainfall

The rainfall data from the three available pivotal year projections that were considered in the assessment for the simulation period are shown in Table 5.3.

Table 5.3 Rainfall data used for each simulated period in the PTM WBM

Scenario	Start date	End date	Period duration (years)
RCP8.5_2030_M_HI5	01-01-2036	31-12-2039	4
RCP8.5_2050_M_HI5	01-01-2040	31-12-2059	20
RCP8.5_2070_M_HI5	01-01-2060	31-12-2079	20
	01-01-2080	31-12-2199	120

The annual mean rainfall for the identified representative climate scenario for each pivotal year identifies an expected decrease in rainfall for this specific location considering the effects on climate change (Table 5.4).

Table 5.4 Annual mean rainfall data for historical data (1960 to 2022) and each pivotal year

Month	SILO Historical data	Pivotal year 2030	Pivotal year 2050	Pivotal year 2070
Annual mean (mm)	576	564	552	539

For the WBM simulations, probabilistically generated estimates of daily rainfall were applied using 100 realisations of stochastic rainfall for forecast modelling, from 2036 (expected closure year for the final pit within the PTM residual void) through to 2199 (the end of the simulation period). Figure 5.3 presents the daily maximum rainfall considered in the WBM simulations.

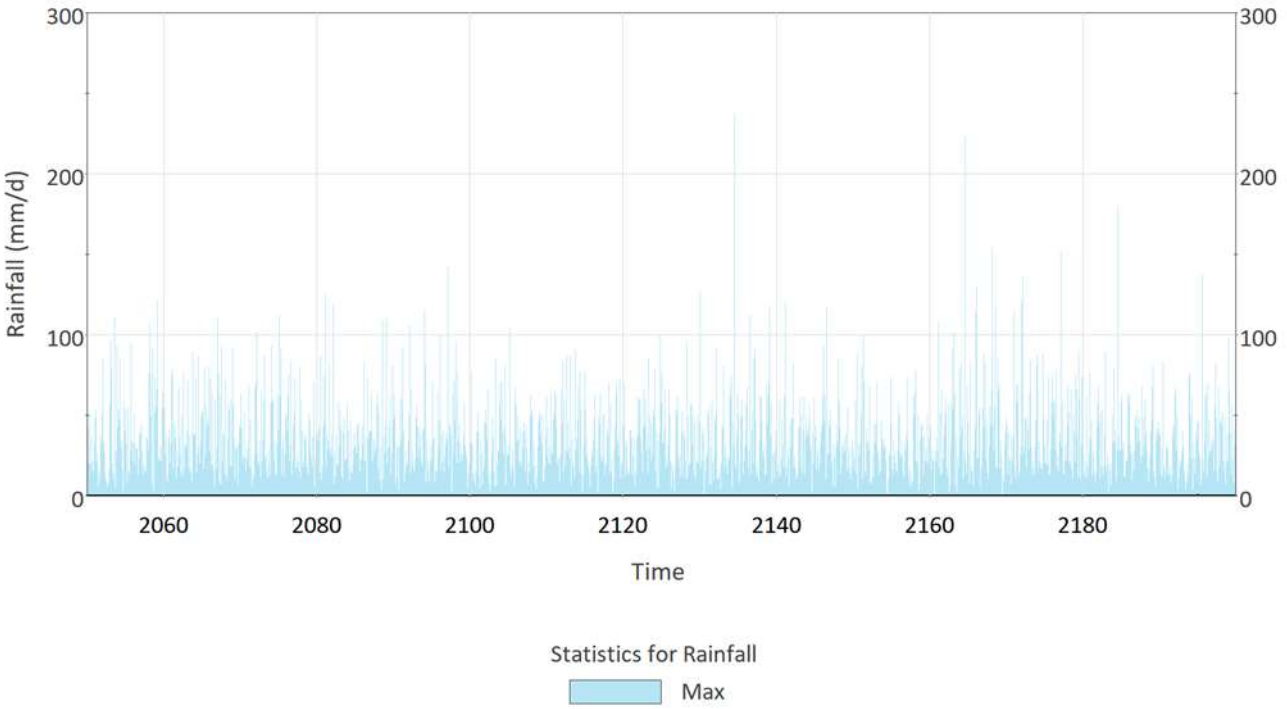


Figure 5.3 Daily maximum rainfall presented in the PTM WBM

In this way, the WBM allows estimates of the water elevation accounting for a level of uncertainty associated with the input rainfall.

Evaporation

The evaporation inputs for the WBM were considered as the percentage change of average monthly evaporation between the climate change time series data and the historical data from 1960 to 2022. The percentage change (increase) of evaporation obtained for each pivotal year is presented in Table 5.5. The percentage increase in evaporation is applied to the historical data to generate evaporation inputs to the WBM that account for climate change.

Table 5.5 Percentage change of average monthly evaporation for each pivotal year applied to the PTM WBM

Month	2030	2050	2070
January	3.3%	6.9%	11.3%
February	3.4%	7.0%	11.4%
March	3.6%	7.5%	12.3%
April	2.2%	4.7%	7.7%
May	2.2%	4.1%	6.8%
June	1.3%	3.3%	5.5%
July	0.8%	2.4%	4.0%
August	0.5%	1.6%	2.8%
September	1.9%	3.9%	6.4%

Month	2030	2050	2070
October	1.9%	4.0%	6.4%
November	3.0%	6.1%	9.9%
December	2.3%	4.9%	7.9%

As presented in Table 5.4 and Table 5.5, on average the expected effects on climate change consist of an increase in evaporation and decrease in rainfall for this specific location.

5.1.5 Groundwater flows

Groundwater inflows to the residual void, as discussed in Section 3, are predicted to equate to approximately 3% of the total volumetric inflow (SLR, 2024). Surface water fluxes act as the dominant driver on final void water levels. The modelled groundwater inflow rates used as inputs to the WBM are presented in Figure 3.2.

5.2 Water balance model outcomes

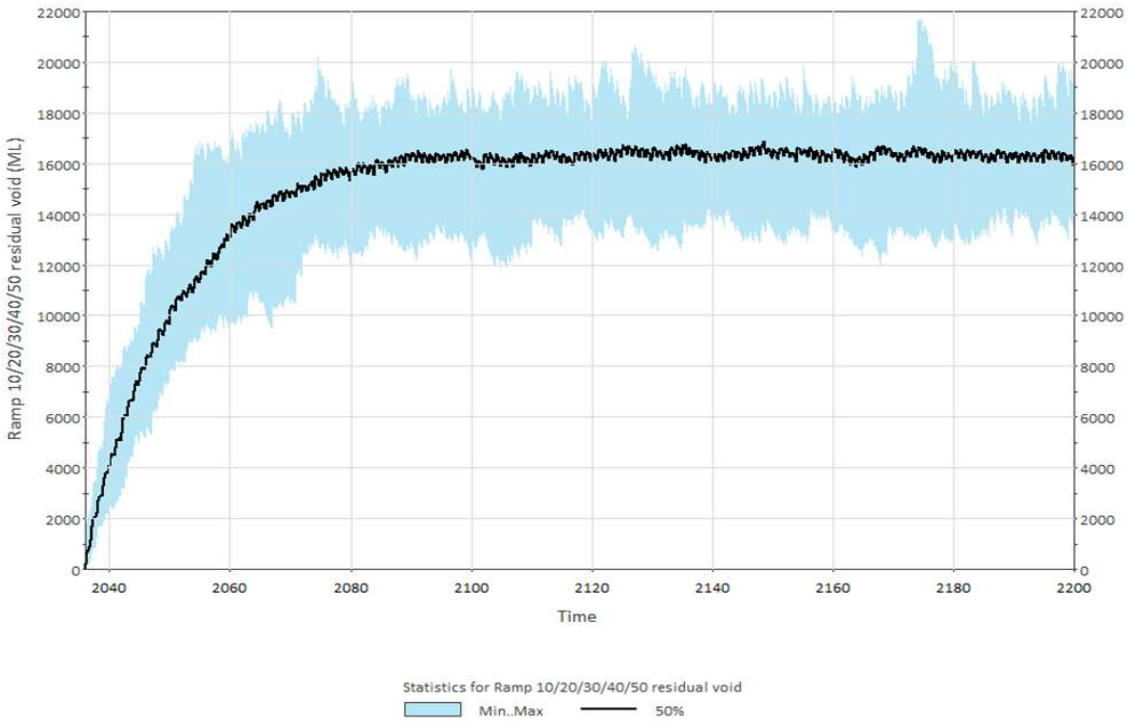
Following the WBM set-up and inputs, the WBM simulation generates a probability distribution of possible void lake levels and volumes for a 164-year simulation period generating 100 sets of unique results. The results for all realisations are assessed to provide probabilistic results for the applied climate scenario.

The results present the following statistics for the simulation period:

- Minimum: Lowest value out of the entire dataset.
- 50th percentile: 50% likelihood of values being greater or less.
- Maximum: Highest value out of the entire dataset.

For the projected climate scenario, the WBM results indicate:

After the year 2120, the mean void water levels start to stabilise, reaching a mean void water elevation of 169 m AHD (Figure 5.4) and a mean void water volume of 16,248 ML (



- Figure 5.5) (considering all realisations). This is approximately 11 m below the interpreted groundwater level (180 m AHD), indicating that the void is expected to act as a sink.
- The long-term mean void lake levels over the final 20 years of the simulation range between 165 m AHD and 172 m AHD which is 8 to 15 m below the groundwater level (180 m AHD). This reflects an available storage capacity of between 15,871 ML and 23,308 ML for the void to continue acting as a sink.
- The void water levels remain below the residual void spill point (197 m AHD) for the duration of the simulation. Therefore, there is a very low risk of overtopping.
- The mean annual inflow to the PTM residual void is 1,934 megalitres per year (ML/year) and the mean annual outflow is 1,935 ML/year (Figure 5.6), calculated for the last 20 years of simulation (2180 and 2199). This indicates the inflows and outflows reach equilibrium by the end of the simulation period.

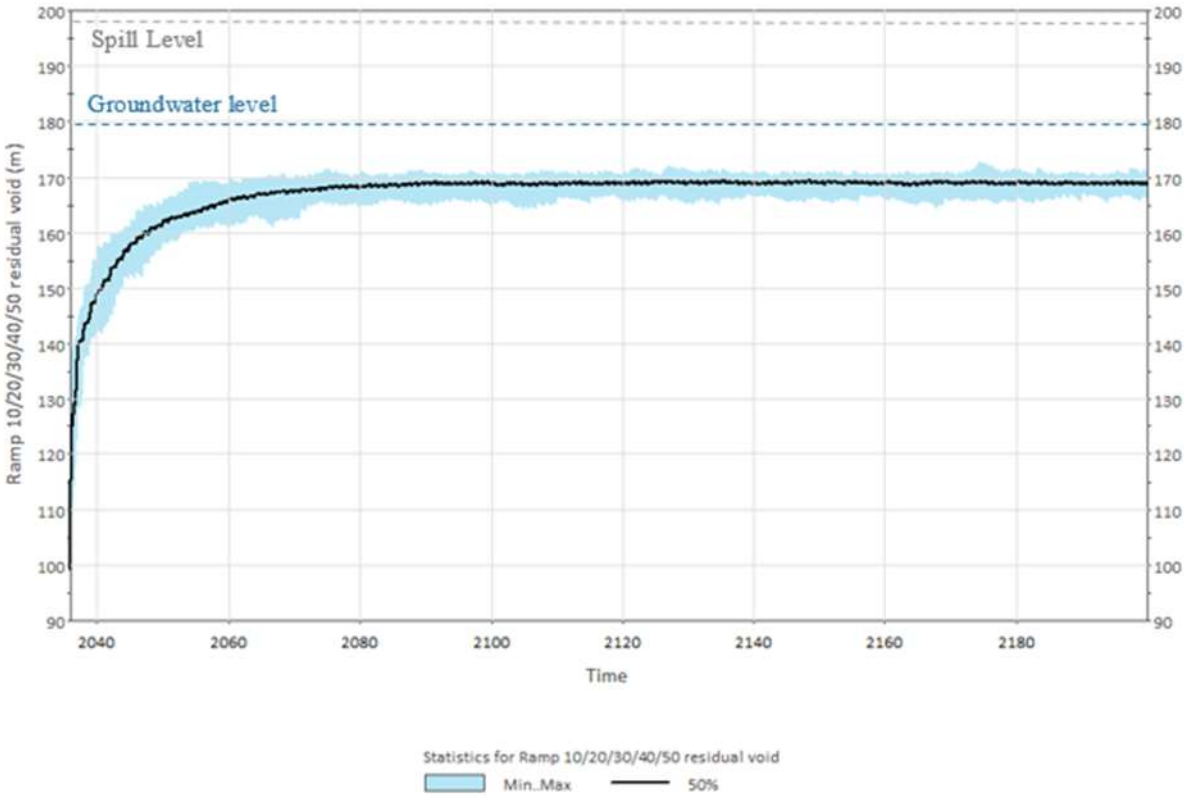


Figure 5.4 Modelled void water level compared to spill level and interpreted surrounding groundwater level for the PTM residual void

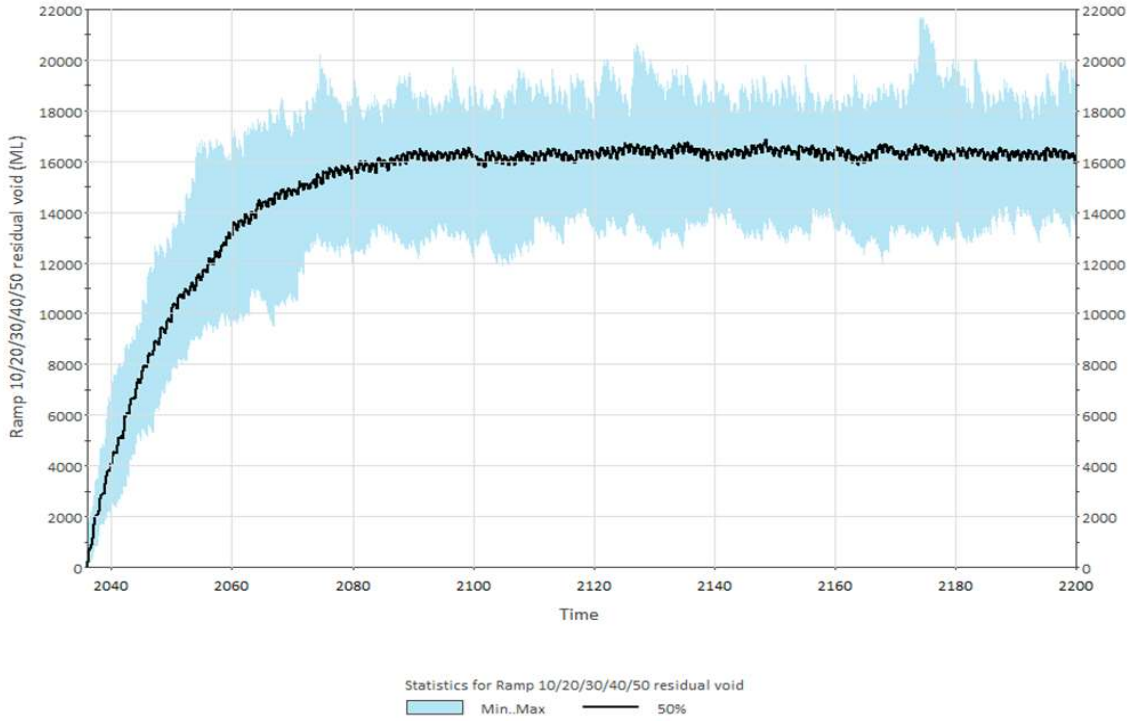


Figure 5.5 Modelled water volumes for the PTM residual void

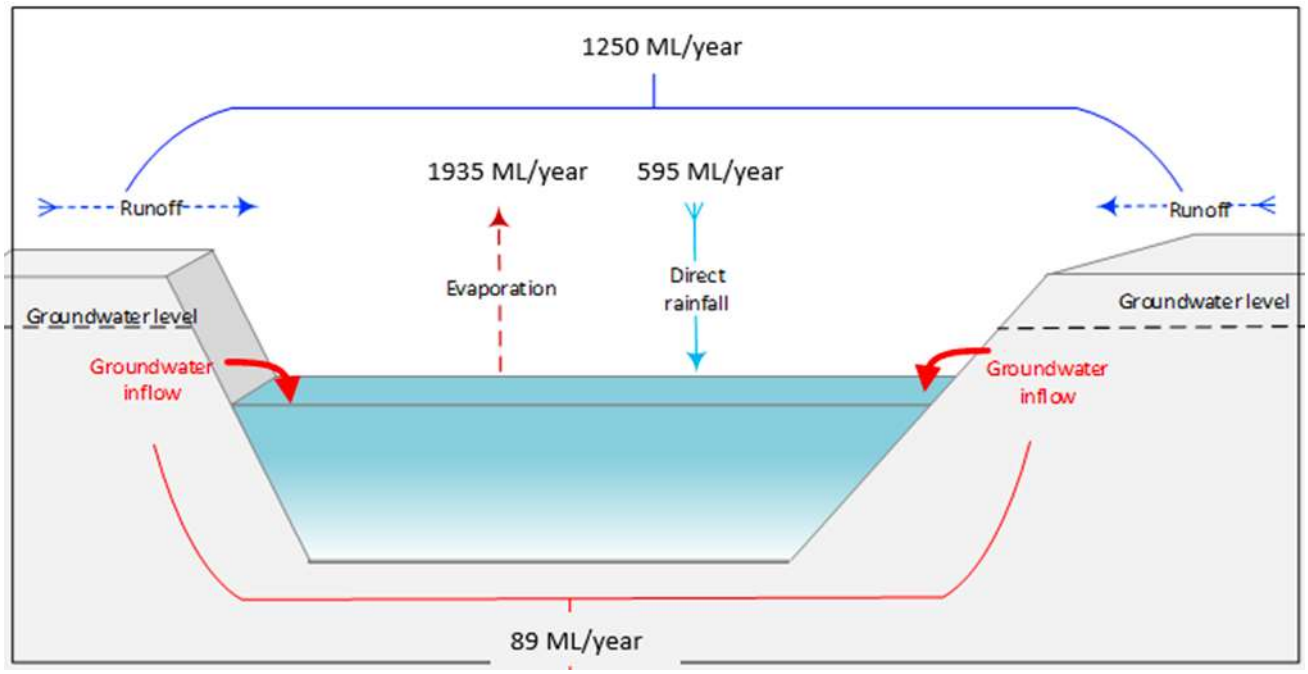


Figure 5.6 Schematic of average inflows/outflows simulated for period from 2180 to 2199 – PTM residual void

6 Geotechnical stability

Geotechnical stability assessments have been completed to demonstrate that, post-closure, the conceptual void high-wall and low-wall slopes will all exhibit long-term geotechnical stability for the PTM residual void. This section presents the assessment findings relevant to void closure at PTM.

6.1 High-wall and end-wall stability assessment

The high-wall geotechnical assessment was undertaken to assess the conceptual void high-wall slope and demonstrate that the slopes will not adversely impact nearby woodland and grazing PMLU for at least the modelled period of 60 years (Henderson Geotech, 2024). This section summarises the assessment findings relevant to the required rehabilitation and management approaches to achieve safe residual void high- and end-walls at closure.

6.1.1 Inputs

From the PTM site geological model - the base of weathering, coal seam roofs and floors, and Yarrabee Tuff layer (a dominant structural feature present within the void) were extracted along with indicative stratigraphy. This information, together with the final mined pit levels and the mine closure landform surface, were incorporated into the geotechnical assessment (Henderson Geotech, 2024).

Six cross-sections were selected to capture the greatest void depth relative to highwall crest (Section 1), the highest low-wall spoil (Section 2), a smaller void/deep section to the south (Section 3), a location where the Isaac River was closest to the high-wall crest (Section 4), and two sections in the northern section to further investigate conditions of marginal highwall stability (sections 5 and 6) (Henderson Geotech, 2024).

The section locations corresponding to the voids (Figure 6.1) are as follows:

- Section 1: Ramp 10 void
- Section 2: Ramp 10 void
- Section 3: Ramp 20/30 void
- Section 4: Ramp 40 void
- Section 5: Ramp 10 void
- Section 6: Ramp 10 void

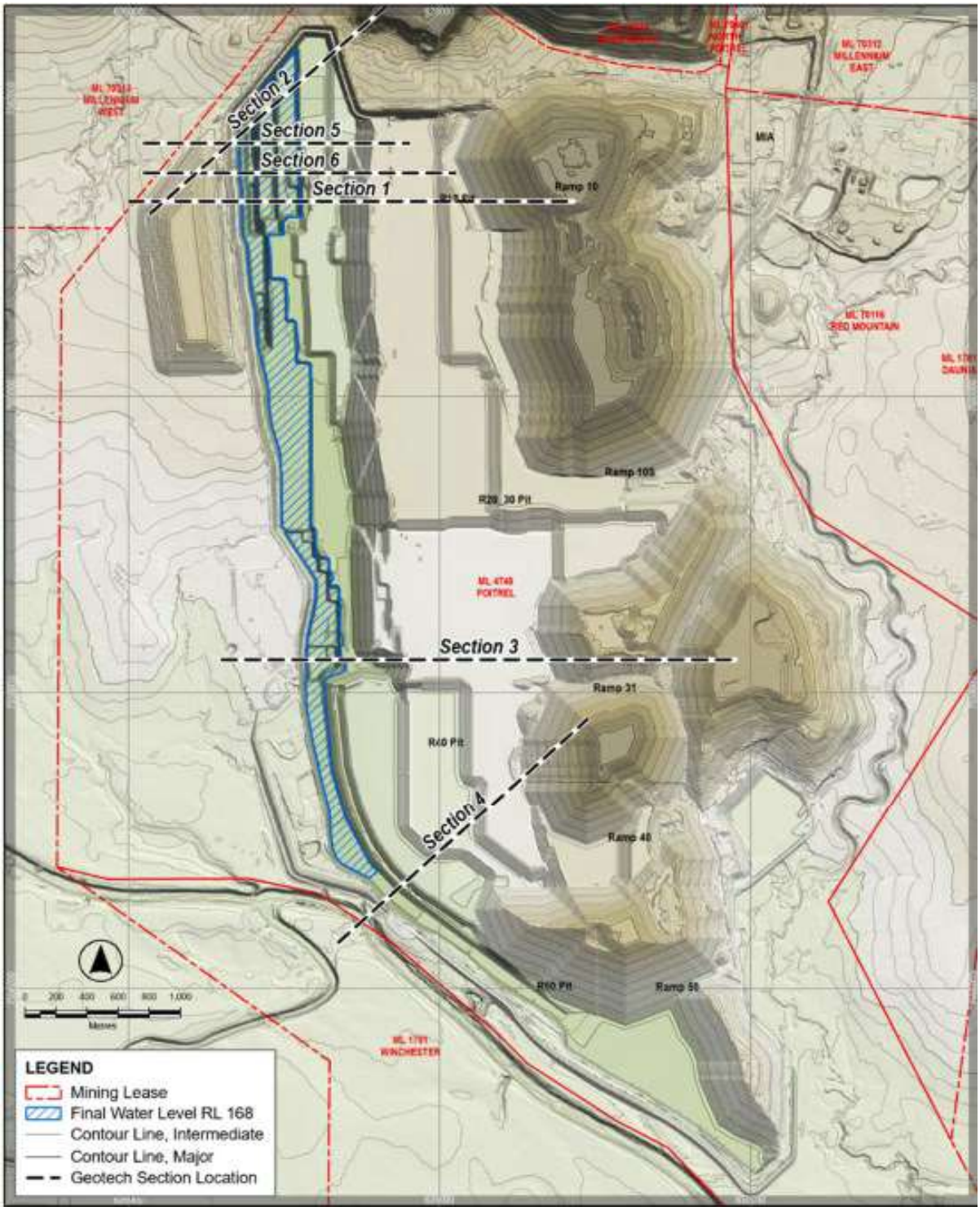


Figure 6.1 Cross-section locations for the PTM residual void high-wall geotechnical assessment (Henderson Geotech, 2024)

The selected cross-sections were analysed using Slide2 Modeler, two-dimensional (2D) Limit Equilibrium Analysis for Slopes to determine the Factor of Safety (FoS). 2D circular and non-circular slip surfaces were considered, with circular slips typical of spoil and sedimentary rock masses while non-circular slips might be dictated by the:

- Yarrabee Tuff and coal seams in the high wall and end-wall
- Yarrabee Tuff below the pit floor
- Interface between saturated and unsaturated spoil in the low-wall.

Table 6.1 Geotechnical parameters applied to PTM geotechnical analyses (Henderson Geotech, 2024)

Material	Weight (kN/m^3)	Cohesion (kPa)	Friction angle (degree)	Coefficient of permeability (m/s)	Vertical to horizontal permeability ratio (kv/kh)
Boxcut spoil	18	30	28	1e-7	0.5
Down dip spoil (unsaturated)	18	40	30	5e-6	0.4
Down dip soil (saturated)	20	23	25	5e-5	0.4
Tertiary overburden	20	50	30	2.78e-6	0.083
Weathered Permian overburden	24	75	30	2.78e-6	0.083
Fresh Permian over/interburden	24	450	4	1.16e-8	0.1
Fresh coal	15	30	35	1.74e-7	0.067
Yarrabee Tuff	24	0	15	1e-7	1

The effects of severe hydrological events were not considered in the geotechnical stability assessment as the residual void is either outside the modelled floodplain and/or the mine closure landform design will incorporate measures to prevent floodwater ingress to the residual voids.

Groundwater head levels considered in the assessment were interpolated from hydrogeological modelling contour maps (refer to Section 3). Residual void lake levels were incorporated from the residual void water balance modelling (refer to Section 5).

Hydraulic properties, primarily saturated coefficients of permeability, were selected to be broadly consistent with hydrogeological modelling and to provide the relative permeability observed in practice – for example, spoil is observed to be more permeable than in situ weathered Permian overburden (Henderson Geotech, 2024).

The assessment, undertaken by an appropriately qualified person, assigned the associated geotechnical modelling a reliability score ranking of High Uncertainty (Henderson Geotech, 2024) - the assessed consequences of geotechnical instability are provided in Table 6.2.

Table 6.2 Consequence assessment of geotechnical instability at PTM (Henderson Geotech, 2024)

Scenario	Consequence of geotechnical instability[1]
High-wall instability that extends beyond crest into grazing PMLU	Medium
High-wall instability that extends beyond crest to creek channels or flood protection structures	Medium
High-wall instability that does not extend outside NUMA	Negligible
Low-wall instability that extends into grazing PMLU	Low
Low-wall instability that extends into woodland PMLU	Low

Scenario	Consequence of geotechnical instability[1]
Low-wall instability that does not extend outside of NUMA	Negligible

(1) As assessed by an appropriately qualified person

Based on consideration of the High Uncertainty ranking and the consequences tabled above, Table 6.3 identifies the adopted design acceptance criteria as determined by the appropriately qualified person undertaking the assessment.

Table 6.3 Adopted design acceptance criteria for PTM geotechnical assessment (Henderson Geotech, 2024)

Scenarios	Minimum Factor of Safety criteria[1]
Instability extending into grazing PMLU	1.5 (also imposed by pre-existing EA conditions)
Instability extending to watercourses or flood protection structures	1.5
Instability extending into woodland PMLU	1.35
Instability contained within NUMA	1.25

(1) As assessed by an appropriately qualified person

6.1.2 Results

The results from the scenarios for the geotechnical assessment for a dry void at the end-of-mining and for when the residual void lake reaches the long-term average water level are presented in Table 6.4.

Table 6.4 Geotechnical stability assessment results for the sections of the PTM residual void (Henderson Geotech, 2024)

Section	Residual void water level	FoS – NUMA (target 1.25)	Management measure required to achieve FoS >=1.5
1	Dry	1.30	Nil – dry void not anticipated in closure landform
1	Final pit lake	1.44	15 – 40 m set-back distance
2 – high-wall	Dry	1.41	Nil – dry void not anticipated in closure landform
2 – high-wall	Final pit lake	1.47	15 – 40 m set-back distance
2 – low-wall	Dry	1.37	Nil – dry void not anticipated in closure landform
2 – low-wall	Final pit lake	1.52	Nil
3	Dry	1.94	Nil
3	Final pit lake	1.94	Nil
4	Dry	2.35	Nil
4	Final pit lake	2.41	Nil
5	Dry	1.32	Nil – dry void not anticipated in closure landform

Section	Residual void water level	FoS – NUMA (target 1.25)	Management measure required to achieve FoS >=1.5
5	Final pit lake	1.43	Nil – FoS>1.5 achieved at crest
6	Dry	1.42	Nil – dry void not anticipated in closure landform
6	Final pit lake	1.52	Nil

Based on the assessment outcomes, the analysed sections achieved a high-wall FoS of greater than (>) 1.25 and therefore met the nominated design acceptance criterion for instability contained within a NUMA. However, to achieve the nominated design acceptance criterion for instability extending into a grazing PMLU, additional set-back distances of between 15 and 40 metres are required. These set-back distances will inform the NUMA boundary and positioning of exclusion bunding and fencing will factor in these distances also.

6.2 Low-wall stability assessment

The geotechnical stability of low-walls has been assessed for the PTM residual void with the purpose of demonstrating that, post-closure, void low-wall slopes will exhibit long-term geotechnical stability.

A stability analyses of the low-wall final closure state landform for the PTM residual void was undertaken using the 2D limit equilibrium analysis software Slide2 (version 9.027). Five cross-sections were selected that provide representative geometries of the final landform with a focus on areas where the spoil material batters or slopes have a relatively high angle in the low-wall. The section locations for the analysis are presented in Figure 6.2 and the corresponding sections are identified as:

- Section 10 (Ramp 10 pit)
- Section 10S (Ramp 10 pit-south)
- Section 31N (Ramp 30 pit-north)
- Section 31 (Ramp 30 pit)
- Section 40 (Ramp 40 pit).

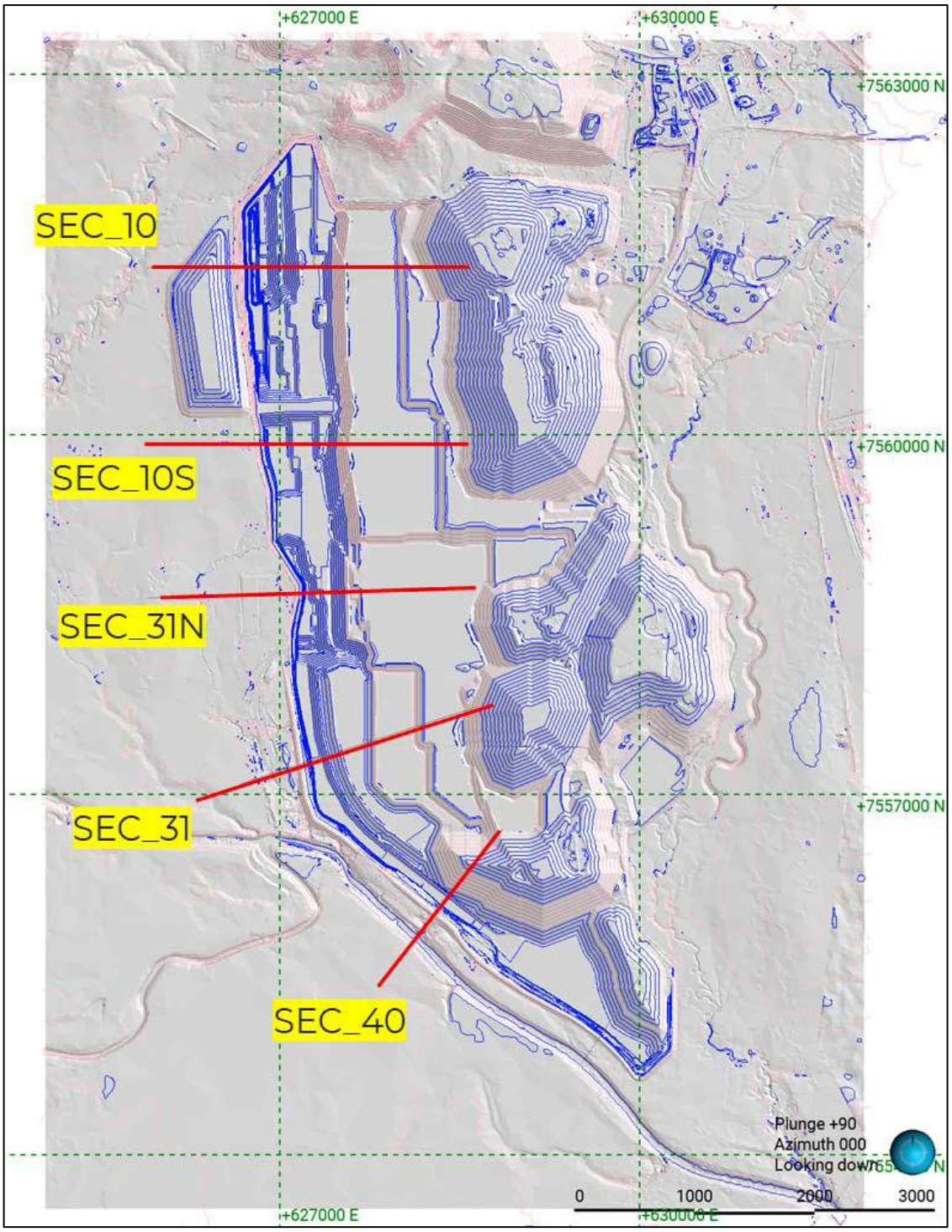


Figure 6.2 Cross-section locations for the PTM residual void low-wall geotechnical assessment

For each of the analysed sections, the minimum FoS failure surface along the slope (global minimum) was identified (Table 6.5) and the position of the global minimum failure surface is shown on the low-wall slope in Figure 6.3 to Figure 6.7.

The geotechnical stability assessment for the PTM residual void sections concluded that, for the mine closure landform, the minimum FoS for all low-wall slopes was greater than 1.5. Based on this assessment, the stability requirements of the low-wall slopes have been met.

Table 6.5 Summary of low-wall geotechnical stability analysis results for the PTM residual void

Section	Minimum FoS (global minimum)
10	2
10S	2.4
31N	2.1
31	2.4
40	1.8

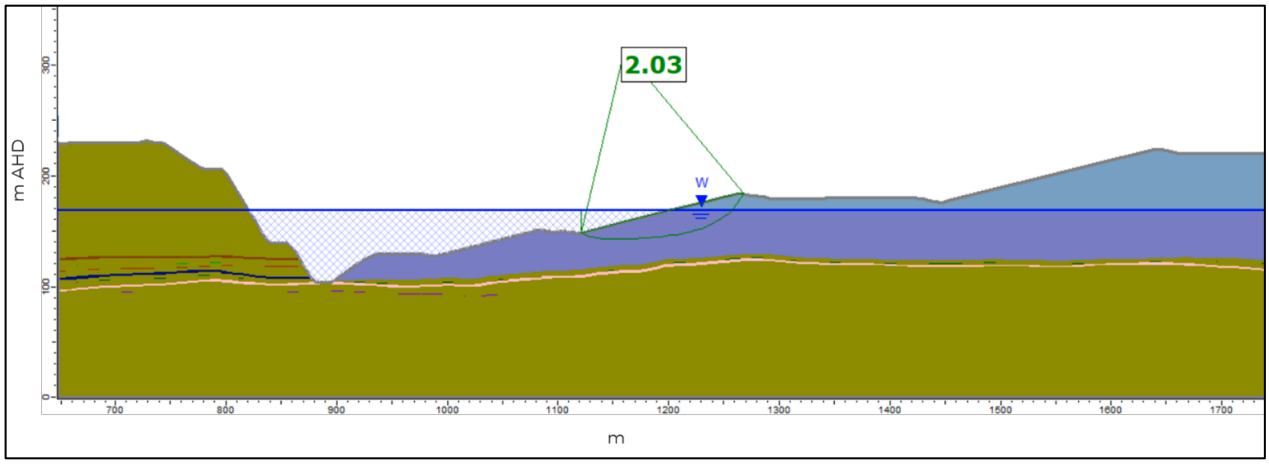


Figure 6.3 Location of global minimum failure surface in section 10 of the PTM residual void

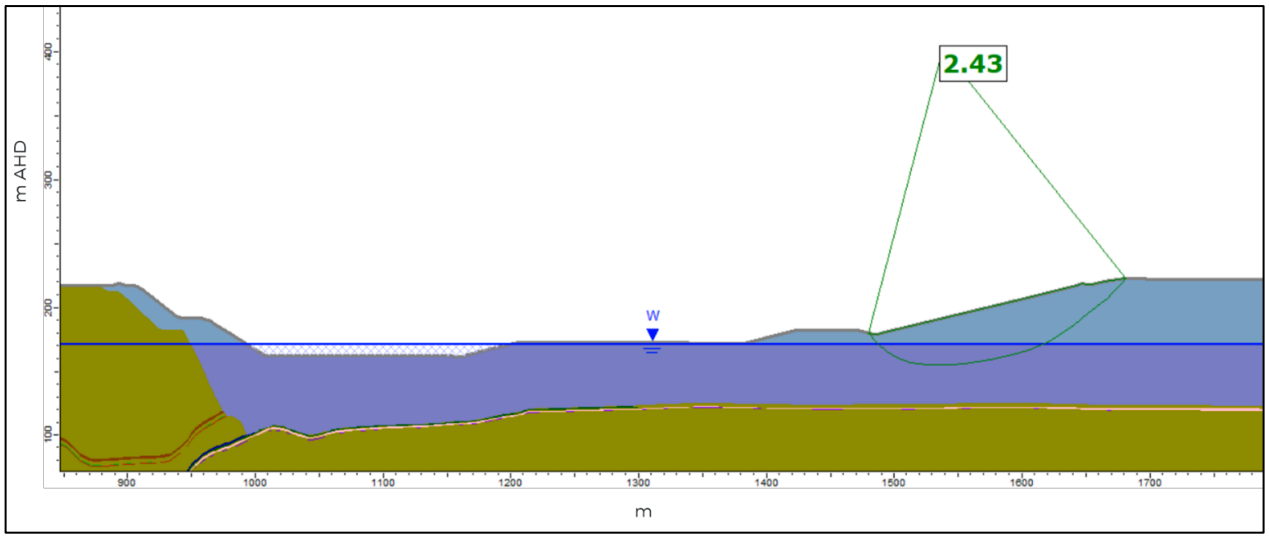


Figure 6.4 Location of global minimum failure surface in section 10S of the PTM residual void

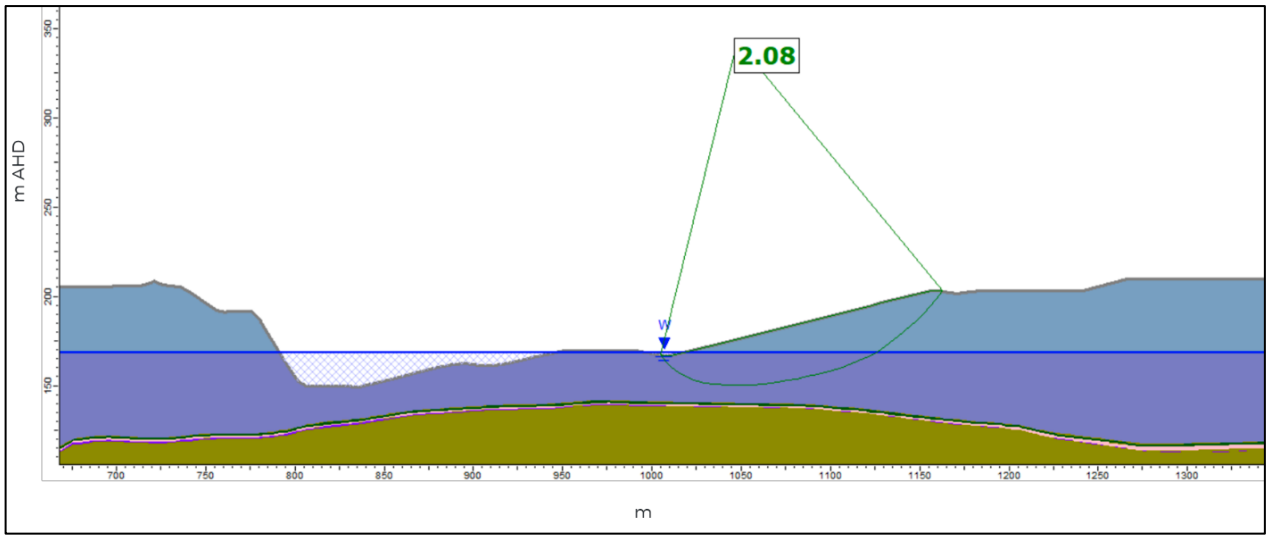


Figure 6.5 Location of global minimum failure surface in Section 31N of the PTM residual void

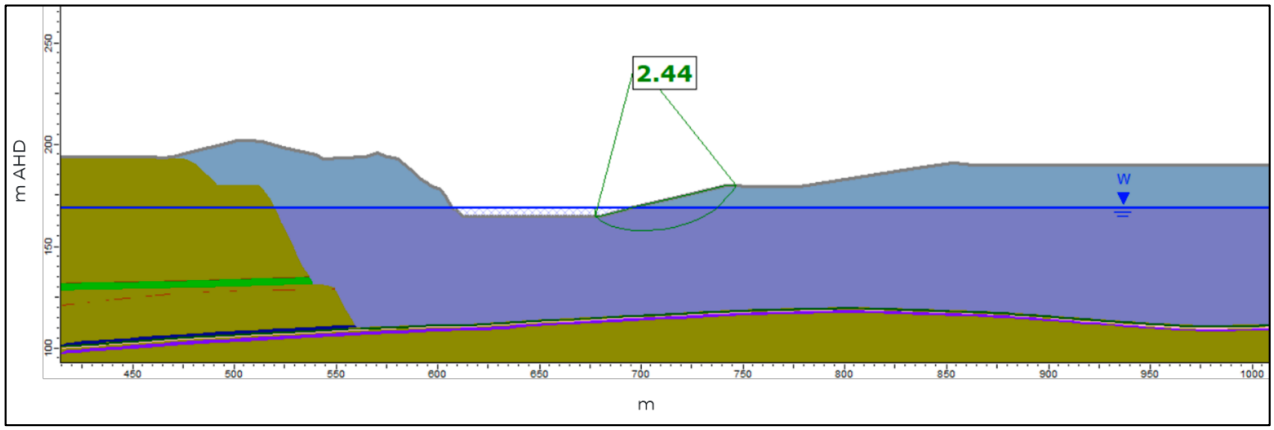


Figure 6.6 Location of global minimum failure surface in Section 31 of the PTM residual void

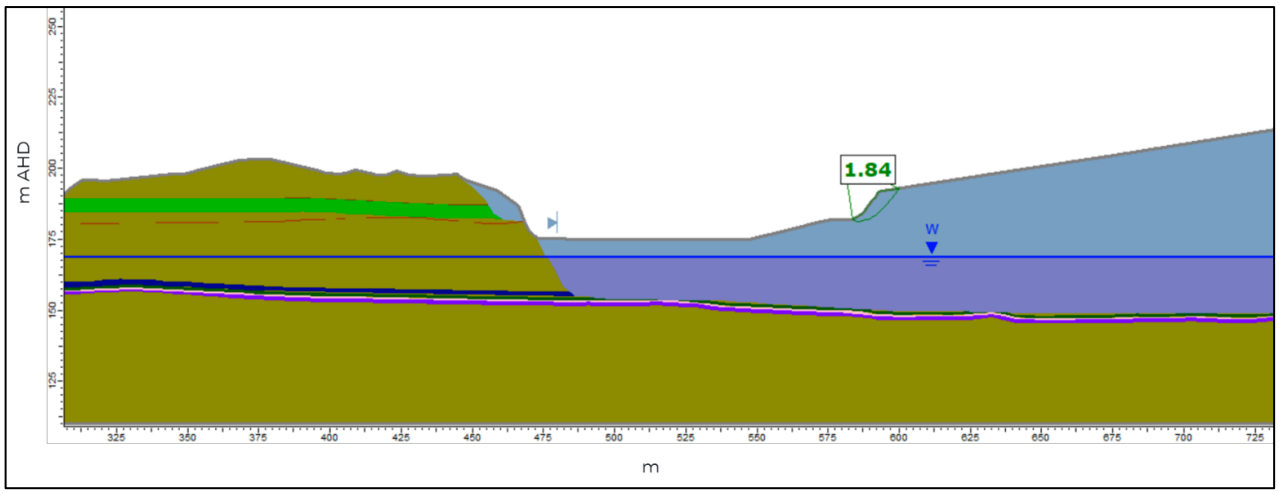


Figure 6.7 Location of global minimum failure surface in Section 40 of the PTM residual void

7 Geochemical stability

A geochemical assessment has been undertaken by WSP to:

- identify the geochemical characteristics of remaining high-wall material and mine waste materials (spoil and rejects)
- model the resulting effects on long-term water quality of the void lake within the mine closure landforms for the PTM residual void.

The objectives of the geochemical assessment were to:

- predict the changes in water quality of the PTM residual void in a long-term closure scenario
- determine, at a conceptual level (by comparison to EA groundwater trigger values), whether the predicted void lake water quality may impact the surrounding environment in a closure setting
- determine, at a conceptual level, if stratified conditions are likely to develop within the void.

This geochemical assessment builds directly on the void water balance assessment undertaken for the PTM residual void (see Section 5) for the same period 164 years post-closure (from 2036 to 2199) for the residual void. Within these timeframes, the water level in the void lake reaches an equilibrium.

7.1 Water quality model

7.1.1 Geological materials

The geologic materials and associated mine waste materials (spoil and rejects) may react with water and release or immobilise solutes, according to their geochemical characteristics. Material interactions considered in the water quality model include:

- Highwall lithologies interacting with rainfall/runoff.
- In-pit spoil/rejects covered with non-carbonaceous interburden interacting with rainfall/runoff (infiltration of rainfall through the spoil/rejects was not included).

The relative proportions of each lithological group on the PTM residual void highwalls were derived from the stratigraphic distribution (meterage) of each material within drill holes. Material with no lithological classification (classified as unknown) was reallocated to carbonaceous and non-carbonaceous domains using the ratio of carbonaceous to non-carbonaceous materials. A similar redistribution was also undertaken for tertiary units, which were not identified within the drill core database. The resulting simplification gives three main lithological groupings: coal, carbonaceous overburden, and non-carbonaceous overburden (Table 7.1). The subdivision of coal materials into specific seams was not considered given the low proportional area of remnant coal exposed on the highwall compared to the overburden.

Table 7.1 Proportions of lithologies in excavated PTM residual void high-walls

Highwall lithology grouping		Normalised high-wall exposure (%)
Non-carbonaceous	Fresh	35.8
	Weathered	44.5
Carbonaceous	Fresh	3.7
	Weathered	6.2
Coal	Fresh	5.9
	Weathered	3.2

Highwall lithology grouping	Normalised high-wall exposure (%)
Total:	**99.2**

7.1.2 Geochemical source terms

The geochemical source terms were derived from the PTM groundwater and environmental geochemistry databases provided by Stanmore.

The environmental geochemistry database (*"PTM_New Drillhole Results_WORKING.xlsx"*) includes the results of analyses undertaken on drill core material collected at PTM. Solubility test work results from two additional drill cores were compiled into the provided working database for the derivation of source term chemistry. Drill core results were filtered based upon lithology. The median of compiled data for each lithological grouping was used to derive the source term for the respective lithology group. Where analytical results were below the limit of reporting (LOR) the entry was substituted with half the LOR.

The groundwater database includes data from February 2008 for 15 monitoring bores across three main aquifer types (Cainozoic, Permian and Rewan aquifers). No distinction was made between aquifers or bores when deriving the groundwater source term, and a median of all available data is taken.

The data used for the derivation of these source terms are summarised in Table 7.2.

Table 7.2 Summary of data used to derive geochemical source terms for the PTM residual void

Water inflow	Data source	Comment
Initial void lake	-	It is assumed that no water is present in the PTM residual void at closure.
Rehabilitated catchment/in-pit spoil runoff	PTM drill-core database	It is assumed that non-carbonaceous interburden will be specified as cover material for final landform. Spoil runoff is, therefore, represented by leachate data from fresh non-carbonaceous drill core samples.
High-wall runoff	PTM drill-core database	The PTM drill core databases were used to derive source terms for each lithological domain/grouping.
Groundwater inflow	PTM groundwater database	Median water quality from PTM groundwater database.
Direct Rainfall	-	Pure water equilibrated with atmospheric CO_2.

7.1.3 Modelling approach and development

The geochemical model was run for major cations, anions, and metal(loid)s where data was available. Further discussion is focused on TDS (as a proxy for Electrical Conductivity (EC)) as identified in the rehabilitation requirements of the EA (EPML00963013). Discussion has also been included for pH.

The results for each timestep were calculated using the geochemical modelling code PHREEQC (Parkhurst, 2013)) with the Minteq.v4 thermodynamic database, derived from the MINTEQA2 version 4 database (US EPA, 1998).

The geochemical model was run as follows:

- source terms were mixed for annual timesteps, with inflow/outflow proportions calculated from the GoldSim water balance
- modelling was incremental, with the output for the void lake from the previous timestep being used as the input for the next time step

- geochemical reactions, such as mineral precipitation/dissolution, gas exchange and sorption were considered.

The following assumptions apply to the geochemical model:

- At all times, the void lake is fully mixed, geochemical reactions occur to equilibrium within the modelled timestep and are not kinetically controlled. Mineral precipitates are retained within the void lake.
- Solute release from high-wall rock and spoil does not occur below the lake water level.
- The release of coal bed methane caused during the dewatering of coal seams does not drive groundwater or lake chemistry towards more reducing conditions.
- There is no infiltration of rainfall or groundwater through the in-pit waste to the void lake.
- Stratification is assessed at a conceptual level based on a TDS threshold. Seasonal temperature, wind patterns, and other impacts on mixing are not considered.
- The geochemical model does not account for biological processes.

A model sensitivity test was performed to highlight the role of geochemical controls on predicted water quality. The two simulations are summarised in Table 7.3 and were performed for the mean water balance scenario for the residual void.

Table 7.3 Model sensitivity simulations

Simulation	Atmospheric CO_2 equilibrium	Mineral precipitation	Surface adsorption
Base case	Equilibrium at $10^{-3.38}$ (420 ppm)*	Equilibrium	Adsorption onto ferrihydrite
No geochemical controls	No equilibrium	No equilibrium	No sorption

Note: *420 parts per million (ppm) is representative of 2024 atmospheric CO_2 concentrations. Variation with time (i.e., geochemical climate change scenarios) is not included in current model scenarios.

A conceptual level assessment of potential chemical stratification was conducted based on the evolution of TDS, which can be used to approximate the fluid density of the fully mixed void lake. A discussion of the stratification assessment is provided in Section 7.2.

7.2 Residual void water quality outcomes

The following sections present the results of the geochemical modelling for the residual void lake at PTM for pH and TDS. The results are presented for both the with and without geochemical controls/reactions (i.e., mineral precipitation, sorption, and gas exchange) scenarios.

The PTM residual void is classified as a NUMA and elevated modelling results should be considered in the context of the void being classified as a NUMA for the PRCP.

The model results are summarised as follows:

pH

Acidic conditions are unlikely to develop in the PTM residual void lake, with alkaline conditions developing through the modelled period (Figure 7.1). Whether geochemical controls are considered or not, the pH begins and remains above the EA upper limit for the modelled period. The simulation with geochemical controls results in a higher pH than the simulation without geochemical controls. The main likely geochemical control is CO_2 degassing which raises pH, resulting in carbonate precipitation and reducing pH. These geochemical processes are driven by the input of dissolved inorganic carbon, from runoff and groundwater inflow to the void lake.

TDS

TDS concentrations increase over the model duration. However, the predicted TDS concentrations are not elevated above the EA derived trigger value until the end of the simulation (after approximately 2190) regardless of whether geochemical controls are considered or not (Figure 7.1).

The increase in TDS concentration is primarily driven by evapoconcentration of residual void lake water.

Minor differences in TDS concentrations in simulations with geochemical controls are due to removal via precipitation of some metals/metalloids that contribute to the TDS concentrations. An 'equilibrium' state for TDS concentrations (i.e., constant TDS) is not reached.

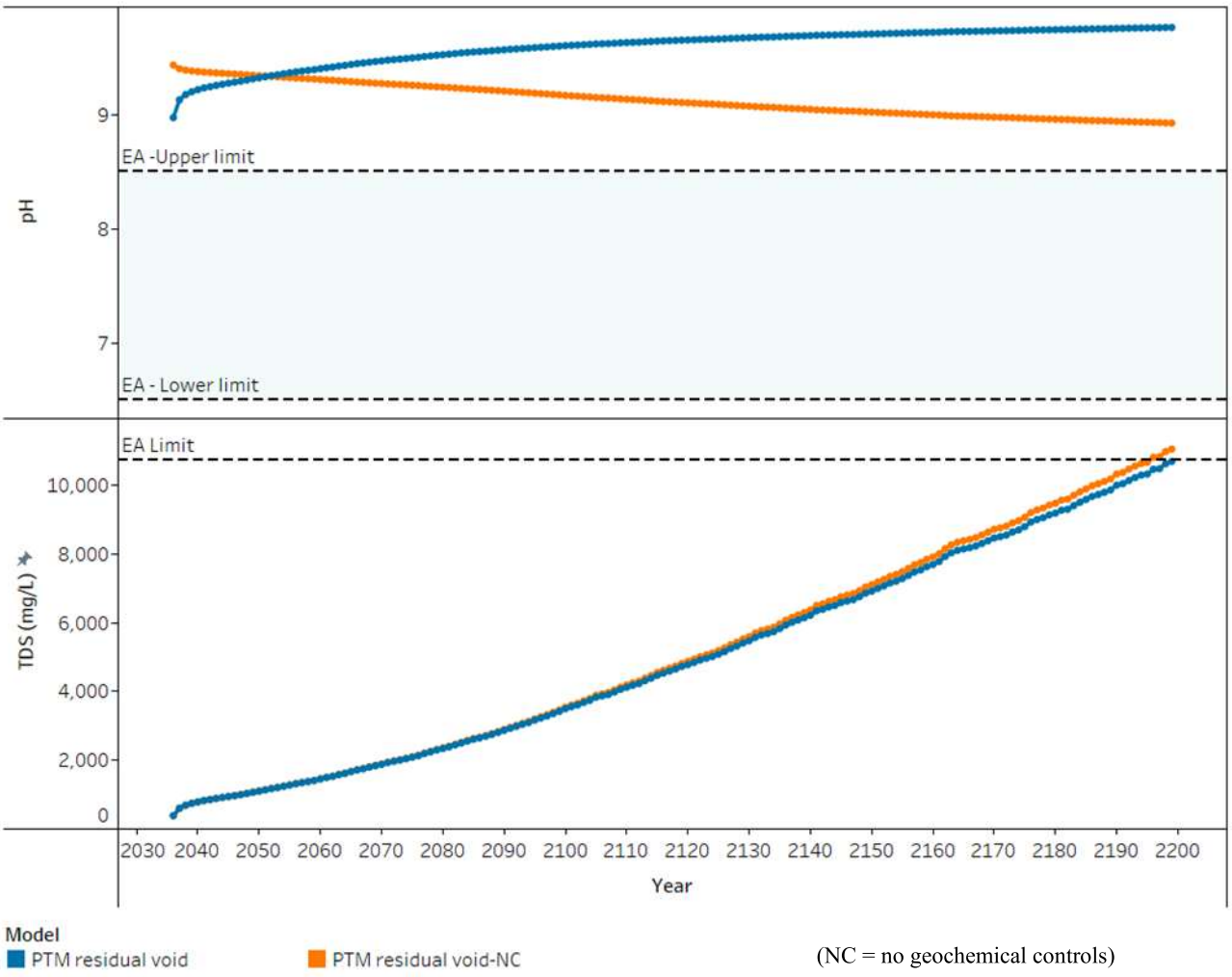


Figure 7.1 Predicted pH conditions and TDS concentrations for the PTM residual void over the modelled period

Stratification

Steep sides, void depths and elevated TDS present favourable conditions for stratification within the PTM residual void. The water of higher density (cooler or more saline) has the potential to become isolated at depth.

Hydrodynamic/limnological analysis is required to assess the potential for thermal/chemical stratification to occur, and the importance of seasonal mixing processes and groundwater mixing inputs. However, as the residual void is considered a NUMA and modelled as a groundwater sink, further stratification assessment is not warranted.

7.2.1 Qualifications

The following caveats and limitations apply to the water quality model, in relation to the TDS and pH modelling, for the PTM residual void:

- Available data at the time of modelling was used to represent relevant geochemical interactions. Availability of additional data in future may result in alternative model outputs.
- Water movements are based on complementary studies (groundwater and water balance). These studies constrain the model duration and the water sources.
- Screening was performed against EA criteria for groundwater contaminant trigger values. The criteria for TDS were derived from the EA EC value using a 0.67 factor that is considered acceptable for freshwater.

8 Residual void management

A summary of the key findings from the technical studies (presented in Sections 3 to 7) used to inform the development of residual void management measures are presented below:

Groundwater

- By the end of the post-closure simulation, groundwater inflows and outflows for all PTM residual voids reach equilibrium with net positive inflows occurring throughout the simulation period. Groundwater levels recover with a groundwater hydraulic gradient maintained towards the PTM residual voids.
- The minor modelled outflows from the residual void to the surrounding in-pit spoil do not move beyond the spoil or mining leases as a result of the modelled hydraulic gradient centred on the PTM residual void.
- Peak lowering of groundwater at locations of potential GDE sites identified near to PTM is predicted to occur at the end of PTM mining with minimal ongoing drawdown occurring in the post-closure environment while groundwater levels recover and stabilise.
- Minor ongoing lowering of groundwater levels post-closure occurs in one third-party water supply bores before the water levels equilibrate. This is likely a result of a lag in mining related draw-down or regional-scale influences represented in the model rather than drawdown associated with the mine closure landform. There is no additional post-closure lowering of groundwater levels at all other locations of potential groundwater users identified near to PTM.
- The particle tracking simulation predicts that the water particles within the potential contaminant source areas of the mining leases, and within the voids themselves, will either migrate towards the residual voids and remain on the mining leases post-closure or remain within the voids.

Flooding

- The floodplain assessment of the pre-mining landform identified that the PTM pits would be located within the floodplains of the Isaac River. For the mine closure landforms, the extents of the residual voids modelled within the floodplain assessment will be reduced and refined through spoil placement, drainage design and placement of landforms/embankments to reduce the extent of void and flooding interactions.
- Floodwaters from the Isaac River and the approved New Chum creek diversion are modelled to interact with the current proposed mine closure landform associated with the residual void. The flood assessment predicts that ingress of floodwaters is modelled to occur into the southern end of the PTM residual void from the Isaac River (adjacent to the Ramp 50 pit) during a PMF event. Floodwater ingress will require consideration during final design of exclusion bunding/embankments around the residual void high-walls in this location.
- Flood velocities from the Isaac River floodwaters during PMF events that interact with the mine closure landform may contribute to scouring and/or erosion of the landform. Appropriate protection at locations where floodwaters of high velocities may interact with the mine closure landform will be considered and incorporated into the mine closure landform as the PTM residual void approaches closure.

WBM

- WBM results indicate the formation of a void lake in the PTM residual void. Void lake levels are modelled to equilibrate and remain below the interpreted and modelled groundwater levels due to evaporative effects on the residual void lakes.
- WBM outcomes predict that the PTM residual void achieves mean void water levels and volumes at the end of the simulation that are well below the spill elevation for the residual void. Therefore, there is a very low risk of the residual void overtopping to the receiving environment.

Geotechnical stability

- High-wall FoS for all sections analysed in the residual void were > 1.25 and therefore met the nominated design acceptance criterion for instability contained within a NUMA.
- To achieve the high-wall FoS nominated design acceptance criterion for instability extending into a grazing PMLU, additional set-back distances of between 15 and 40 metres from the crest of the slope are required. The NUMA boundary and positioning of exclusion bunding and fencing will factor in these distances.
- The mine closure landforms have been designed such that the geotechnical stability for the low-walls achieved a FoS ≥1.5. Therefore, the low-walls of the mine closure landforms can be considered stable.

Geochemistry

- Water quality modelling of the residual void predicts the development of alkaline water quality in the void lake and increasing salinity over time. There may be potential for beneficial post-closure uses of the void water prior to the water quality deteriorating beyond the EA trigger values. Extractive uses of this water may also alter the chemistry and dissolved solid accumulation within the void that occurs via evapoconcentration. Further investigation into potential options for use of void lake water post-closure, including review of the WBM and water quality assessment of the residual void, could be carried out.

Management and monitoring

The PTM residual void will be retained as a NUMA. The management considerations presented in Table 8.1 will be implemented to support attainment of a NUMA that is safe and does not present an unacceptable risk of off-tenure environmental harm.

Monitoring of the residual void will be undertaken as part of monitoring of the NUMA extents (see relevant monitoring and maintenance section in the PTM PRCP). Monitoring will have the objective of demonstrating achievement of sufficient improvement in accordance with the NUMA management milestones that enables certification from an appropriately qualified person that the residual void:

- Does not present an unacceptable risk of environmental harm outside of the tenure boundary
- Is safe to humans and livestock.

Table 8.1 PTM residual void closure aspects, context and management considerations

Residual void closure aspect	Closure objective			Residual void closure context	Management consideration
	Safety	Stability	Non-polluting		
Geotechnical stability	✓	✓	-	— Stability outside of the NUMA extents of the high-walls (including set-back distances where necessary) = FoS ≥1.5. — Stability of the low-walls outside of the NUMA extents = FoS ≥1.5. — Extents of all PTM residual voids have been defined by geotechnical analysis based on currently available information.	— Develop geotechnical parameters that are specific to PTM for spoil and other materials to apply to the geotechnical modelling. — As mining approaches the final limits, re-assess the geotechnical stability of the high- and low-walls based on the latest available data, including any developed site-specific geotechnical parameters. — Use a minimum FoS≥1.5 as a guidance for ongoing void closure planning for NUMA boundary. (This may be refined over the mine life should industry research provide optimised guidance on observational methods and consequence assessment).
Void hydrology	✓	✓	✓	Based on rehabilitation flood modelling completed: — The residual void in the current mine closure landform are not subject to inundation from floodwaters for the 0.1% AEP event. — Flood velocities may interact with the mine closure landform associated with the residual void. — As the water levels remain below the recovered groundwater levels for all the residual void (and well below the void spill point), the void will not overtop and environmental harm beyond that of the void itself is not expected. Therefore, no management activities required.	— Undertake regular update of hydrological models to ensure that residual void catchment is minimised as far as practicable. — Update and refine the final mine closure landform to consider spoil dumping and landform design to exclude floodwaters entering the residual void. — If necessary, identify and implement mitigation measures for appropriate protection works of landforms where floodwaters from watercourses interact with the final mine closure landforms at elevated velocities.

Residual void closure aspect	Closure objective			Residual void closure context	Management consideration
	Safety	Stability	Non-polluting		
				— The long-term mean void lake levels for the residual void are modelled to remain below the interpreted and modelled groundwater levels due to evaporative effects on the residual void lakes. An available storage capacity remains for the voids to keep acting as long-term sinks. — The mean water balance for the residual void reaches equilibrium. — After 2120, mean water levels the residual void start to stabilise, with simulated mean inflows of 1,934 ML/year being equal to mean outflows of 1,935 ML/yr.	— At cessation of mining activities, review and update the void water balance modelling, incorporating identified changes to the voids' final mine closure landform and spill point elevation, rainfall and evaporation, surface water runoff, groundwater inflows, and climate projections. — Obtain certification from an appropriately qualified person that the residual void will not cause environmental harm beyond the tenure boundary.
Void hydrogeology	-	-	✓	— Mining-related dewatering activities have lowered groundwater levels that will result in continued suppression of the water table centred on the PTM residual void. — Void lakes are predicted to form in the residual void post-mining. Water levels in the void lake are modelled to remain below the interpreted and modelled groundwater levels due to evaporative effects on the residual void lake. — The PTM residual void remains as groundwater sinks post-closure or any minor groundwater outflows remain within the mine closure landform and do not leave the tenure. — Modelling, including particle tracking, indicates that infiltration of rainfall through the spoil and other areas around the void within the tenure will migrate towards, and be captured within the residual void. Groundwater flow is not expected to flow off-tenure toward the receiving environment, minimising the risk of environmental harm due to the proposed final mine closure landform.	— At cessation of mining activities, review and update the groundwater modelling, incorporating updated void WBM outputs and in-field groundwater sampling data, as required. — Obtain certification from an appropriately qualified person that, upon completion of mining, residual void does not present an unacceptable risk of environmental harm beyond the tenure boundary.

Residual void closure aspect	Closure objective			Residual void closure context	Management consideration
	Safety	Stability	Non-polluting		
Void water quality	-	-	✓	— Acidic conditions are not expected to establish within the PTM residual void. — TDS concentration in the PTM residual void will continue to increase over time but may be suitable for use for approximately 150 years following closure. In addition to the above, the PTM residual void does not present an unacceptable risk of environmental harm beyond that of the void itself as it: — is a NUMA. — remains as a groundwater sink over time or any minor groundwater outflows remain within the PTM mine closure landform. Void water quality should be interpreted in this context.	— At cessation of mining activities, review and update the void geochemical assessment including additional or refined data from in-pit surface water samples, surface- and groundwater samples, and biochemical modelling. — Obtain certification from an appropriately qualified person that the residual void will not present an unacceptable risk of environmental harm beyond the tenure boundary.
Void access control	✓	-	-	Access to the residual void will be restricted for humans and livestock.	Following cessation of mining activities: — Construct a safety bund at the relevant geotechnical setback distance for each residual void high-wall. — Erect fencing and signage (where required) around the perimeter of the safety bund. — Erect fencing and signage around the perimeter of the woodland PMLU (where required). — Obtain certification from an appropriately qualified person that the residual void is safe to humans and livestock.

9 Conclusion

This void closure plan provides outcomes of technical studies completed to support closure planning and achievement of a safe, stable and non-polluting residual void at PTM and the suggested management measures. This void closure plan is an appendix to the PTM PRCP and has been compiled in terms of the requirements of the PRCP Guideline.

The documented technical studies – including water balance, hydrogeological, rehabilitation flooding, geochemical and geotechnical stability modelling, have been undertaken through an iterative approach with the development of the mine closure landform design. These iterations have resulted in a mine closure landform design that minimises the area of the void, provides protection from flood water, and contributes to minimising environmental harm as it relates to the final PTM residual void.

This plan (and associated supporting technical studies) may be required to be updated should amendments to the site's PRCP be required.

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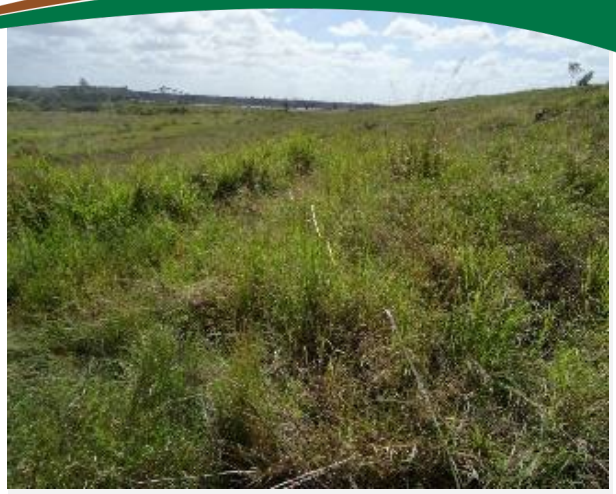
Appendix 9 Cover Design (28 June 2024)

COVER DESIGN: POITREL MINE



Stanmore Resources

June 2024

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1 INTRODUCTION

1.1 Background

Queensland legislation requires all mines with a site-specific Environmental Authority (EA) to prepare a Progressive Rehabilitation and Closure Plan (PRC plan). The PRC plan must be developed in accordance with the Guideline – Progressive Rehabilitation and Closure Plans (DES 2023) (ESR/2019/4964) (Guideline).

The primary purpose of the PRC plan is for the holder of an EA to plan for how and where activities will be carried out on land in a way that maximises progressive rehabilitation to a stable condition and to provide for the condition to which the holder must rehabilitate the land before the EA is surrendered.

Stanmore SMC Pty Ltd, a wholly owned entity of Stanmore Resources Ltd (Stanmore) are the holders of an EA for mining activity at Poitrel Mine (EA reference: EPML00963013).

1.2 Location

Poitrel is an open cut coal mine in the Bowen Basin, located approximately 20km east of Moranbah, and is situated in the Isaac Regional Council Local Government Area (Figure 1). The mine is south of the Peak Downs Highway, directly to the west of the existing Daunia coal mine and south of the Millennium coal mine.

1.3 Mining

Mining at PTM commenced in 2006 and uses open cut strip mining techniques with an excavator, truck and dozer fleet. Run-of-mine (ROM) coal is transported to Red Mountain Joint Venture (RNJV) Coal Handling and Processing Plant (CHPP) located on the adjoining infrastructure Mining Lease (ML) 70312. The coal forms part of the Leichhardt and Vermont Seams.

1.4 Cover design objectives

A cover design is required for Poitrel to describe the surface treatment of the mining landforms. Exposure of mining wastes can potentially result in chemical reactions that cause an acidic, neutral, or alkaline discharge with elevated metal and/or sulphate concentration. The management of mined wastes to ensure contaminants are not released to the receiving environment is critical to rehabilitation success.

Separate to geochemical risks, the final cover of the rehabilitated landform must be able to manage erosion risk and be able to support vegetation growth.

Figure 1: Location of Poitrel (Source: Stanmore).

2 SCOPE OF WORK

To assist in the development of the cover design, Landloch completed the following tasks:

- Review existing information on the post mining land use, soils, spoils, and the proposed cover design.
- Model water movement through the proposed cover design (salt was not modelled given salt movement was not identified as a risk to the performance of the cover).
- Produce a report (this document) that:
  - Outlines the intent of the cover design;
  - Summarises the properties of the cover materials to be used;
  - Describes the ameliorants required;
  - Describes the cover design including thicknesses of the required layers; and
  - Outlines the source and quantity of the cover materials required.

3 COVER DESIGN APPROACH

Key to the assessment of the need for a cover design is the identification of the geochemical risks associated with the wastes to be stored within the mining landform. Considering this, the following approach was taken:

- Define the waste type(s) to be stored within the mining landforms at closure;
- Review the geochemical characterisation data for these materials with specific reference to risks posed by:
  - Acidic, neutral, or alkaline discharge,
  - Elevated metal concentrations, and/or
  - Elevated sulphate concentrations.
- Determine the need for a cover; and
- If a cover is required, define the cover; or
- If a cover is not required, state that a cover is not needed.

4 BACKGROUND INFORMATION

4.1 Post mining land use

The Post Mining Land Uses (PMLUs) at Poitrel include:

- Cattle grazing;
- Dryland cropping (not considered applicable);
- Woodland habitat;
- Water Storage (stock use); and
- Watercourse.

The rehabilitated landform will be rehabilitated to cattle grazing and woodland habitat PMLUs. Cattle grazing is to be used for landform sections with pasture vegetation (<15% slope). Woodland habitat is to be used for landform sections with native vegetation (>15% slope).

4.1.1 Rooting depths of target vegetation

Rooting depths of Eucalyptus species are highly variable, and governed by geology and groundwater levels, especially the depth to groundwater as this impedes root growth (Eamus *et al.* 2006). There are very few empirical studies that have assessed actual rooting depths, especially in native vegetation communities.

The bulk of the fine roots in eucalypts (i.e. those frequently involved in active plant water use) are found within the surface 0.3–0.5m of soil (Ochoa-Hueso *et al.* 2020). Species can access water at greater depths if required (i.e. dry surface soil profiles) and depending on the groundwater level and its hydrodynamics. Maximum rooting depths for the species present in the proposed target ecosystems are commonly in the order of 4–7m.

Therefore, it was concluded that – for the purposes of supporting vegetation – a rehabilitation cover profile should contain a surface layer 0.3–0.5m thick made from materials suitable for plant growth, and that the underlying materials will be required to provide additional water storage and structural support for the larger vegetation. The surface layer could consist of soils or other materials (e.g. subsoils or spoils) that are shown to be suitable. The current revegetation plan includes the use of 0.1—0.15m of soil, and this can overlie or be mixed into (in the case of the woodland PMLU) a Fresh Permian overburden.

4.2 Materials available for rehabilitation

4.2.1 Stockpiled soils

Information on stockpiled soils and their location was provided by BHP (the previous owner). The approximate total volume of available stockpiled soil is 2,793,354m^3. Locations of soil stockpiles on PTM are presented in Figure 2. Soil stockpile characterisation occurred in 2022 (Landloch 2023). A total of 84 samples were collected from 21 locations within soil stockpiles. Stockpiled soils were named and categorised into two groups:

- Red/Brown Clays; and
- Red/Grey Loams.

Red/brown clays are the dominant soil stockpiled at Poitrel. In general, they are dark brown, brown, or reddish brown in colour with textures of clay loam to medium clay. Gravel content is generally <10%, although sometimes gravel content of up to 20% is present. All red/brown clays were non-sodic and generally stable. Erodibility studies conducted on a similar clay topsoil at an adjacent mine site indicate these soils are comparable to the most stable clay topsoils available for rehabilitation in the region.

Red/grey loams form a minor portion of stockpile soils at Poitrel. Less than 15% of samples collected are characterised as loams. In general, they are pale red, pale grey, or grey in colour, with textures of sandy loam to sandy clay loam. Gravel content is 10—20%. All red/grey loams were non-sodic but susceptible to slaking and dispersion.

A summary of key chemical and physical properties of these soils is given in Table 1.

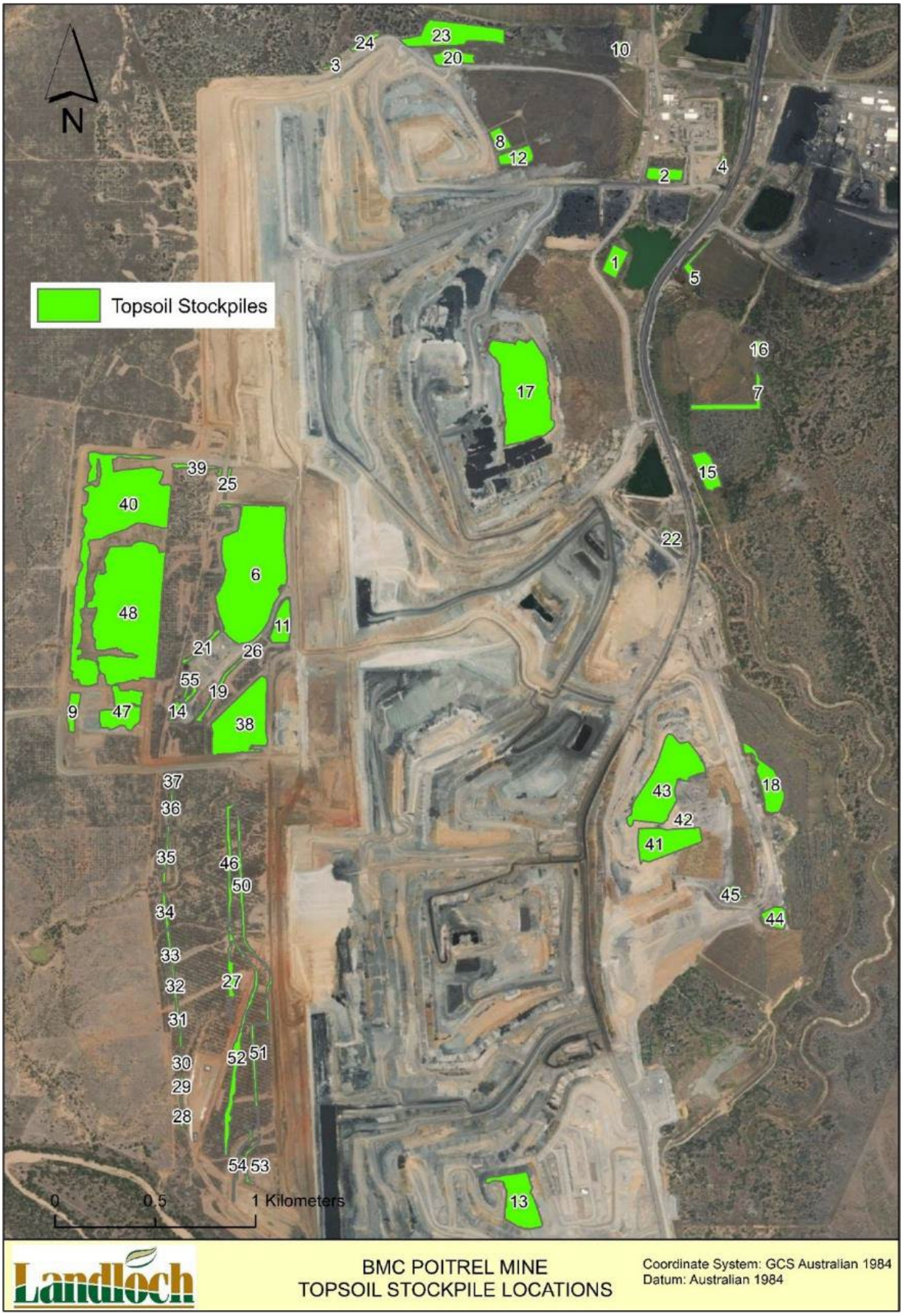

Figure 2: Stockpiled topsoil materials across Poitrel.

Table 1: Summary of key chemical and physical properties for stockpiled soils.

Analysis	Red/Brown Clay	Red/Grey Loam
pH_w (pH units)	Neutral to strongly alkaline (7.1–8.5)	Neutral to strongly alkaline (6.9–8.5)
$EC_{1:5}$ (dS/m)	Low to moderate (0.9–0.28)	Low (0.12–0.14)
ESP (%)	Non-sodic (1.2–4.9)	Non-sodic (2.8–3.5)
Total N (mg/kg)	Low the moderate (270–1,384)	Low (396–471)
Available P (mg/kg)	Low (4–16)	Low (4–14)
Available K (mg/kg)	Low the moderate (76–364)	Low the moderate (124–222)
Organic C (%)	Low to moderate (0.57–1.82)	Low (0.29 – 0.83)
Clay content (%)	>30	<30
Rock content (%)	<20	10 – 20
Dispersion (EAT)	Slightly dispersive to stable (3b–7)	Slightly dispersive to slaking (3b–5)

Note: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed.

4.2.2 Spoils

Geochemical and physical characterisation data for the spoil were collated from multiple assessments conducted throughout the project. These included:

- *Poitrel Mine – Final Void @ Landform Management Plan, June 2015* (BHP Mitsui Coal 2010);
- *Soil and waste erodibility and landform design: Daunia Mine* (Landloch 2017);
- *Poitrel Coal Mine Project – Environmental Impact Statement* (BHP Billiton, 2005); and
- *BHP ALL SITES Coal Tailing and Rejects All Sites Earth Systems laboratory data spreadsheet* (BHP 2022).

Wastes at PTM were found to be very similar to the neighbouring Daunia Mine (~1km). Therefore, many physical properties are associated with the erodibility testing Landloch completed in 2017 (Landloch 2017).

A summary of key chemical and physical properties is presented in Table 2. Additional waste characterisation testing is in progress at PTM. Initial results indicate similar results to those outlined above. However, if this more recent report indicates different ranges to those outlined in Table 2, those more recent results would supersede the ranges outlined in Table 2.

Table 2: Summary of key chemical and physical properties for spoils at Poitrel.

Analysis	Spoil Material	
	Permian Overburden	Weathered Sediments and Clay Interburden
pH_w (pH units)	Moderate to strongly alkaline (8.0–9.5)	Neutral to strongly alkaline (7.0–9.0)
$EC_{1:5}$ (dS/m)	Low to moderate (0.18 – 0.82)	Moderate to high (0.51 – 1.20)
ANC (H_2SO_4/t)	High (20–30)	High (20–50)
PAF	No	No
ESP (%)*	Non-sodic to strongly sodic (5–27)	Sodic to strongly sodic (6–24)
Metals	Comparable to background levels	Comparable to background levels
Clay content (%)	<25	>35
Rock content (%)	>30	<20
Slake durability (%)	Moderate (50–75)	Low (<50)
Dispersion (EAT)	Dispersive (2)	Dispersive (2)

4.2.2.1 Overburdens

Characterisation of the overburdens was undertaken as part of the EIS (BHP Billiton 2005) and throughout the life of the mine, subsequent analysis of overburdens has been conducted by BHP (the previous owner). Broad overburden characteristics were found to be similar across all studies and identify two spoil management groups:

- Permian spoil (overburden); and
- Weathered sediments and clay spoil (interburden).

Both spoil management groups have identical properties to spoils characterised at the nearby Daunia Mine. Therefore, it is assumed erodibility properties of Poitrel overburdens can be inferred from the testing conducted by Landloch in 2017 on Daunia.

Generally, Permian overburden is a rocky material consisting primarily of sandstone, siltstone, and claystone with clay content below 25%, resulting in low water holding capacity. It is generally grey or pale brown in colour. Permian overburden properties can vary depending on the strata location and degree of carbonaceous inclusions present. The materials are sodic and dispersive.

Fresh Permian is considered the most suitable option as a growth medium. Fresh or recently stripped Permian sandstone that has not be exposed to extended periods of weathering could be used in the upper growth media profile to greatly increase batter slope resistance to erosion while vegetation establishes.

The volume of fresh Permian overburden at PTM has been estimated at approximately 400Mbcm. However, the source and availability of this material (beyond it being located within the current waste landform) is currently unknown.

4.2.2.2 Interburden

The weathered sediments and clay interburden is a highly weathered material containing portions of fragile rock and a clay content of >35%, resulting in moderate to high water holding capacity. It is typically pale orange to brown in colour. The materials are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Key chemical and physical properties are summarised in Table 2.

Placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended due its high erodibility. Consideration could only be given to use as a secondary growth medium on flat or very low gradient areas if the intended material has no chemical limitations to vegetation growth.

4.2.3 Coal rejects

Initial analysis of interburden material, representative of coal rejects for Poitrel, was completed as part of the Environmental Impact Statement (EIS) (BHP Billiton 2005). Over the life of the mine subsequent analysis of reject samples for acid/base and salinity characteristics has been conducted by BHP (the previous owner). The materials were found to have the following properties:

- Variable sulphur content, but low acid generating capacity;
- Strongly alkaline; and
- Low to moderate salinity.

The rejects are currently not being considered as a rehabilitation resource but can be considered a benign bulk fill material.

4.2.4 Geochemical hazard

The vast majority of wastes from Poitrel (overburden and interburden) are considered non-acid forming and pose a low risk in terms of acid drainage, neutral metalliferous drainage, and saline drainage. As such, no specific management measures are expected to be required to manage geochemical risks posed by the wastes during rehabilitation and closure, outside of:

- Operational spoil placement and landform reshaping activities already proposed in the PRC plan; and
- Requirements to create a cover that can support the PMLU.

4.3 Ameliorants

Application rates for fertiliser and other ameliorants for soils are dependent on the intended PMLU for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus

based ameliorants would be recommended for these areas. As a guide amelioration application should aim to provide:

- Phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40 mg/kg;
- An appreciable source of starter nitrogen;
- Adequate macro and micronutrients; and
- Reduced potential for dispersion.

Further information of amendments can be found in the material characterisation report (Landloch 2022). A summary of the information is provided below.

4.3.1 Gypsum

Gypsum has been recommended for sodic/dispersive materials or where calcium is low. It should be applied during soil preparation stages, in a manner that allows for as thorough mixing as is practicable of the surface materials. Gypsum should be applied prior to seeding and fertilising.

The depth to which sodicity is ameliorated should be dependent upon erosion risk/gradient. For slopes with gradients:

- less than approximately 35%, incorporate gypsum into the upper 0.3m of sodic materials; and
- greater than approximately 35%, incorporate gypsum into the upper 0.5m of sodic materials.

Considering the annual rainfall depth at PTM is approximately 520mm, it is expected that, as a 'rule of thumb', gypsum will dissolve at a rate of 0.5–1t/ha per year. Hence, there is benefit in applying gypsum at recovery of materials, or as soon as is practicable in the rehabilitation program.

4.3.2 Fertiliser

A balanced NPK fertiliser such as Crop King (CK) 55 (N: ~13.5%, P: ~15 %, K: 12.5%) and slow-release nitrogen source such as coated urea (N: ~46%) or organic compost is recommended to provide a balanced source of nutrients to plants during rehabilitation. Any composted material should comply with the Australian Standard for Composting (AS4454-2012).

Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. Spreaders are typically suitable for slopes with gradients less than 35%, and pneumatic or hydraulic applications will be required for steeper slopes.

Accurate application rates should be determined by a suitably qualified person prior to use in rehabilitation.

4.4 Cover thickness

The required thickness of cover was modelled using the desktop version of the HowLeaky model (McClymont *et al* 2008). HowLeaky was developed with support of the Queensland Government Department of Environment and Science (DES) under a partnership between DES and University of Southern Queensland. The model was used to consider water balance impacts caused by different surface material profile conditions. HowLeaky parameters for climate, materials, and vegetation are required.

Climate data used was sourced for -22.00°S, 148.15°E from 1 January 1960 to 31 December 2023 from the Queensland Government's SILO (Scientific Information for Land Owners) data drill data sets. The average annual rainfall for the period was 574mm, and mean monthly rainfall values are shown in Figure 3. The largest daily rainfall total in the record was 163mm, 7 days had rainfall greater than 100mm, and 100 days had rainfall greater than 50mm.

The required materials data relate to moisture holding capacity and runoff potential. Typical water holding capacity data for a clay textured material were used (Hazelton and Murphy 2016): field capacity 40% and wilting point 25%. Air dried moisture content was set at 9% and saturated moisture content was set at 46%, based on pedotransfer functions in the Rosetta soil hydraulic parameter estimation tool that relate material texture to hydraulic parameters (Schaap 2001). Bulk density was set to 1.5g/cm^3, consistent with a clay-rich material. Maximum drainage of 150mm/day in the surface 250mm and 110mm/day in the sublayer was set based on recommendations given in the HowLeaky model (surface layer) and values derived from the Rosetta soil hydraulic parameter estimation tool (sublayer), respectively.

The runoff curve number was set to 77, consistent with soils that:

1. Have slow infiltration capacity such as clay textured soils, and
2. Are supporting good quality grazing or open woodland vegetation (>75% grass cover) (Ponce 1989).

Figure 4 shows the relationship between thickness of the cover layer and the predicted drainage expressed as a percentage of rainfall (black line labelled 'Modelled Conditions'). Drainage essentially reaches a minimum at a layer thickness of 1.0m. Therefore, adoption of a 2m thick cover is recommended to allow for erosion of the cover over time, and for some variation in the layer thickness actually applied by machinery during the rehabilitation. This thickness of cover could include a soil layer (0.1—0.15m thick) overlying a suitable spoil that is not hostile to vegetation growth, such as Fresh Permian waste.

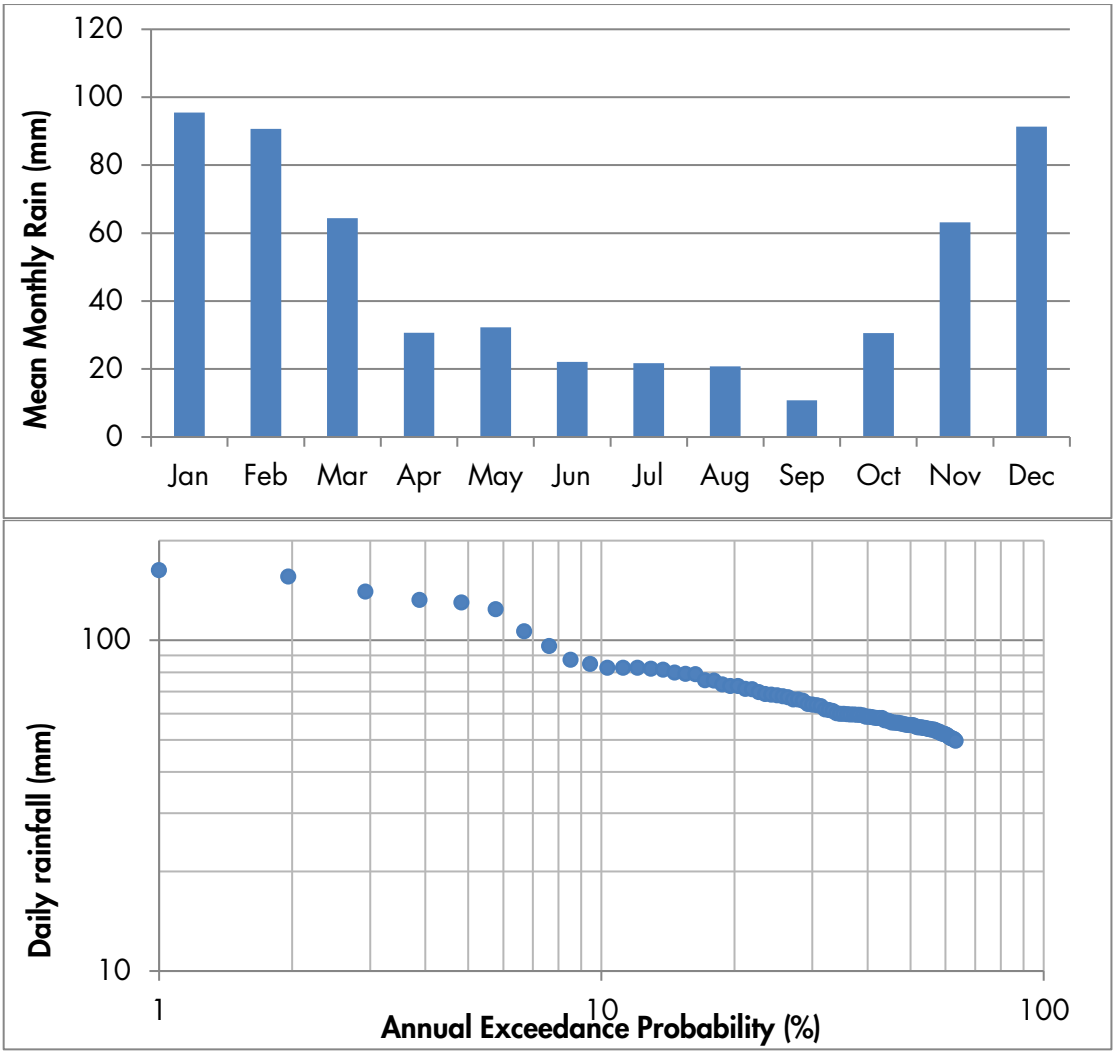

Figure 3: Mean monthly rainfall for SWC for Jan 1960 to Dec 2023 (top) and annual exceedance probability of daily rainfall events in the same period (bottom).

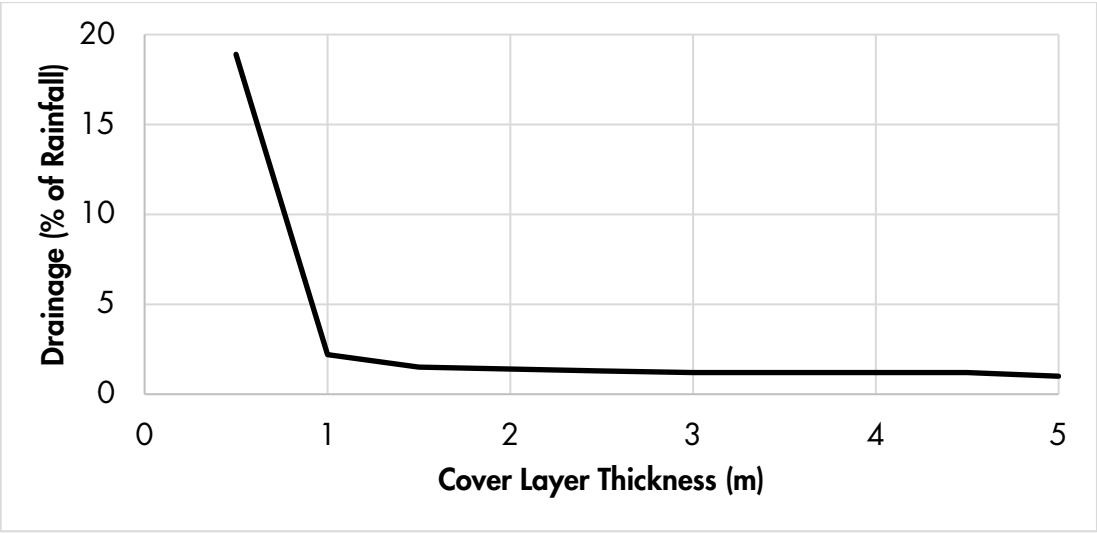

Figure 4: Predicted drainage from the base of a cover layer with thickness ranging from 0.5m to 5m.

5 COVER DESIGN

The geochemical assessment has shown that the wastes are not anticipated to pose a significant risk in terms of acid, neutral metalliferous, or saline drainage, or elevated metal and/or sulphate concentration in surface waters or groundwaters. As a result, a specific engineered cover design to address these risks is not required. Therefore, the intent of the cover design is to manage erosion risk and support vegetation growth.

The cover profile recommended to manage erosion risk and support vegetation growth is as follows:

- A topsoil surface layer with a minimum thickness of 0.10m placed on grazing PMLU area, to support ≥80% groundcover. This would overlie a minimum 1.9m thick layer of non-acid forming fresh Permian waste.
- A topsoil surface layer with a minimum thickness of 0.10m mixed with fresh Permian overburden at a ratio of 2–4 parts fresh Permian rock to 1 part topsoil placed on woodland PMLU area, to support >30% vegetation groundcover (>50% for improved performance). This would overlie a minimum 1.9m thick layer of non-acid forming fresh Permian waste.

6 ASSUMPTIONS AND LIMITATIONS

Assumptions and limitations relevant to the cover design include:

- The fresh Permian overburden is used as a cover over the less suitable Tertiary overburden.
- The fresh Permian overburden poses a low risk and acid, metalliferous and saline drainage, such that the intent of the cover is for management of erosion and promotion of vegetation growth.
- Fresh, benign, rocky Permian overburden can be sourced in sufficient quantities to achieve the required cover.
- Identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability may be required to allow the cover design specifications to be met. Further, processes by which future mining can segregate suitable wastes is recommended.
- Vegetation groundcover levels of ≥80% can be sustainably achieved for the grazing PMLU.
- Vegetation groundcover levels of >30% can be sustainably achieved for the woodland PMLU.

7 CONCLUSIONS AND RECOMMENDATIONS

Wastes to be stored within landforms at Poitrel do not require a dedicated cover design to manage any geochemical risks. Therefore, the intent of the cover design is to manage erosion risk and support vegetation growth.

The cover profile recommended to manage erosion risk and support vegetation growth is a minimum 0.1m growth media layer (topsoil and topsoil/fresh Permian rock for Grazing and Woodland respectively) overlying a 1.9m minimum fresh Permian layer (2.0 total cover depth).

The revegetation plan (Landloch 2024) addresses the plant growth needs of the surface layers of the rehabilitated landforms.

Adoption of a 2m thick cover is recommended to allow for erosion of the cover over time, and for some variation in the layer thickness actually applied by machinery during the rehabilitation. This thickness of cover could include the soil layer (0.1—0.15m thick) overlying a suitable fresh Permian overburden.

The weathered sediments and clay interburden is a highly weathered material containing portions of fragile rock and a clay content of >35%. They are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Placement of this material close to the final rehabilitated surface or its use for the construction of flow control structures (e.g. contour banks and drains) is not recommended.

The supply of fresh, benign, rocky Permian overburden is limited by the current site practice of not segregating wastes by their function/use for rehabilitation and closure. As a result, identification of sources of fresh, benign, rocky Permian overburden from within the existing waste landform and confirmatory testing of its suitability will be required. Further, processes by which future mining can segregate suitable wastes is recommended.

Application rates for fertiliser and other ameliorants for soils are dependent on the intended PMLU for a rehabilitated area. For example, cattle grazing requires generation of biomass from the growth media and planted grass species. Nitrogen and phosphorus based ameliorants would be recommended for these areas.

Gypsum has been recommended for sodic/dispersive materials or where calcium is low. It should be applied during soil preparation stages, in a manner that allows for as thorough mixing as is practicable of the surface materials. Gypsum should be applied prior to seeding and fertilising. The depth to which sodicity is ameliorated should be dependent upon erosion risk/gradient. Details of this are provided in Section 4.3.

A balanced NPK fertiliser such as Crop King (CK) 55 (N: ~13.5%, P: ~15 %, K: 12.5%) and slow-release nitrogen source such as coated urea (N: ~46%) or organic compost is recommended to provide a balanced source of nutrients to plants during rehabilitation. Any composted material, if used, should comply with the Australian Standard for Composting (AS4454-2012). Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. More detail is provided in Section 4.3.

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Appendix 10 Flooding Assessment (25 June 2024)

ENGENY

STANMORE RESOURCES LTD

Poitrel Mine PRCP

Rehabilitation Flood Assessment

QC1024_005-REP-001-3

25 JUNE 2024

DISCLAIMER

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	1/05/2024	Client Issue	Chris Harris	Annaliese Mitchell	Chris Harris	Samantha Breslin
1	27/05/2024	Final Issue	Chris Harris	Annaliese Mitchell	Chris Harris	Samantha Breslin
2	14/06/2024	Client Issue	Sean Willis	Samantha Breslin	Chris Harris	Samantha Breslin
3	14/06/2024	Client Issue	Sean Willis	Chris Harris	Chris Harris	Samantha Breslin
Signatures:						

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1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) has been engaged by Stanmore Resources Limited (Stanmore) to undertake a flooding assessment of the Poitrel Mine proposed final landform as part of progressive rehabilitation and closure planning.

Poitrel Mine (PTM) is located 20 km southeast of Moranbah and approximately 140 km south-west of Mackay in the northern Bowen Basin, Queensland (Figure 1.2). Mining is authorised on mining leases (MLs) ML4749 and ML70116, under Environmental Authority (EA) EPML00963013 (effective 12 July 2022). PTM comprises a series of open-cut pits and shares process and rail facilities with neighbouring Millennium Mine to the immediate north.

This report details the flood modelling conducted, and an assessment of the final landform's susceptibility to impacts due to flooding. It has been prepared to address Section 3.6.1 'Flooding' of the Department of Environment and Science's (DES) *Guideline: Progressive rehabilitation and closure plans (PRC plans)* (PRCP Guideline*)* (DES, April 2023).

1.1 Scope of Works

As per the PRCP Guideline, a hydrologic model of the catchment and a hydraulic model of the proposed mining area was developed to address the following requirements:

- The location of domains in relation to potential flood levels for the 1%, 0.1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF).
- Alteration of flow upstream and downstream.
- Model flood levels (including probable maximum flood levels) for a range of design storm events.
- Develop a flooding risk profile.

1.2 Final Landform

The conceptual final landform presented in Figure 1.1 was developed by Stanmore and provided to Engeny for use in this assessment. The following items related to the final landform should be noted when considering the modelling outputs:

- The final landform topography data did not extend over a portion of the hydraulic model assessment area. Additional Shuttle Radar Topographic Mission (SRTM) topography data was used to complete the model topography required:
  - The final landform was not easily integrated with this data. Some smoothing and merging of topography data has been undertaken to form a realistic topography model.
- This assessment does not address the efficacy of the final landform design and seeks only to identify the key risks related to flooding behaviour and the interaction with the final landform.
  - Further design is incorporated into rehabilitation milestones to address and manage the risks presented by the current revision of the final landform. That is, additional drainage or monitoring of the final landform embankment will be considered as part of re-habilitation milestones, to manage the flooding risk to an acceptable level.

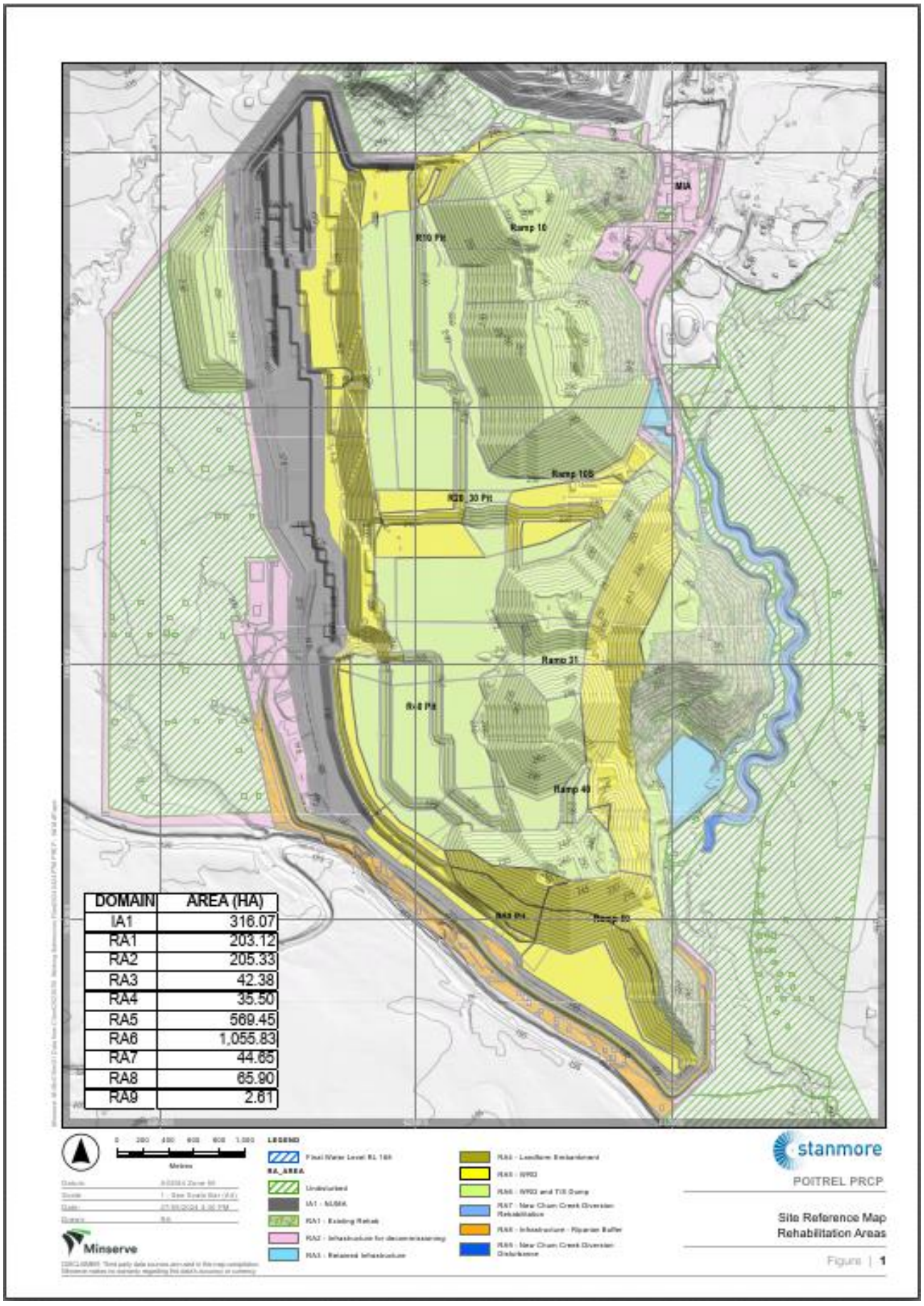

Figure 1.1: Final Landform Design

1.3 Site Information

Poitrel Mine is located 20km South-East of Moranbah township in the Queensland Bowen Basin. Refer to Figure 1.2 for further information.

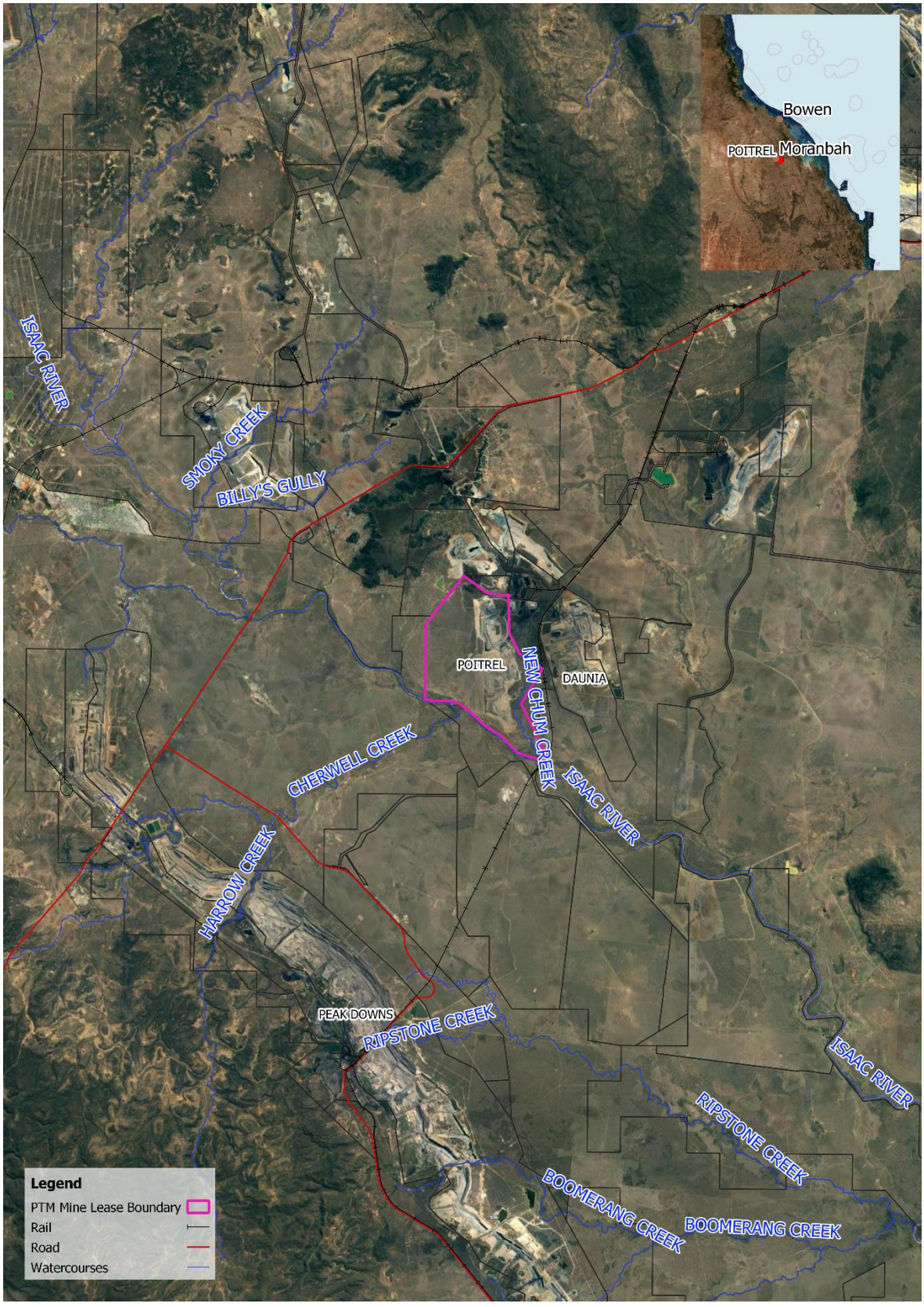

Figure 1.2: Site Location

2. HYDROLOGY

Engeny has developed a runoff routing hydrological model using Watershed Bounded Network Model (WBNM). The following sections of this report detail the inputs for the WBNM built for PTM and the hydrological outputs.

2.1 Catchment Inputs

Sub-catchment delineation for PTM was developed using the final landform topography previously displayed in Figure 1.1. The hydrological model includes the total catchment for Isaac River to past the Daunia mine further downstream, a total area of approximately 3687 square kilometres.

The final landform is proposed to be fully rehabilitated apart from a portion at the bottom of pit voids that will remain as spoil and/or pit lake. The hydrology model has assumed no impervious surfaces remain and a 0% impervious fraction (F_i) for catchments areas below and including the remaining spoil areas within pits.

Figure 2.1 provides the PTM sub-catchment extents used for the WBNM, and Appendix A provides the catchment inputs for WBNM.

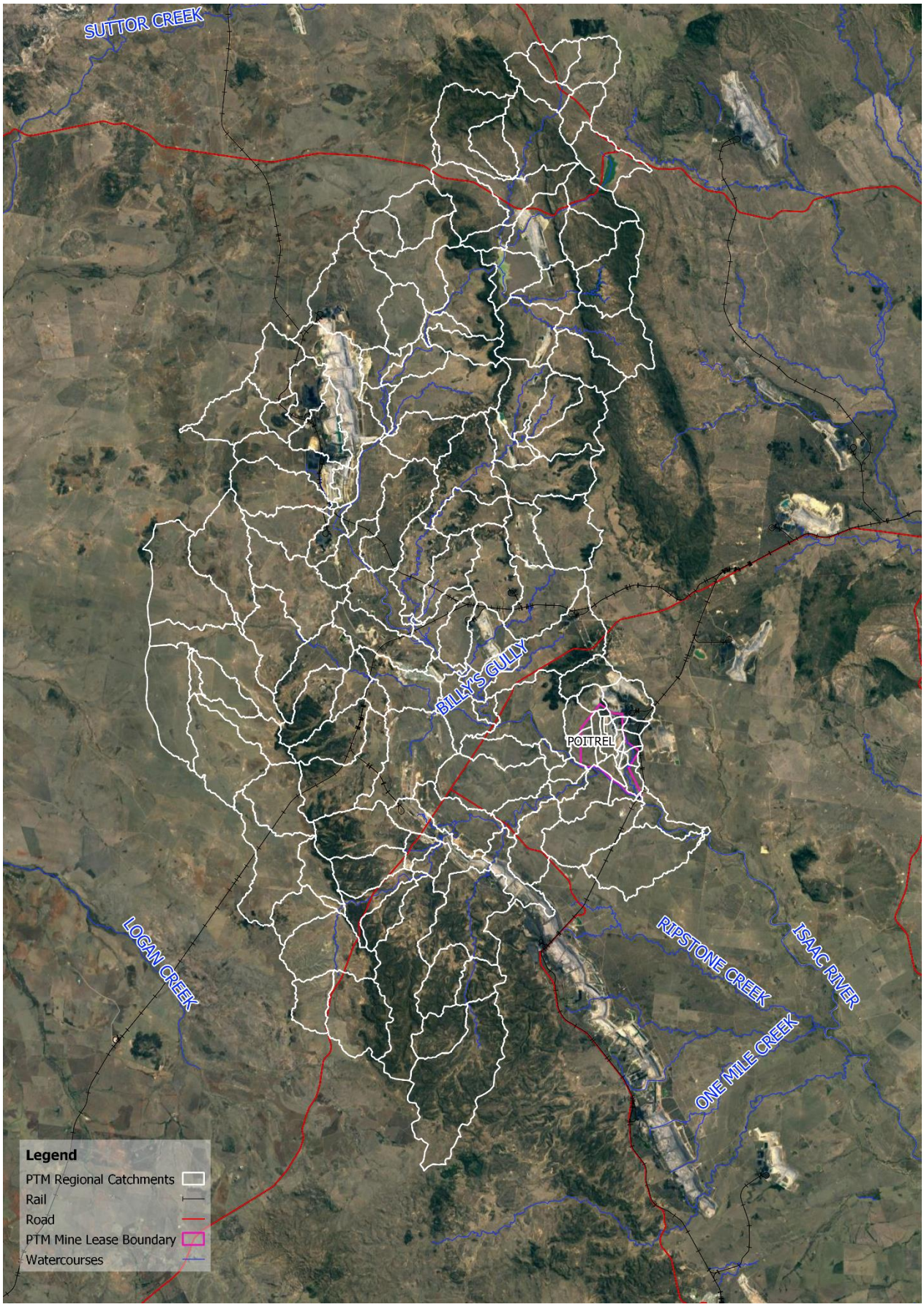

Figure 2.1: Poitrel Mine WBNM Sub-Catchments – Total

2.2 Hydrological Inputs

The following sections detail the hydrological inputs, gathered in accordance with the Australian Rainfall & Runoff 2019 (ARR2019) Guidelines.

2.2.1 Design Rainfall

The 1% AEP (100yr) and 0.1% AEP (1000yr) were sourced using the Australian Rainfall and Runoff 2019 IFD generation tool available on the Bureau of Meteorology (BoM) website (www.bom.gov.au), at Latitude 28.6625 (S), Longitude 153.6125 (E). Areal Reduction Factors (ARF) have been applied for all design events.

2.2.2 Extreme Events

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 the 6-hour duration. The Revised Generalised Tropical Storm Method (GTSMR) was used to estimate PMP rainfall for event durations greater than or equal to 24hours, rainfall depth estimates for PMP event durations between the 6 hour and 24 hour were interpolated.

2.2.3 Temporal Patterns

Design events (1% - 0.1% AEP) have utilised the 'East Coast North' point temporal patterns, with all ten temporal patterns being simulated. Durations assessed range from 12 hours to 168 hours.

For the PMP event, the full historical ensemble of ten temporal patterns (plus AVM) have been simulated. Durations simulated range from 12 hours to 168 hours.

2.2.4 Initial and Continuing Losses

The initial and continuing loss used for each modelled event AEP have been summarised in Table 2.1 below.

TABLE 2.1: HYDROLOGY INITIAL AND CONTINUING LOSS PARAMETER

Event AEP	Initial Loss	Continuing Loss)
1%	5	2
0.1%	0	2
PMP	0	1

2.2.5 Other Model Parameters

The default stream lag factor of 1.3, pervious lag parameter of 1.8 and impervious lag parameter of 0.1 have been adopted for the WBNM.

2.3 Model Validation

The 1% and 0.1% AEP peak flow for the PTM model has been validated using two available methods: the Regional Flood Frequency Estimation (RFFE) Method (ARR, 2021), and a scaled Flood Frequency Analysis (sFFA). Each method uses the following information:

- RFFE: is a recommended peak flow validation method from the ARR 2019 guidelines (Ball, et al., 2019). The RFFE provides peak flow estimations based on the catchment area and a catchment shaping factor, determined using the catchment centroid and outlet coordinates. The RFFE peak flow estimates were calculated using the ARR RFFE Model online tool (http://rffe.arr-software.org/).
- FFA: provides peak flow estimates for different AEPs by developing a fitted distribution from recorded peak flows from historical flood events.

2.3.1 Scaled Flood Frequency Analysis

This assessment was undertaken using the data available on the Water Monitoring Information Portal (WMIP), with the closest gauge downstream of the site being Gauge 130410A, which has been in operation since 20/05/1968. A summary of the yearly maximum is provided in Table 2.2. A Low Outlier Test was undertaken on the recorded gauge data using the Multiple Grubbs-Beck Test. The Multiple Grubbs-Beck Test identified a threshold value minimum of 68 m^3/s, flows below this value have been removed from the sFFA analysis.

TABLE 2.2: 130410A GAUGE ANNUAL RECORDED PEAK FLOWS

Year	Annual Peak Flow (m^3/s)	Year	Annual Peak Flow (m^3/s)
1967	0	**1995**	236
1968	3	**1996**	1198
1969	220	**1997**	1706
1970	102	**1998**	581
1971	188	**1999**	144
1972	233	**2000**	638
1973	1261	**2001**	68
1974	424	**2002**	195
1975	533	**2003**	350
1976	156	**2004**	20
1977	1703	**2005**	308
1978	2113	**2006**	401
1979	179	**2007**	2142
1980	608	**2008**	466
1981	83	**2009**	501
1982	1124	**2010**	1827
1983	307	**2011**	1122
1984	137	**2012**	263
1985	142	**2013**	1
1986	184	**2014**	205
1987	2638	**2015**	1791

Year	Annual Peak Flow (m^3/s)	Year	Annual Peak Flow (m^3/s)
1988	2137	**2016**	1625
1989	235	**2017**	25
1990	2429	**2018**	30
1991	110	**2019**	56
1992	0	**2020**	610
1993	753	**2021**	214
1994	**30**	**2022**	**353**

The flood frequency analysis has used the Log-Normal Distribution Fitting Analysis approach for this assessment and is presented in Figure 2.2. An assessment of WBNM peak flow estimates has been undertaken to validate the WBNM modelling as suitably accurate based on its comparison to Flood Frequency results taken from real-world gauge data. The outcome of the validation process has been provided in Table 2.3 and shows the WBNM Peak flows to be reasonably close to the Scaled FFA Peak Flow Estimate analysis.

Table 2.3 provides a summary of the 1% and 0.1% AEP FFA values, as well as the scaled results. The total catchment of the PTM model was 3687 km^2, whilst gauge 130410A has a total catchment area of 4092 km^2. This has calculated a scaling factor value of 0.935 based on the equation below.

$$Q_u = \left(\frac{A_u}{A_g}\right)^n Q_g$$

Where Qu is the estimated peak flow for the ungauged catchment, Au is the area for the ungauged catchment, Ag is the catchment area for the stream gauging station, Qg is the peak flow for the gauging station determined from the flood frequency analysis and the exponent n is determined from the regional flood frequency regression analysis undertaken by the Queensland Department of Transport and Main Roads (Palmen & Weeks, 2008).

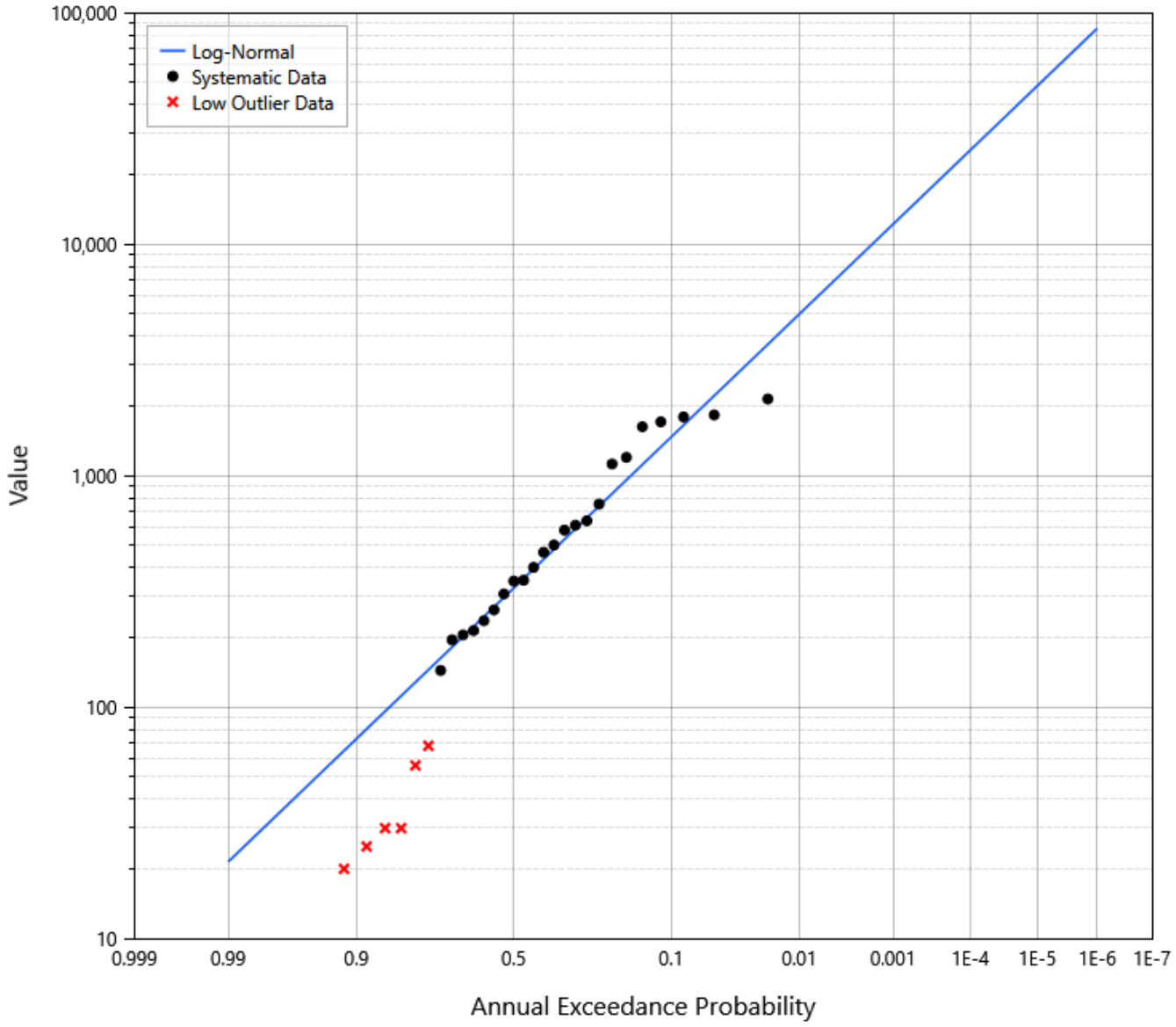

Figure 2.2: 130410A - Log Normal Flood Frequency Plot

An assessment of WBNM peak flow estimates has been undertaken to validate the WBNM modelling as suitably accurate based on its comparison to Flood Frequency results taken from real-world gauge data. The outcome of the validation process has been provided in Table 2.3 and shows the WBNM Peak flows to be reasonably close to the Scaled FFA Peak Flow Estimate analysis.

TABLE 2.3: 130410A FFA AND SCALED FFA PEAK FLOW

Event	FFA Peak Flow (m^3/s)	Scaled FFA Peak Flow Estimate (m^3/s)	WBNM Peak Flows (m^3/s) (PTM_137)
0.1% AEP	12,180	11,389	10,720
1% AEP	4,981	4,658	5,429

2.4 Model Results

For the purposes of identifying the critical events to simulate in the hydraulic model, two focus points have been identified; the critical events at the Isaac Creek confluence (PTM_134) and the critical events for the local catchments surrounding the final void (C_15). The peak flow, critical duration, and temporal pattern for each of these catchments for all simulated events have been provided in Table 2.4.

TABLE 2.4: BME WBNM PEAK FLOW RESULTS

	Isaac River Catchment (PTM_134)		PTM Local Catchment (C_15)	
Event	**Peak Flow (m^3/s)**	**Critical Duration & Temporal Pattern**	**Peak Flow (m^3/s)**	**Critical Duration & Temporal Pattern**
PMF	37,044	24hr_tp4	1,963	4hr_tp1
0.1% AEP	10,438	24hr_tp8	359	18hr_tp1
1% AEP	5303	24h_tp8	206	18hr_tp1

3. HYDRAULICS

Engeny has developed a two-dimensional hydraulic model using TUFLOW. The following sections detail the key model inputs and present hydraulic model results.

3.1 Model Inputs

3.1.1 Boundary Conditions

The inflow boundary conditions apply the hydrographs generated for flows to Isaac River and local catchments to the hydraulic model. Source area inflow locations within the model have been applied using a flow over area boundary, the location of these flow source areas is based on the reporting location of the sub-catchments they relate to.

The models downstream outflow boundary has used an auto-generated stage-discharge relationship based on an outlet slope of 0.1%. Note the location of the downstream boundary has been moved downstream to of the poitrel site to reduce the impact of downstream boundary outflow conditions on results closer to the Poitrel site. The location of all boundary conditions is provided in Figure 3.1. In this way, alteration of flows downstream have been considered in the model design.

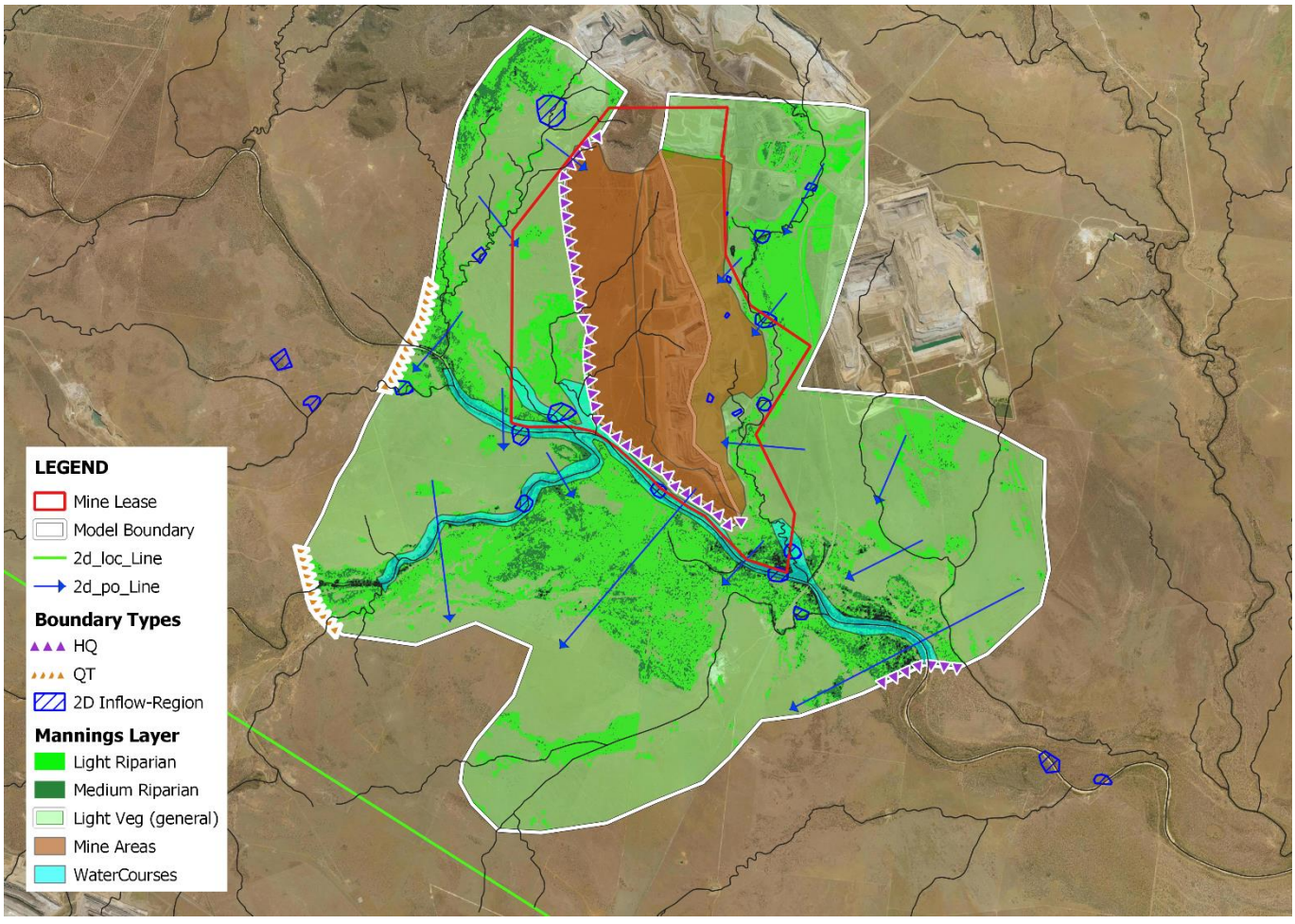

Figure 3.1: PTM Final Landform TUFLOW Build

3.1.2 Surface Roughness

The hydraulic roughness (Manning's 'n') values applied in the TUFLOW model were adopted based on aerial imagery and channel geometry. The adopted Manning's 'n' Roughness values are summarised in Table 3.1, with the modelled extent provided in Figure 3.1.

TABLE 3.1: MANNING'S ROUGHNESS

Land Use	Manning's 'n'
Low Vegetation (Partially Clear)	0.045
High Vegetation	0.08
Waterbody	0.035
Creek Channel / Watercourse	0.045
Rural Residential	0.1
Mine Area	0.05

3.1.3 Model Resolution & Time Step

The latest TUFLOW GPU/HPC version has been used for this assessment, which involves a variable time step for the model to provide stable hydraulic results. A model cell size of 10m has been used for this assessment.

3.1.4 Terrain Modifications

There was no full LiDAR set available for the entire proposed TUFLOW model boundary, and what was available does not fully cover the Isaac River. Figure 3.2 demonstrates the areas where detailed LiDAR was available, with the remaining model extent being covered using SRTM, which aligned poorly with the detailed LiDAR. Therefore, to accurately represent the Isaac River for the entire model extent, terrain modifications were made to stitch together two separate LiDAR sets to ensure the river was hydraulically consistent.

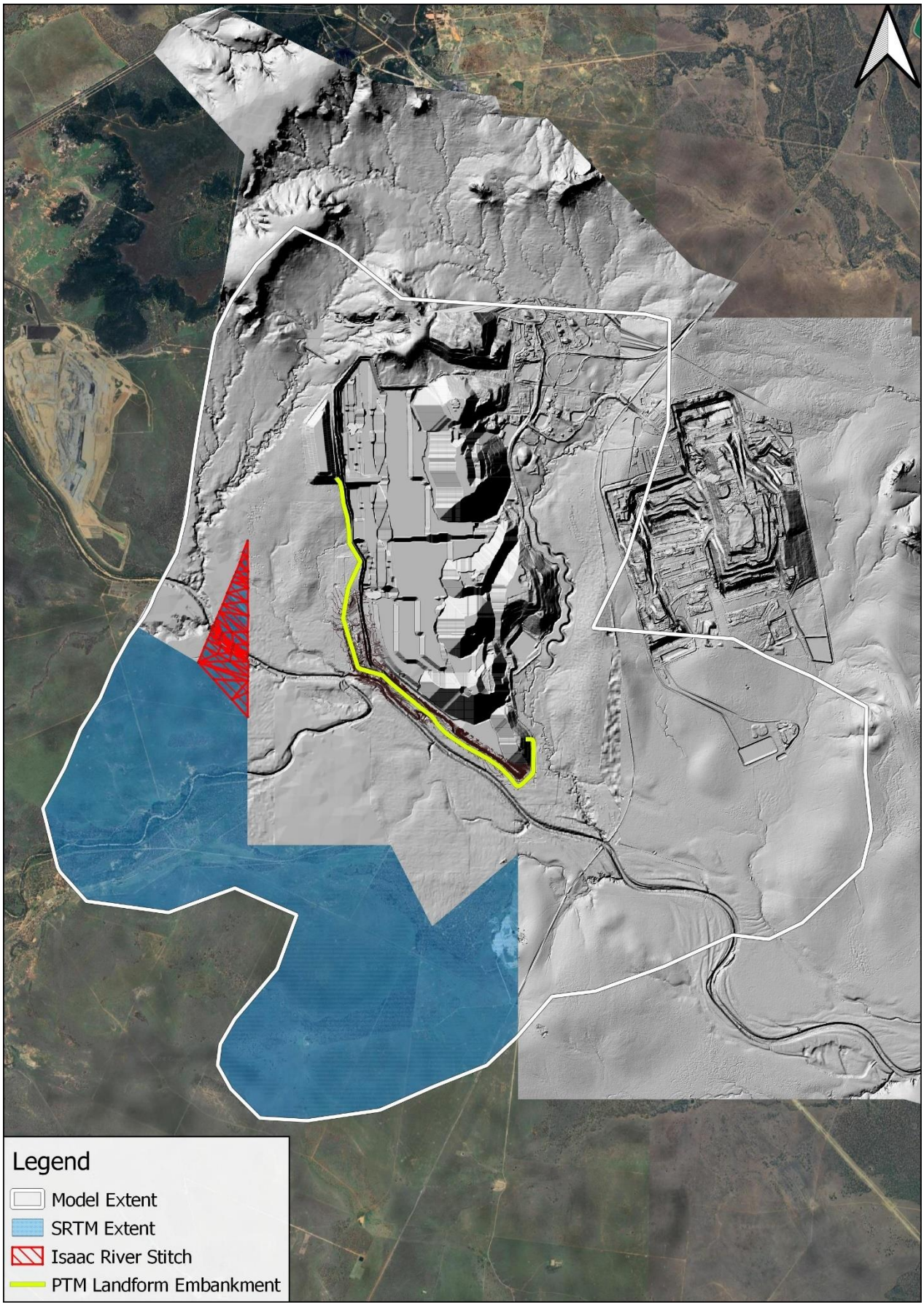

Figure 3.2: PTM Final Landform TUFLOW Terrain Adjustments

4. RESULTS

4.1 Overview

A summary of the findings from the hydraulic model using the PRCP Final Landform are presented below. These findings are based on the hydraulic results for a range of modelled design storm events, being the 1%, 0.1% AEP and PMF flooding simulations. Flood maps presenting depth and velocity results for each AEP are provided in Appendix B.

Model results highlight the following outcomes for the rehabilitated final landform during design flood events:

- The final landform embankment between the Isaac River and R40/ R50 Pit provides flood immunity from 1% and 0.1% AEP flood events in the Isaac River.
- The final landform embankment between Isaac River and R40/ R50 Pit does not provide flood immunity for the PMF, with a depth over the embankment exceeding 2 m at its deepest.
- The configuration of the final landform and the out of pit dumps located on the eastern side of the site (adjacent to Ramp 10, 10S, 31 and 50) prevents flood waters from entering the final void from the eastern side.
- Some artificial features (such as dams, roads and culverts) remain in the provided final landform topography. These features result in trapped areas of ponded water. Where not intended to be infrastructure that remains, future rehabilitation milestones and detailed design should propose to remove these features and render these areas free-draining, and an additional flooding assessment should be undertaken to determine if these changes influence flooding behaviour.
- No stream velocities more than 1.5m/s occurred in flood events up to and including the 0.1% AEP. It is expected that the final landform is likely to have low erosion/scour risk following the establishment of vegetation.
- Stream velocities exceed 1.5m/s in the PMF event against the final landform embankment. Events less frequent but of greater magnitude (i.e. rarer than the 0.1% AEP) may therefore present an erosion/sour risk to the embankment. It is recommended that future monitoring of the embankment considers protection methods to reduce the erosion/scour risk.

The results above support the importance of the rehabilitation milestones associated with future landform establishment including finalisation of engineering and design plans and erosion/scour protection for the PMF event.

4.2 Final Landform Embankment Current Immunity

The final landform embankment adjacent to the Isaac River has been divided into 2 portions for the purposes of the flooding immunity assessment, a northern section which protects the R40 Pit void that will remain as part of the final landform and a southern embankment which protects the R50 pit void that will remain as part of the final landform.

Figure 4.1 below presents the location of the final landform embankment as well as the location where two cross sections through each of the respective embankments and a long section have been extracted to present the current configuration of these structures. The cross section through the northern embankment and southern embankment are presented in Figure 4.2 and Figure 4.3 respectively. As noted previously in this report, results indicate that the current design provides flood immunity for events up to and including the 0.1% AEP event.

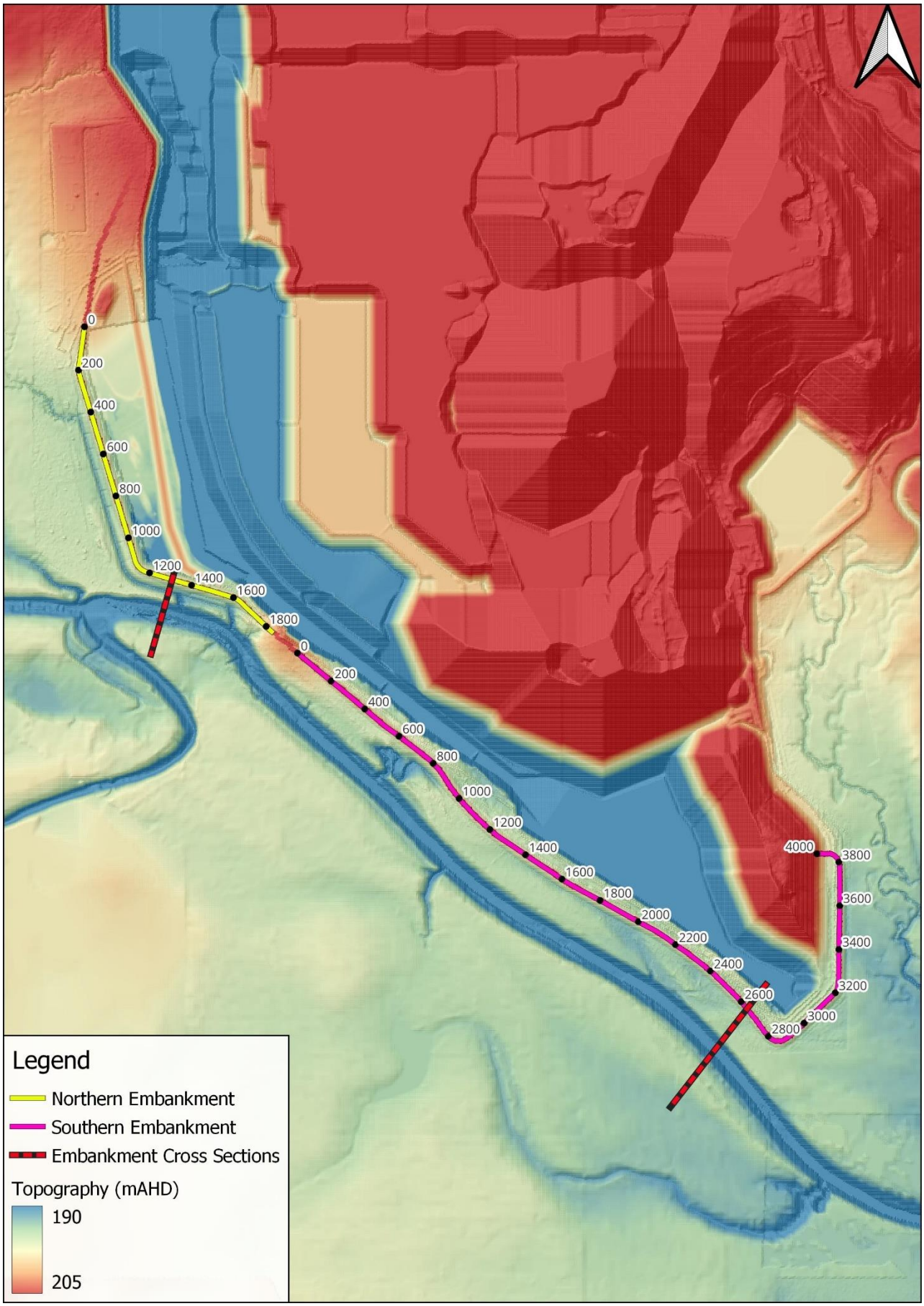

Figure 4.1: Landform Embankment Sections

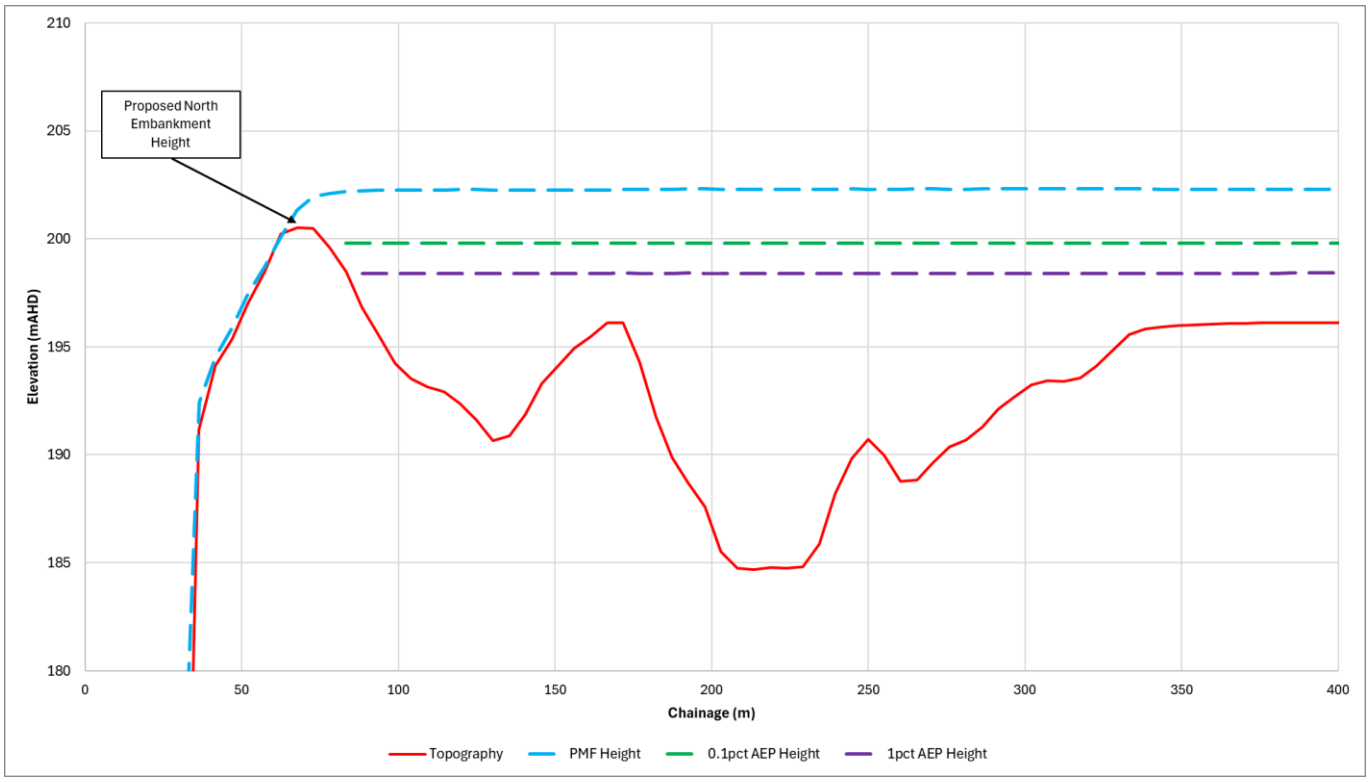

Figure 4.2: Northern Embankment – Cross Section at Chainage 1300 along Final Landform Embankment

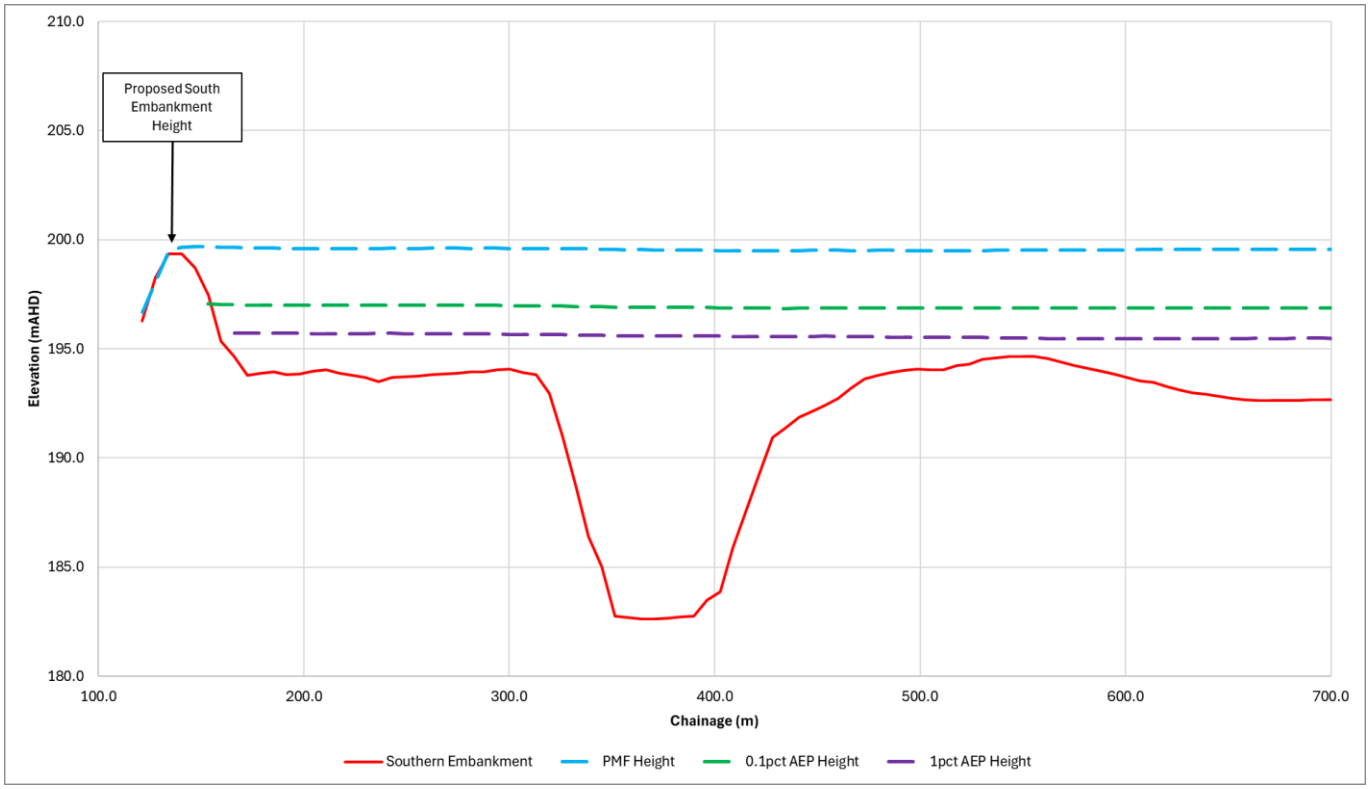

Figure 4.3: Southern Embankment – Cross Section at Chainage 2600 along Final Landform Embankment

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(g) This Report does not provide legal advice.

6. REFERENCES

DES. (2020, August 24). Environmental authority EPML00879213.

DES. (2021). Environmental Authority EA0002465.

APPENDIX A: POITREL MINE WBNM SUB-CATCHMENT INFORMATION

TABLE A.1: PTM WBNM SUB_CATCHMENT INFORMATION

ID	Total Area (ha)	ID	Total Area (ha)	ID	Total Area (ha)
BG1	3231.07	PTM10	1800.83	PTM122	2907.99
C_1	142.63	PTM100	1325.88	PTM123	1818.15
C_10	78.88	PTM101	91.83	PTM123	1818.15
C_11	205.9	PTM102	395.66	PTM123	2023.15
C_12	1743.32	PTM103	777.72	PTM123	2023.15
C_13	290.48	PTM105	4425.73	PTM124	2127.44
C_14	231.13	PTM106	12.63	PTM125	2736.96
C_15	497.18	PTM107	4754.45	PTM126	430.46
C_16	384.5	PTM108	2700.23	PTM13	2462.18
C_17	202.25	PTM11	2288.45	PTM130	518.48
C_18	145.64	PTM110	96.6	PTM131	5263.94
C_19	617.54	PTM111	4003.5	PTM132	614.46
C_2	80.98	PTM112	1905.99	PTM133	1596.84
C_20	302.83	PTM113	721.39	PTM134	392.52
C_3	57.32	PTM114	1637.74	PTM135	38.94
C_4	133.73	PTM115	1253.65	PTM136	1386.8
C_5	411.21	PTM116	3302.77	PTM137	73.46
C_6	43.15	PTM117	1004.83	PTM14	4108.31
C_7	101.29	PTM118	1441.37	PTM15	1762.86
C_8	849.46	PTM119	649.52	PTM16	2782.96
C_9	884.62	PTM12	6476.97	PTM17	5036.93
LE1	2744.3	PTM120	2899.07	PTM18	2711.97

ID	Total Area (ha)	ID	Total Area (ha)	ID	Total Area (ha)
PTM1	2099.89	PTM36	2661.41	PTM56	4143.01
PTM121	25.34	PTM37	3708.23	PTM57	3929.5
PTM19	5819.07	PTM38	6225.68	PTM58	5060.86
PTM2	1616.82	PTM39	5213	PTM59	2521.6
PTM20	1988.9	PTM4	1701.85	PTM6	1870.94
PTM21	3158.75	PTM40	3345.59	PTM60	4985.28
PTM22	2788.35	PTM41	1918.88	PTM61	1651.78
PTM23	2003.82	PTM42	2409.9	PTM62	1680.39
PTM24	3190.28	PTM43	2845.83	PTM63	1935.57
PTM25	3003	PTM44	1541.27	PTM64	2491.23
PTM26	3102.16	PTM45	4695.95	PTM65	1932.74
PTM27	3986.45	PTM46	2201.34	PTM66	7584.41
PTM28	4050.65	PTM47	3053.68	PTM67	4604.98
PTM29	4626.7	PTM49	1851.95	PTM68	2165.14
PTM3	4264.06	PTM5	2317.27	PTM69	9193.29
PTM30	2410.17	PTM50	5906.4	PTM7	3566.34
PTM31	2783.23	PTM51	5204.08	PTM70	3766.77
PTM32	4111.04	PTM52	4854.86	PTM71	1821.75
PTM33	2030.05	PTM53	3592.91	PTM72	1131.36
PTM34	5255.02	PTM54	3251.11	PTM73	4284.55
PTM35	5365.04	PTM55	2720.45	PTM74	1610.9

ID	Total Area (ha)	ID	Total Area (ha)
PTM75	788.23	PTM96	3387.41
PTM76	291.47	PTM97	46.09
PTM77	1369.67	PTM98	82.2
PTM78	4775.75	PTM99	1033.42
PTM79	4360.39	T1	3880.81
PTM8	2355.07	-	-
PTM80	3443.25	-	-
PTM81	1297.09	-	-
PTM82	3549.29	-	-
PTM83	2614.58	-	-
PTM84	4683.39	-	-
PTM86	5688.74	-	-
PTM87	5130.7	-	-
PTM88	622.41	-	-
PTM89	226.39	-	-
PTM9	2830.11	-	-
PTM90	1.5	-	-
PTM91	2144.83	-	-
PTM92	1705.29	-	-
PTM94	2571.05	-	-
PTM95	865.23	-	-
		Total (ha)	**372559.5**

APPENDIX B: FINAL LANDFORM FLOOD MAPPING RESULTS

616,000 618,000 620,000 622,000 624,000 626,000 628,000 630,000 632,000 634,000 636,000 638,000 640,000 642,000

7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- >5.0

R	DETAILS	DATE
1	Final Issue	25-06-2024

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APPROVED	SB	DATE	25-06-2024

NOTES: XXXXXXXXX

N

0 1 2 km

Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Figure 1 - 1% AEP Flood Depth

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-001

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MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- >5.0

R	DETAILS	DATE
1	Final Issue	25-06-2024

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NOTES: XXXXXXXXX

N

0 1 2 km

Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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DATA SOURCE
QLD Government Open Data Source

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Figure 2 - 0.1% AEP Flood Depth

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-002

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Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- >5.0

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NOTES: XXXXXXXXX

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Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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Figure 3 - PMF Flood Depth

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-003

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MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

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0 1 2 km

Scale in metres (70,000 @ A3)
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Figure 4 - 1% AEP Flood Velocity

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-004

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7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

R	DETAILS	DATE
1	Final Issue	25-06-2024

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Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

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QLD Government Open Data Source

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Figure 5 - 0.1% AEP Flood Velocity

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-005

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7,564,000 7,562,000 7,560,000 7,558,000 7,556,000 7,554,000 7,552,000 7,550,000 7,548,000

MIA
Ramp 10
R10 Pit
R20_30 Pit
Ramp 10S
Ramp 31
R40 Pit
Ramp 40
R50 Pit
Ramp 50

Legend

- Model Boundary
- Mining Lease Boundary

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

R	DETAILS	DATE
1	Final Issue	25-06-2024

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DRAWN	SW	CHECKED	CH
APPROVED	SB	DATE	25-06-2024

NOTES: XXXXXXXXX

N

0 1 2 km

Scale in metres (70,000 @ A3)
AGD84 / AMG zone 55

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Figure 6 - PMF Flood Velocity

Stanmore
Poitrel Mine Progressive Rehabilitation Closure Plan
Flood Study
Final Landform

Drg Ref.
QC1024_005-FIG-001-A-006

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Appendix 11 Geotechnical Stability Assessment (June 2024)

STANMORE SMC PTY LTD

Assessment of Geotechnical Stability of Residual Voids at Poitrel Mine

June 2024

henderson geotech pty ltd

11 Olive St
MORNINGSIDE 4170
ph: 07 3399 5020

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2. STATEMENT OF LANDFORM DESIGN INTENT 1
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L I S T O F F I G U R E S

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1. INTRODUCTION

Dr Sue Henderson (RPEQ 4952) of Henderson Geotech Pty Ltd was requested to provide assessment of pit wall geotechnical stability for inclusion in void closure plans for Poitrel Mine. The work was undertaken in the second half of 2023 and the first half of 2024.

The assessment described in this report was made in accordance with the principles of the Guidelines for Assessment of Geotechnically Safe and Stable Post-Mining Landforms (Simmons et al, 2024).

1.1 Limitation

This report has been prepared by Henderson Geotech Pty Ltd for Stanmore SMC Pty Ltd (Client) for the purpose of supporting preparation of Progressive Rehabilitation and Closure Plan for Poitrel Mine. No parties other than the Client and the Department of Environment, Science and Innovation are authorised to rely on this report without the prior written consent of Henderson Geotech Pty Ltd.

This report is, in part, based on information provided by the Client or by other parties on behalf of the Client (Client-supplied information) in addition to data collected by Henderson Geotech Pty Ltd from the public domain. Henderson Geotech Pty Ltd has not always verified the accuracy of such information and makes no representations regarding its accuracy. Henderson Geotech Pty Ltd is not responsible for the consequences of any error or omission in Client-supplied information.

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2. STATEMENT OF LANDFORM DESIGN INTENT

This assessment of geotechnical stability for residual voids at Poitrel Mine was undertaken to support the 2024 Progressive Rehabilitation and Closure Plan, to demonstrate that the voids can be rehabilitated as NUMAs that will not adversely impact nearby woodland and grazing PMLUs for at least 60 years.

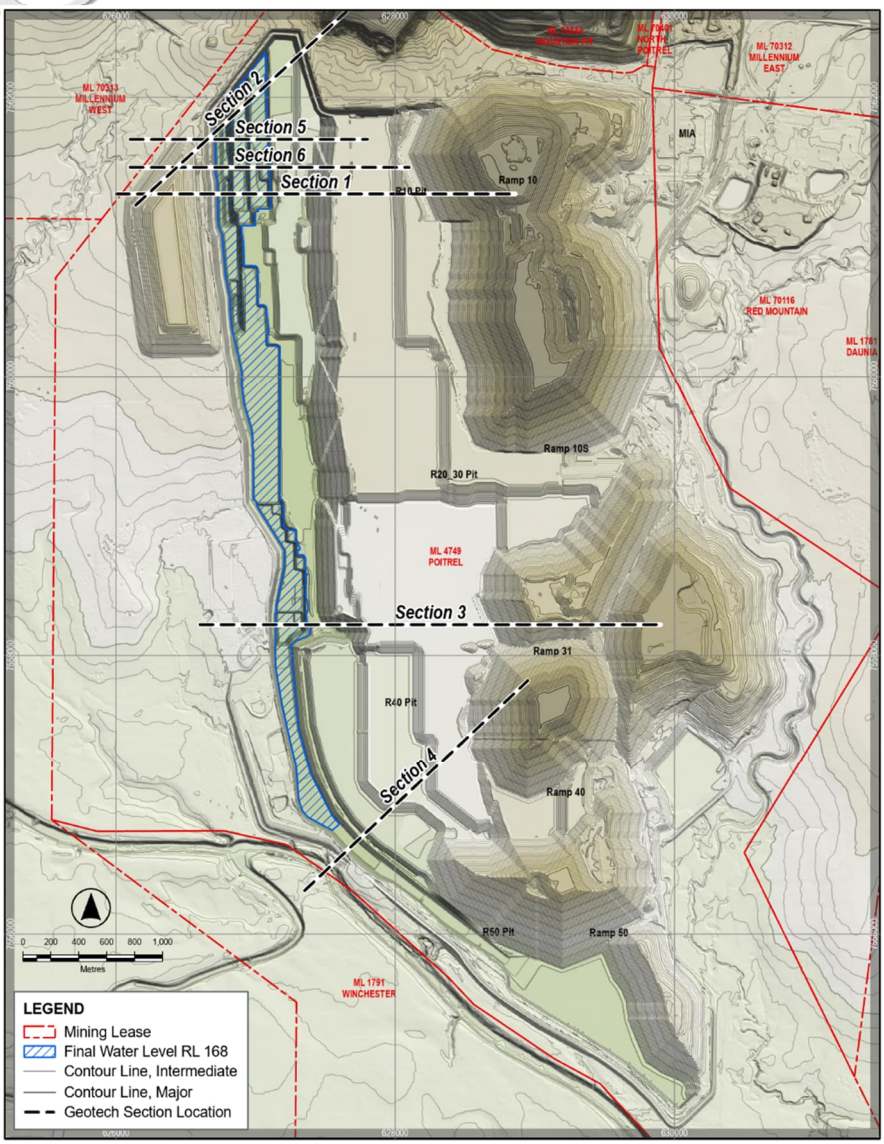
The geotechnical stability analyses and assessment described in this report are applicable only to the scenarios and inputs also described herein. A new assessment will be required if there are:

- Non-trivial changes to the location or geometry of the planned residual voids;
- Changes to proposed post-mining land uses of the voids or adjoining lands;
- Substantial changes to the understanding of stratigraphy or geotechnical properties; or
- Substantial changes to the understanding of end-of-mining and long-term groundwater levels or long-term pit lake levels.

3. GEOTECHNICAL MODEL

A topographic model of the proposed final landform, provided in September 2023, was examined to identify four cross-sections intersecting greatest void depth, greatest spoil height, and closest proximity to Isaac River. After initial stability analyses, two more cross-sections were selected to investigate the persistence of conditions of marginal highwall stability. The locations of the six cross-sections analysed are shown on Figure 3-1.

Figure 3-1: Location of Cross-sections analysed



3.1 Strata and Properties

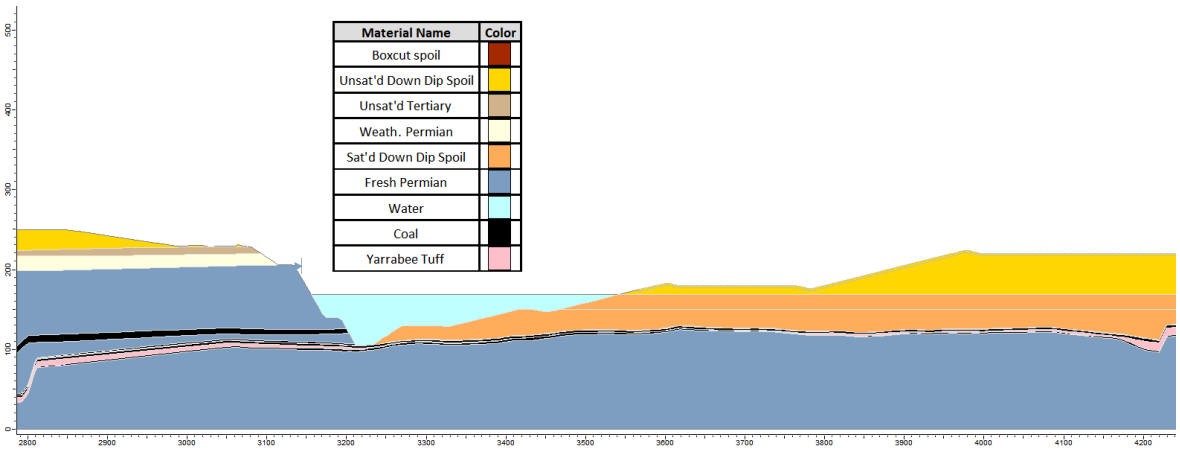
For each cross-section, the Client's geotechnical and geological departments provided base of weathering, coal seam roofs and floors, and the Yarrabee Tuff layer – all extracted from the site geological model – plus an indicative stratigraphy. The mined pit shell was interpreted as the V1 seam floor, based again on advice from Stanmore personnel.

Strength properties were sourced from BHP (March 2019), Table 6, and are summarised in Table 3-1. An example of a cross-section set up for stability analysis is included as Figure 3-2.

Table 3-1: Geotechnical parameters used in stability analyses

Material	Weight kN/m^3	Cohesion kPa	Friction Angle degree	Coeff. of Permeability m/s	k_v/k_h
Boxcut spoil	18	30	28	1e-7	0.5
Down dip spoil (unsaturated)	18	40	30	5e-6	0.4
Down dip soil (saturated)	20	23	25	5e-5	0.4
Tertiary overburden	20	50	30	2.78e-6	0.083
Weath. Permian overburden	24	75	30	2.78e-6	0.083
Fresh Permian over/interburden	24	450	42	1.16e-8	0.1
Fresh coal	15	30	35	1.74e-7	0.067
Yarrabee tuff	24	0	15	1e-7	1

Figure 3-2: Example cross-section for analysis



3.2 Groundwater Pressure Model

Piezometric heads were interpolated from groundwater table elevation maps output from hydrogeological modelling (SLR, May 2024), and were applied as total head boundaries at the edges of each cross-section.

Void lake water levels were obtained from void water balance modelling (WSP, March 2024).

Three groundwater scenarios were applied in highwall and lowwall stability analyses for each cross-section, namely:

- dry void at end-of mining with zero pore water pressure at the lowest part of the mined floor;
- void lake at predicted long-term water level; and
- void lake at an interim void water level for the year 2040 with modelled post-mining groundwater heads.

Hydraulic properties, primarily saturated coefficients of permeability, were selected to be broadly consistent with hydrogeological modelling and to provide the relative permeability observed in practice – for example, spoil is observed to be more permeable than in situ weathered Permian Overburden. The relevant parameter values are included in Table 3-1.

3.3 Potential Geotechnical Instability Mechanisms

Aside from the presence of the Yarrabee Tuff stratum, the geological model did not indicate dominant structural features close to the highwall face along the cross-sections selected for analyses. The impact of minor structures – for example bedding and general jointing – is accommodated in the rock-mass strength parameters.

In this context, 2D circular and non-circular slip surfaces were considered. Circular slips are typical of spoil and sedimentary rock masses while non-circular slips might be dictated by material interfaces - the tuff and coal seams in the highwall and endwall, and by tuff below the pit floor or the interface between saturated and unsaturated spoil in the lowwall.

Rainfall runoff over the highwalls and endwalls will be limited by exclusion bunds and/or flood protection landforms as necessary. The level of geotechnical profile detail available for this assessment did not suggest weak overburden strata overlain by more competent strata that could be susceptible to undercutting. On the lowwall side, rainfall runoff will mainly flow straight down the batters, with vegetation in the grazing and woodland PMLUs limiting the quantity of such runoff. On these bases, it was concluded that erosion is not likely to materially affect long-term geotechnical stability.

The absence of major structure close to the highwall face also suggests that, within the time frame nominated for this assessment, further weathering on highwalls and endwalls is unlikely to penetrate deeply enough to cause anything more than surface fretting that is not geotechnically significant. The open porous character of dumped spoil may allow physical weathering, such as slaking, to some depth, however, the associated strength reduction is already accommodated in the provided strength parameters.

The residual voids are either outside the modelled 1:1000 AEP floodplain and/or landforms to prevent inundation to that standard will be included in the mine's final landform design. The void water balance modelling covered a period of 300 years. Therefore, the effects of severe hydrological events are managed outside the scope of this geotechnical stability assessment.

3.4 Statement of Model Uncertainty

The stability assessment methodology described in Simmons et al (2024) includes a matrix to consider and score the confidence in the geotechnical model, based of the quality of input data for various aspects of the model. This subsidiary assessment is included as Appendix

A. In summary. the combined geotechnical and groundwater pressure model has a reliability score of 40/100 and is therefore ranked as High Uncertainty.

4. CONSEQUENCE ASSESSMENT

A consequence assessment, also undertaken in accordance with Simmons et al (2024), is included as Appendix B and the outcomes are summarised in Table 4-1.

Table 4-1: Consequence category assessment for geotechnical instability

Scenario	Consequence of Geotechnical Instability
Highwall instability that extends into grazing PMLU behind crest	Medium
Highwall instability that extends to watercourse channels or flood protection structures behind crest	Medium
Highwall instability that extends into woodland PMLU behind crest	Low
Highwall instability that does not extend outside NUMA	Negligible
Lowwall instability that extends into grazing PMLU	Low
Lowwall instability that extends into woodland PMLU	Low
Lowwall instability that does not extend outside NUMA	Negligible

5. DESIGN ACCEPTANCE CRITERIA

Instability along potential slip surfaces is most commonly assessed using limit equilibrium analyses, with results expressed as Factor of Safety. The typical range in factor of safety adopted for slope design is 1.2 to 1.5, with the target value reduced for lower model uncertainty and/or less severe consequences. Based on assessment of the geotechnical model as High Uncertainty and the consequence levels listed in Section 4, the selected minimum factors of safety are set out in Table 5-1.

Table 5-1: Adopted design acceptance criteria

Scenarios	Minimum Factor of Safety
Instability extending into grazing PMLUs	1.50
Instability extending to watercourses or flood protection structures	1.50
Instability extending into woodland PMLU	1.35
Instability contained within NUMA	1.25

6. STABILITY ANALYSES

The cross-sections were analysed using Slide2 Modeler, 2D Limit Equilibrium Analysis for Slopes. The main analytical methods used were Spencer - Vertical Slices - Circular Surfaces and Sarma - Vertical Slices - Non-Circular Surfaces, both with Auto Refine Search Method. Generally, the Sarma method produced lower minimum Factors of Safety because

it was better able to generate potential slip surfaces that intersected the weak Yarrabee Tuff layer.

Results for the highwall sections analysed are presented in Table 6-1. In overview:

- At all cross-sections, the minimum factor of safety met the Design Acceptance Criterion for NUMAs;
- Where the void depth was greater than 120m (Sections 1 & 6), ground immediately behind the crest did not meet the Design Acceptance Criterion for woodland, but the criterion was achieved within 25m behind the crest;
- Along the main northern void, the Design Acceptance Criterion for grazing was met within 40m behind the highwall crest. That is, the first 40m behind the crest should not be assigned the PMLU of grazing;
- Where it is close to the Isaac River, the final void highwall meets the relevant Design Acceptance Criterion.

Table 6-1: Geotechnical stability results for final void highwalls

Location/scenario	Minimum Factor of Safety	Distance behind crest to achieve FoS >1.5
Section 1		
End-of-mining	1.30	FoS >1.35 22m behind crest FoS >1.5 39m behind crest
Interim pit lake	1.36	FoS >1.5 34m behind crest
Long-term pit lake	1.44	FoS >1.5 36m behind crest
Section 2		
End-of-mining	1.41	FoS >1.5 at crest
Interim pit lake	1.37	FoS >1.5 36m behind crest
Long-term pit lake	1.47	FoS >1.5 15m behind crest
Section 3		
End-of-mining	1.94	
Interim pit lake	1.93	
Long-term pit lake	1.94	
Section 4		
End-of-mining	2.35	
Interim pit lake	2.36	
Long-term pit lake	2.41	
Section 5		
End-of-mining	1.32	FoS >1.35 16m behind crest FoS >1.5 19m behind crest
Interim pit lake	1.34	FoS >1.35 18m behind crest FoS >1.5 25m behind crest
Long-term pit lake	1.43	FoS >1.5 at crest
Section 6		
End-of-mining	1.42	FoS >1.5 14m behind crest
Interim pit lake	1.44	FoS >1.5 26m behind crest
Long-term pit lake	1.52	

Results for the lowwalls are presented in Table 6-2. Only Section 2 (highest spoil) had minimum factors of safety less than 1.5 and for those the critical slip surfaces were within the extent of the long-term pit lake – that is, inside the area defined as NUMA. For all sections and scenarios, the minimum factor of safety extending outside the NUMA was greater than 1.5.

Table 6-2: Geotechnical stability results for final void lowwalls

Location/scenario	Minimum Factor of Safety
Section 1	
End-of-mining	1.92
Interim pit lake	1.70
Long-term pit lake	1.64
Section 2	
End-of-mining	1.37
Interim pit lake	1.45
Long-term pit lake	1.52
Section 3	
End-of-mining	3.65
Interim pit lake	2.58
Long-term pit lake	3.17
Section 4	
End-of-mining	4.80
Interim pit lake	4.80
Long-term pit lake	3.21

7. SAFETY ASSESSMENT

Simmons et al (2024) requires a qualitative safety risk assessment to be undertaken for the designed slopes, to identify further risk reduction measures aligned with the ALARP principle. That is, even though compliance with the Design Acceptance Criteria achieves an appropriate level of risk, further mitigative measures should be considered if the cost and difficulty are “reasonable” in the context of the incremental reduction in safety risk.

The safety risk assessment is included as Appendix D. In essence, the recommended additional measures consist of exclusion bunds on the highwall, exclusion fencing all around the NUMA, and explanation of the function of the bunds and fences in the Land Management Plan that will be attached to the land when leases are relinquished.

8. CONCLUSIONS

For the final landform geometry provided, geotechnical stability of void walls and slopes will meet appropriate Design Acceptance Criteria if the following conditions are imposed:

1. Wherever the highwall or endwall is deeper than 120m (crest to exposed toe), the NUMA should be defined to extend at least 25m behind the wall crest;
2. Around the main northern void, grazing PMLU should not be defined closer than 40m behind the wall crest.

These constraints may be refined following further investigation and analyses as mining approaches end-of-mine limits.

9. REFERENCES

BHP, March 2019, Guideline to Open Cut Geotechnical Constraints, company internal document

Simmons J, Henderson S and Kennedy G, June 2024, Guidelines for Assessment of Geotechnically Safe and Stable Post-Mining Landforms, ACARP C34028 project report.

SLR, May 2024, Poitrel Mine PRCP Hydrogeology Assessment, Rev 01.

WSP, March 2024, file 'PS203205-WSP-BNE-MNG-XLS-PTM-WBM-LF#3-1081-Rev3.xlsx'.

APPENDIX A MODEL RELIABILITY STATEMENT

Model Element	Max.		Uncertainty Level	and Weighting		Score
	Score	Introductory	High	Medium	Low	
		0.0	0.2	0.6	1.0	
Strata & landform profile information	10	Basic surfaces with unreliable or absent data	Assessment based on 'typical' regional conditions.	Geological surfaces extracted from site geological model.	Use of information such as drill logs and field mapping to define sub geotechnical units within broader geological units.	6
Structural Model	15	No information	Structure assumed typical of the region	Structure broadly understood from observation and experience at the site	Either no dominant structure OR structure well understood from mapping and drilling	9
Strata Complexity	5	No information	Strata or structure are highly variable with distance OR properties are greatly affected by moisture content.	Strata and structure do not vary rapidly with distance, AND properties not greatly affected by moisture content changes.	Strata quite uniform in thickness and properties AND structure clearly defines slip surfaces	3
Strength Properties	10	No information	Derived from published data for the material classifications, without specific regional data.	Derived from tests on key strata sampled from sites within the region.	Derived from site specific tests on key strata	6
Deformation Properties	5	No information, or not considered in stability assessment	Derived from published data for the material classifications, without specific regional data.	Derived from tests on key strata sampled from sites within the region.	Derived from site specific tests on key strata	0
Groundwater Pressure Model	20	No site measurements; conceptual hydrogeological assessment only	Pre-mining groundwater study OR sensitivity analyses included in stability analyses	>2 years measurement for site groundwater network, with interpretation.	>2 years measurement of at least 2 piezometers at the slope in question, with associated groundwater analysis	12

Method of Analysis	10	No quantitative analyses	Able to accurately represent the failure mechanism BUT there is limited industry experience interpreting the results	Able to approximately represent the failure mechanism AND there is wide industry experience in interpreting the results	Able to accurately represent the failure mechanism AND there is wide industry experience in interpreting the results	6
Reported field performance observations	25	<2 years visual observation of the slope in question.	2-5 years visual observation of the slope in question.	>5 years visual observation or > 2 years movement measurement	> 5 years movement measurement	0

TOTAL = 40

Rating	**Ranking**	**Safety and Stability Implications**
80 - 100	Low Uncertainty	Risk management to an ALARP standard is possible with due allowances for model elements ranked as medium or high uncertainty level
50 - 79	Medium Uncertainty	Risk management to an ALARP standard may not be possible without some combination of improvements to the model, significant increases in design acceptance criteria, or uncertainty allowances in observational stability acceptance criteria
< 50	High Uncertainty	Risk management to an ALARP standard is not likely to be possible. Assessment must be qualified accordingly, or significant improvements made to the model, significant increases in design acceptance criteria, or uncertainty allowances in observational acceptance criteria prior to finalising assessment.

APPENDIX B CONSEQUENCE CATEGORY ASSESSMENT

Consequence Category Levels and Thresholds

	N/A or Negligible	Low	Medium	High
Harm to Humans				
	People are not routinely present in the impacted area or only injuries requiring first aid are likely	Loss of life is not expected and only short-term disabling injuries are expected.	Single loss of life or long-term disabling injuries are expected	Multiple loss of life expected
Environmental Harm				
	Minor, temporary impact to the environment	Measurable impact to an area $\leq$ 1km^2; where remediation of damage is likely to take $\leq$ 1 year	Impact to an area $\leq$ 5km^2; where remediation of damage is likely to take $\leq$ 5 years	Impact to an area > 5km^2; where remediation of damage is likely to take > 5 years
Property Loss & Damage				
	Minor, temporary community impact that recovers with little intervention; Damage to property or compensation or repair costs < \$0.5M	Measurable but limited community impact lasting less than six months; Damage to property or compensation or repair costs \$0.5M - \$10M	Serious impact on community lasting up to 12 months; Damage to property or compensation or repair costs \$10M - \$50M	Severe impact on community lasting more than 12 months; Damage to property or compensation or repair costs > \$50M

Assessment for Poitrel Mine Highwall / Endwall

Extent of Instability *(length or area affected)*	**Exposure** *(people, ecosystems & property within extent)*	**Harm to Humans**		**Environmental Harm**		**Property Loss & Damage**	
		Impacts	***Cat.***	***Impacts***	***Cat.***	***Impacts***	***Cat.***
Crest Zone							
Woodland PMLU	People will not routinely access the area	People not routinely present	Negl.	Measurable impact to area <1km^2 Stabilisation work to encourage re-establishment of vegetation would take <1year	**Low**	No repair or compensation costs	Negl.
Grazing PMLU	A small number of people likely to access the area due to cattle grazing operations Grassland habitat with some shade trees, suitable for managed grazing Property such as fencing and water troughs may be present	Single loss of life or long-term disabling injuries are possible	**Medium**	Measurable impact to area <1km^2 Stabilisation work to encourage re-establishment of grassland would take <1year	Low	Costs to replace damage property expected to be <$0.5M	Negl.
Isaac River	People will not routinely access the area. Ephemeral aquatic ecosystem	People not routinely present	Negl.	Measurable impact to area <1km^2 Repair work including to re-establish vegetation would take >1year	**Medium**	Damage to property or compensation or repair costs $0.5M - $10M	Low
Body of Slope							
Within NUMA	People will not routinely access NUMA Low value habitat on batter No property in NUMA	People not routinely present	Negl.	Minor impact to the environment	Negl.	No repair or compensation costs	Negl.

Extent of Instability *(length or area affected)*	**Exposure** *(people, ecosystems & property within extent)*	**Harm to Humans**		**Environmental Harm**		**Property Loss & Damage**	
		Impacts	***Cat.***	***Impacts***	***Cat.***	***Impacts***	***Cat.***
Toe Zone							
Within NUMA	People will not routinely access NUMA Low value habitat in pit lake No property in NUMA	People not routinely present	Negl.	Minor impact to the environment	Negl.	No repair or compensation costs	Negl.

Negligible consequence for geotechnical instability contained within NUMA

Low consequence for geotechnical instability that extends into Woodland PMLU

Medium consequence for geotechnical instability that extends into Grazing PMLU or to Isaac River

Assessment for Poitrel Mine Lowwall

Extent of Instability *(length or area affected)*	**Exposure** *(people, ecosystems & property within extent)*	**Harm to Humans**		**Environmental Harm**		**Property Loss & Damage**	
		Impacts	***Cat.***	***Impacts***	***Cat.***	***Impacts***	***Cat.***
Crest Zone							
Woodland PMLU	People will not routinely access the area	People not routinely present	Negl.	Measurable impact to area <1km^2 Stabilisation work to encourage re-establishment of vegetation would take <1year	**Low**	No repair or compensation costs	Negl.
Grazing PMLU	A small number of people likely to access the area due to cattle grazing operations Grassland habitat with some shade trees, suitable for managed grazing Property such as fencing and water troughs may be present	Only short-term disabling injuries expected	**Low**	Measurable impact to area <1km^2 Stabilisation work to encourage re-establishment of grassland would take <1year	Low	Costs to replace damage property expected to be <$0.5M	Negl.
Within NUMA	People will not routinely access NUMA Low value habitat on slope No property in NUMA	People not routinely present	Negl.	Minor impact to the environment	Negl	No repair or compensation costs	Negl.

Extent of Instability *(length or area affected)*	**Exposure** *(people, ecosystems & property within extent)*	**Harm to Humans**		**Environmental Harm**		**Property Loss & Damage**	
		Impacts	***Cat.***	***Impacts***	***Cat.***	***Impacts***	***Cat.***
Body of Slope							
Woodland PMLU	People will not routinely access the area	People not routinely present	Negl.	Measurable impact to area <1km^2 Stabilisation work to encourage re-establishment of vegetation would take <1year	**Low**	No repair or compensation costs	Negl.
Within NUMA	People will not routinely access NUMA Low value habitat on slope No property in NUMA	People not routinely present	Negl.	Minor impact to the environment	Negl	No repair or compensation costs	Negl.
Toe Zone							
Within NUMA	People will not routinely access NUMA Low value habitat in pit lake No property in NUMA	People not routinely present	Negl.	Minor impact to the environment	Negl.	No repair or compensation costs	Negl.

Negligible consequence for geotechnical instability in NUMA

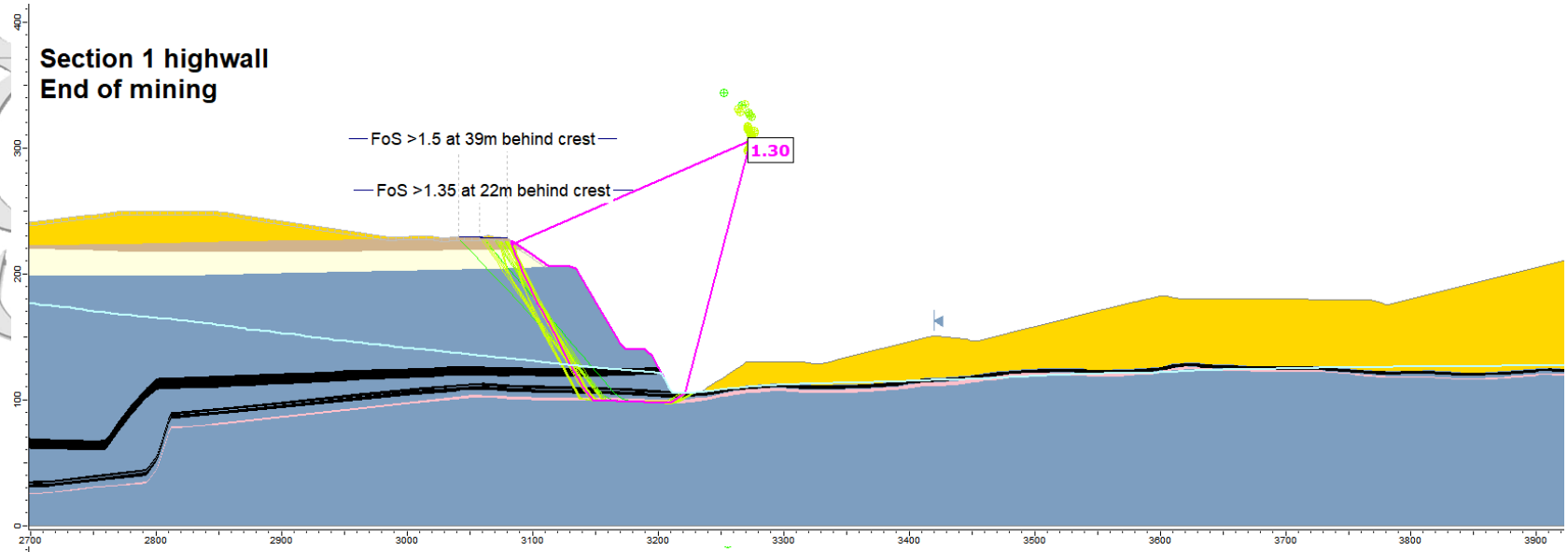
Low consequence for geotechnical instability that extends into Woodland PMLU

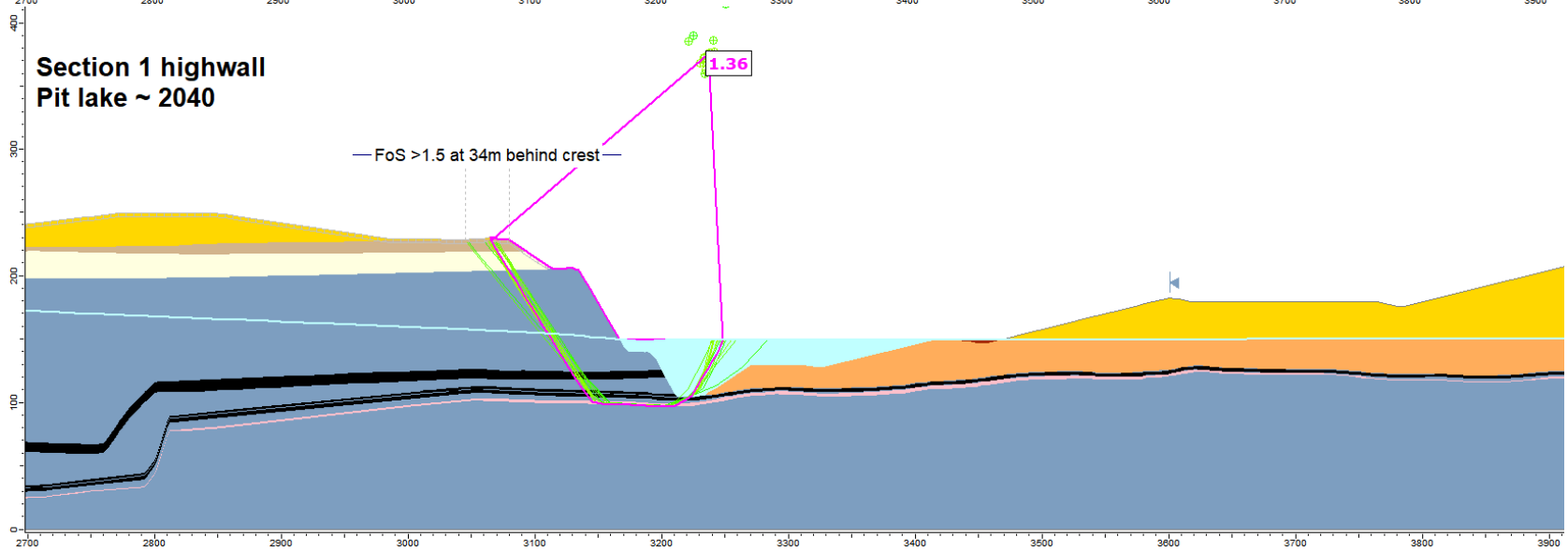
Low consequence for geotechnical instability that extends into Grazing PMLU

APPENDIX C STABILITY ANALYSES

Material Name	Color
Boxcut spoil	
Unsat'd Down Dip Spoil	
Sat'd Down Dip Spoil	
Unsat'd Tertiary	
Weath. Permian	
Fresh Permian	
Coal	
Yarrabee Tuff	

Highwalls


Section 1 highwall
End of mining
FoS >1.5 at 39m behind crest
FoS >1.35 at 22m behind crest
1.30
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
0
100
200
300
400


Section 1 highwall
Pit lake ~ 2040
FoS >1.5 at 34m behind crest
1.36
2700
2800
2900
3000
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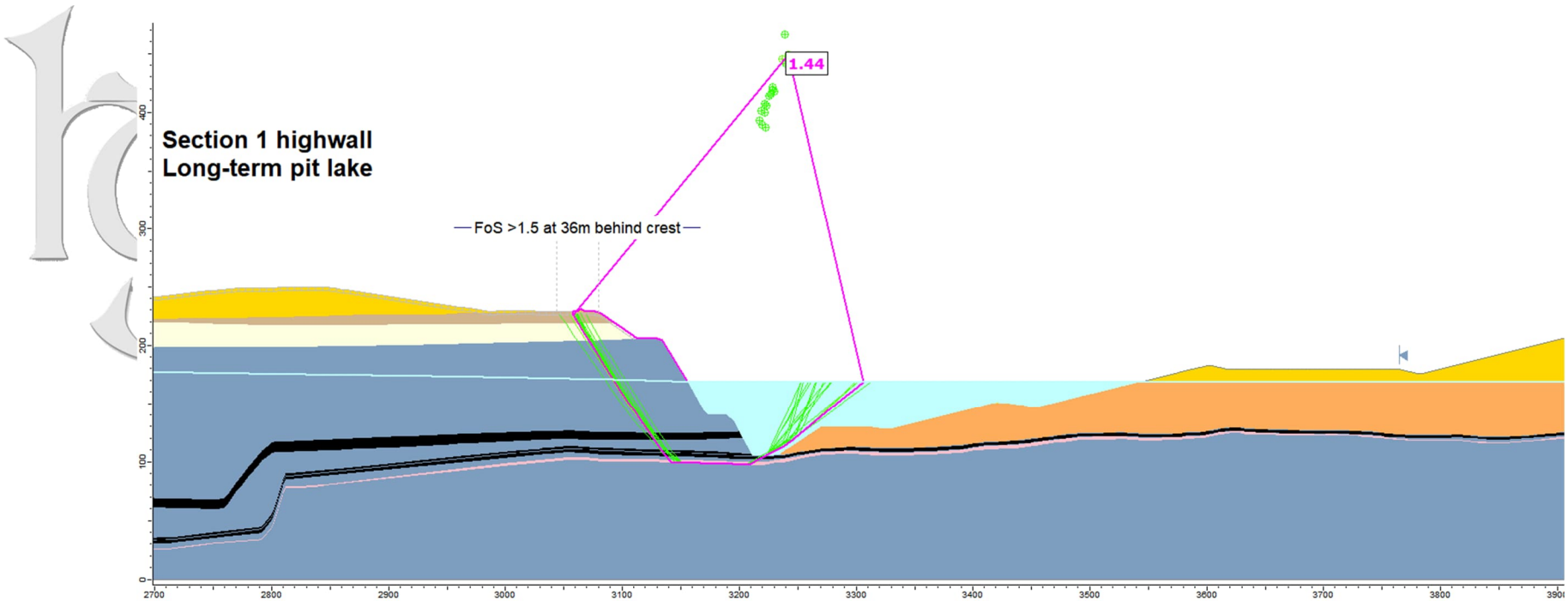
3400
3500
3600
3700
3800
3900
0
100
200
300
400


Section 1 highwall
Long-term pit lake
FoS >1.5 at 36m behind crest
1.44
0
100
200
300
400
2700
2800
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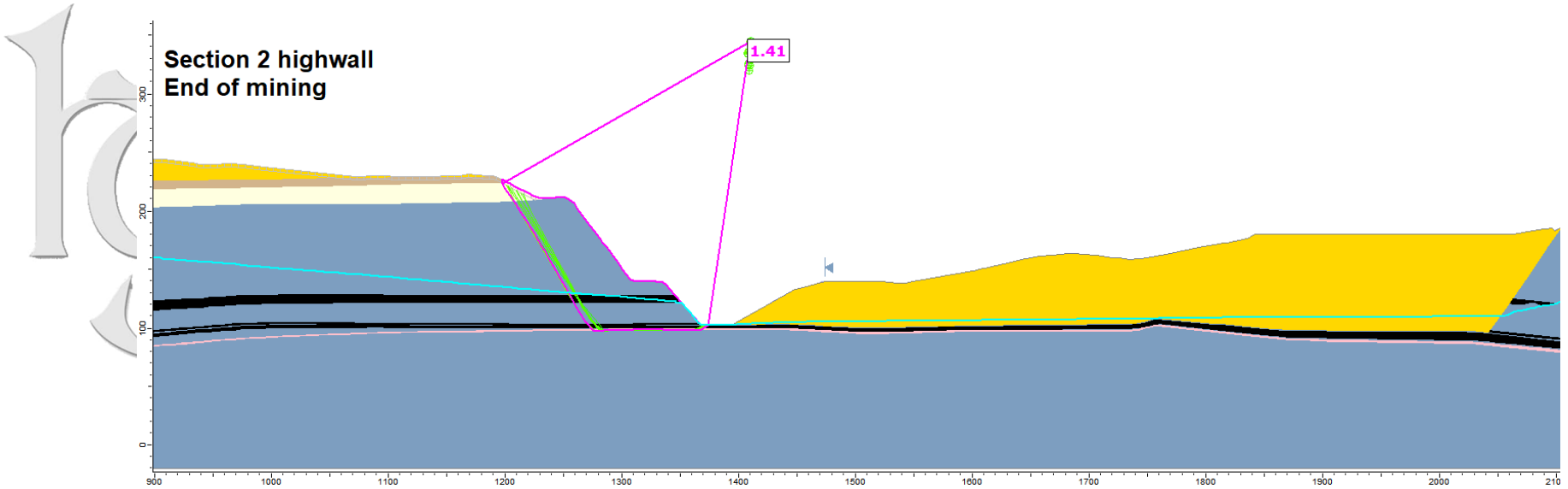
3000
3100
3200
3300
3400
3500
3600
3700
3800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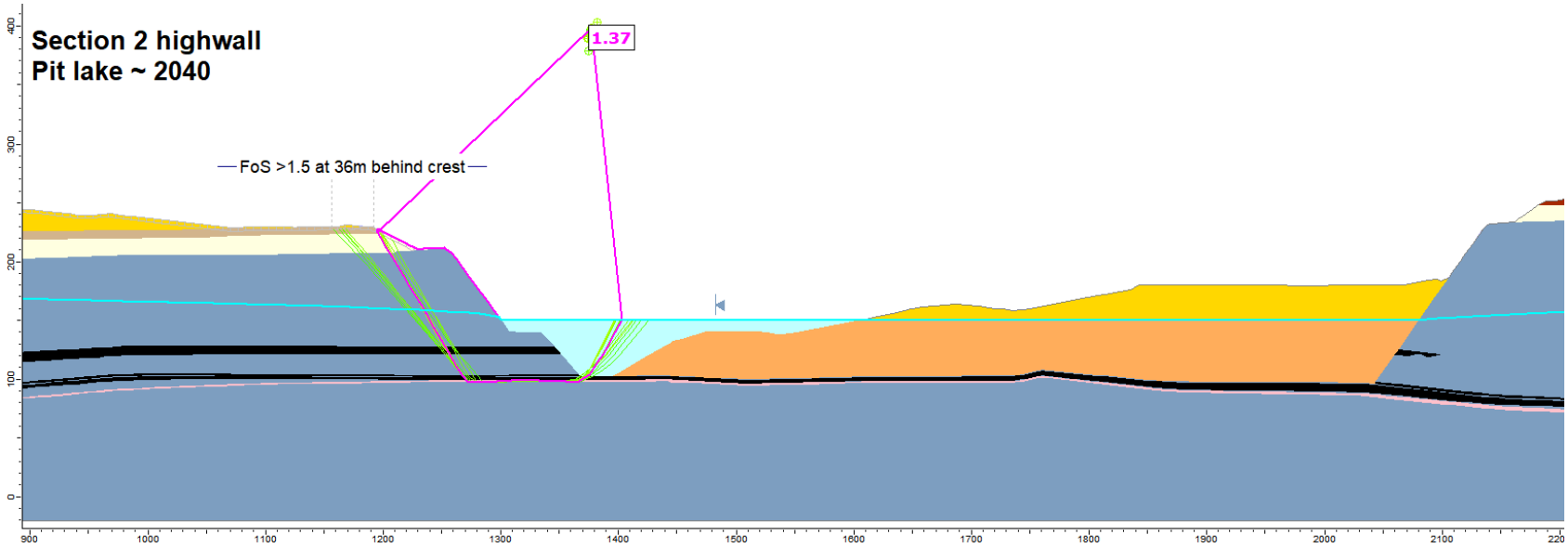
End of mining
1.41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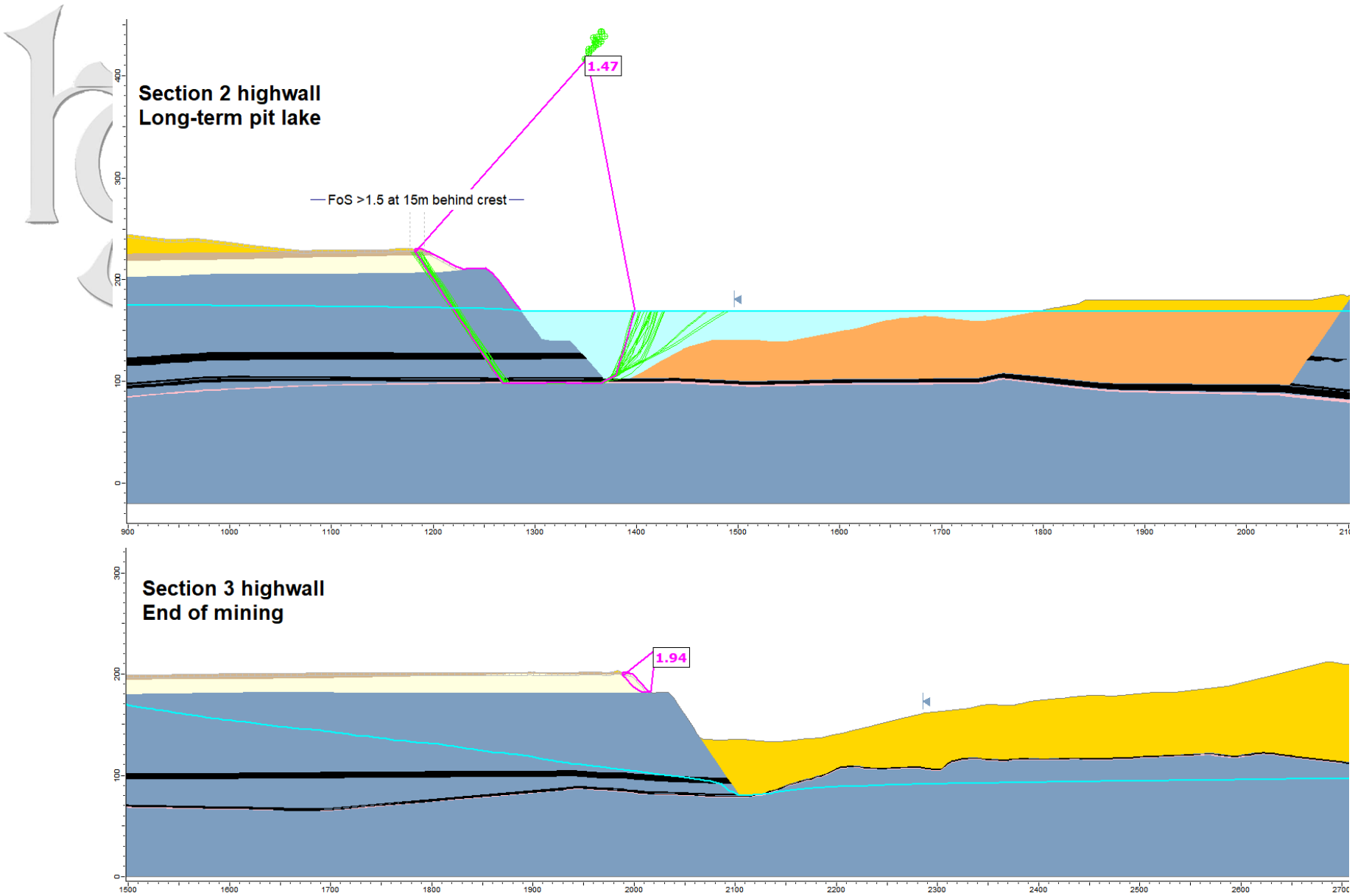
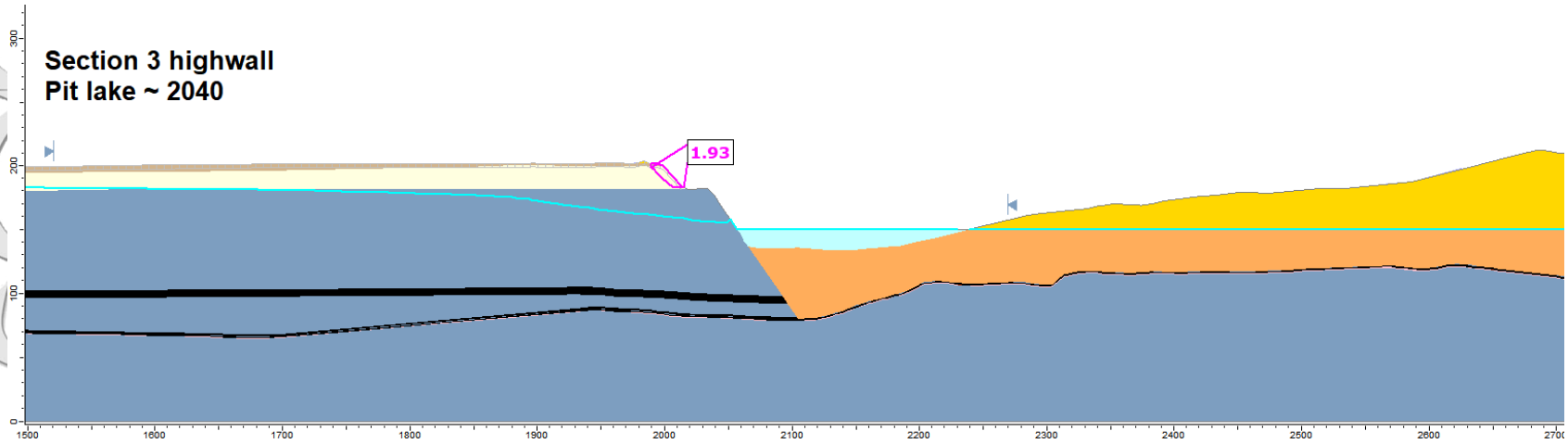
Pit lake ~ 2040
1.37
FoS >1.5 at 36m behind crest


Section 2 highwall
Long-term pit lake
1.47
FoS >1.5 at 15m behind crest
Section 3 highwall
End of mining
1.94


Section 3 highwall
Pit lake ~ 2040
1.93
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1600
1700
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2100
2200
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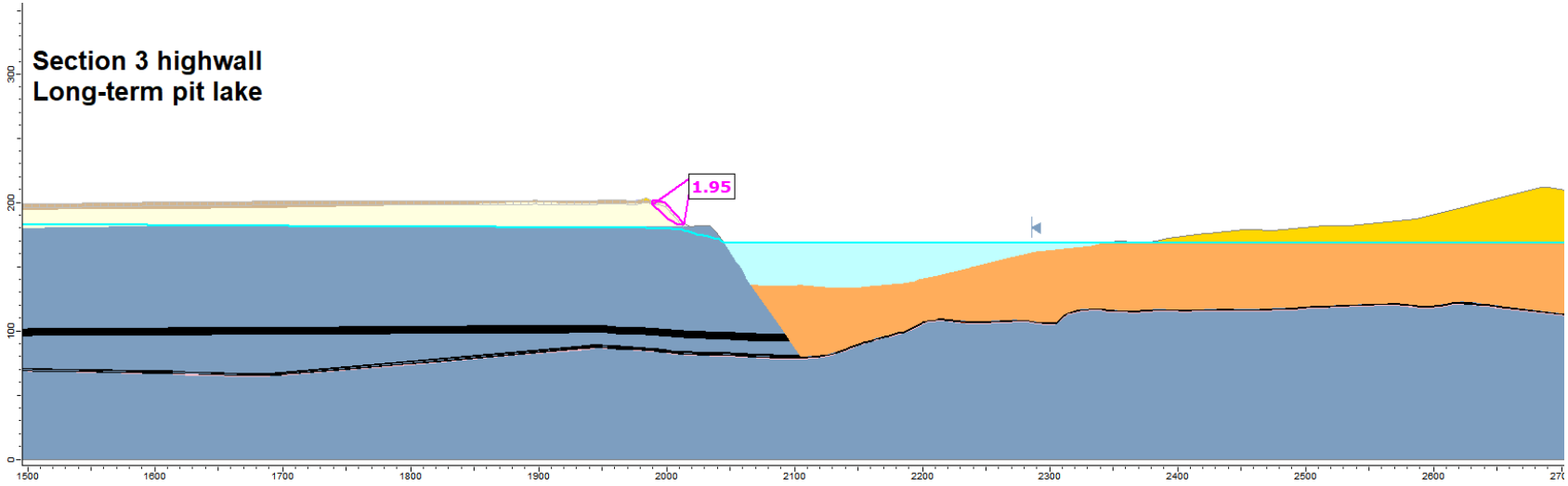
2400
2500
2600


Section 3 highwall
Long-term pit lake
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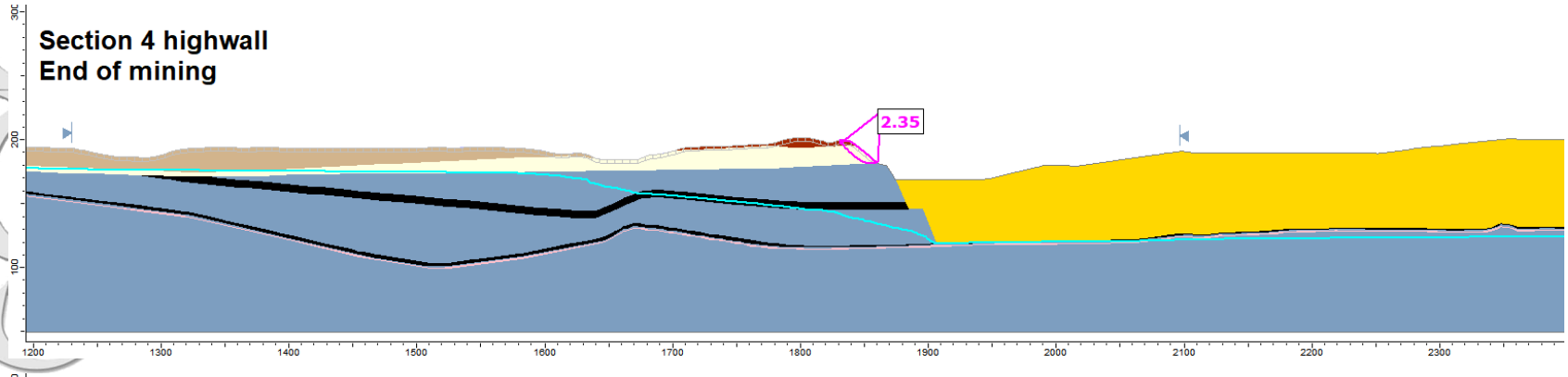
2500
2600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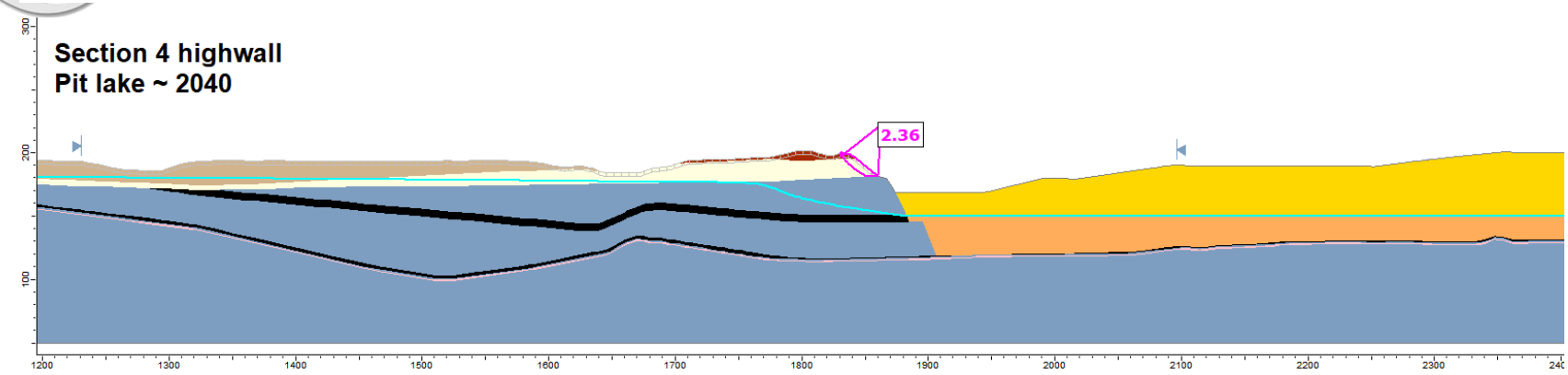
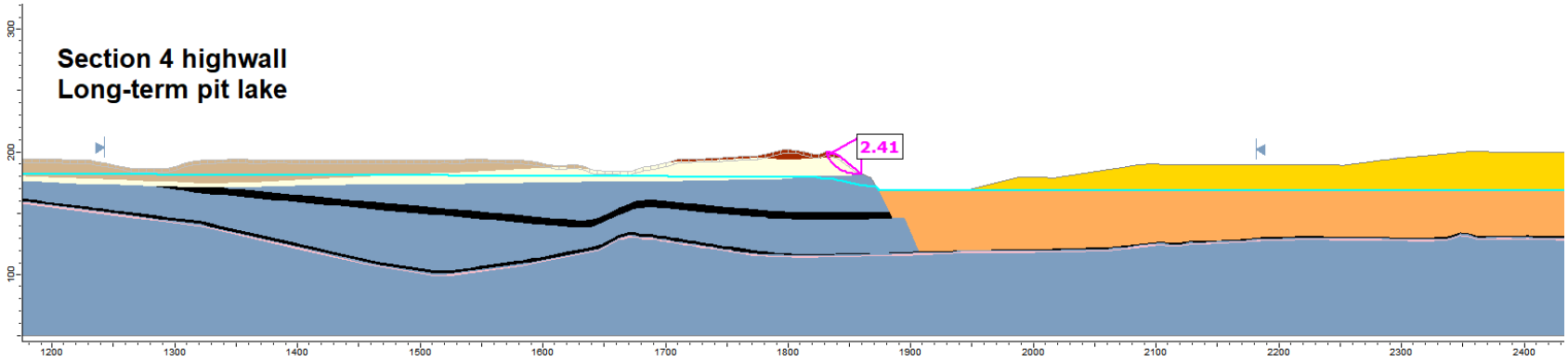
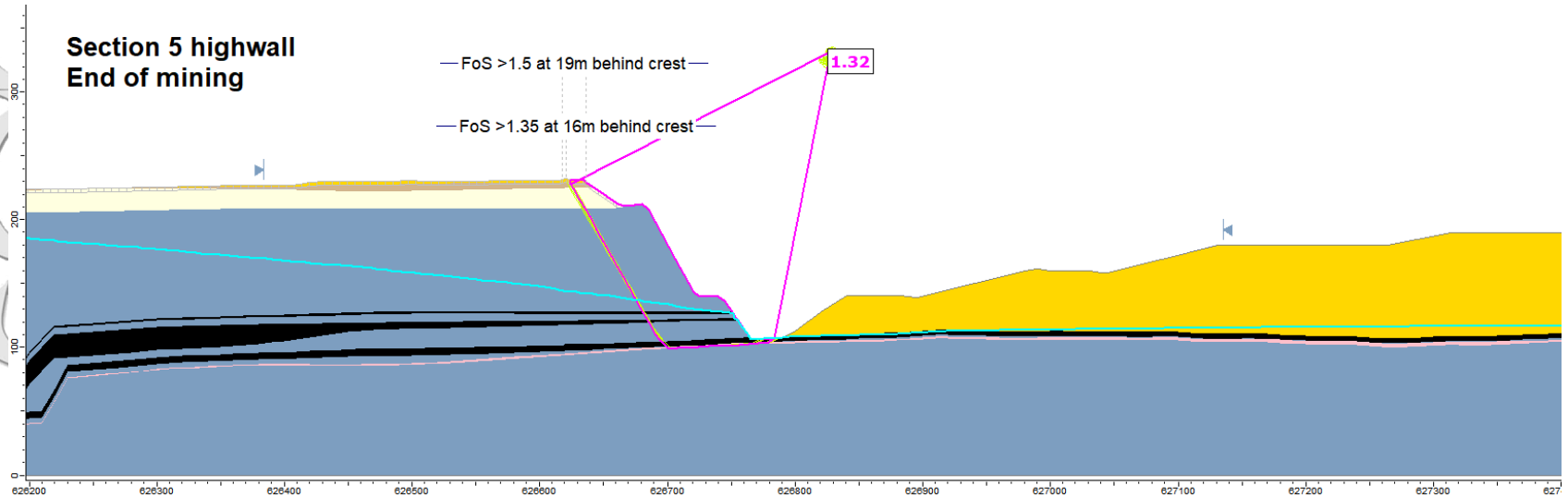
End of mining
2.35


Section 4 highwall
Pit lake ~ 2040
2.36


Section 4 highwall
Long-term pit lake
2.41


Section 5 highwall
End of mining
FoS >1.5 at 19m behind crest
FoS >1.35 at 16m behind crest
1.32
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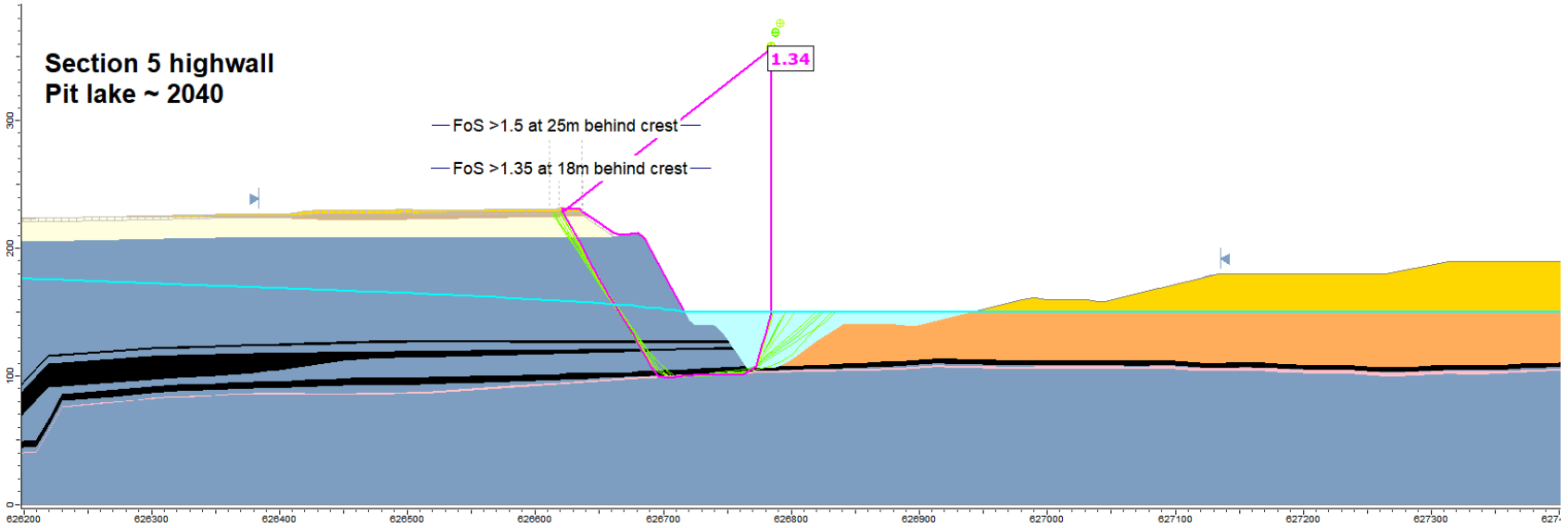
Section 5 highwall
Pit lake ~ 2040
FoS >1.5 at 25m behind crest
FoS >1.35 at 18m behind crest
1.34
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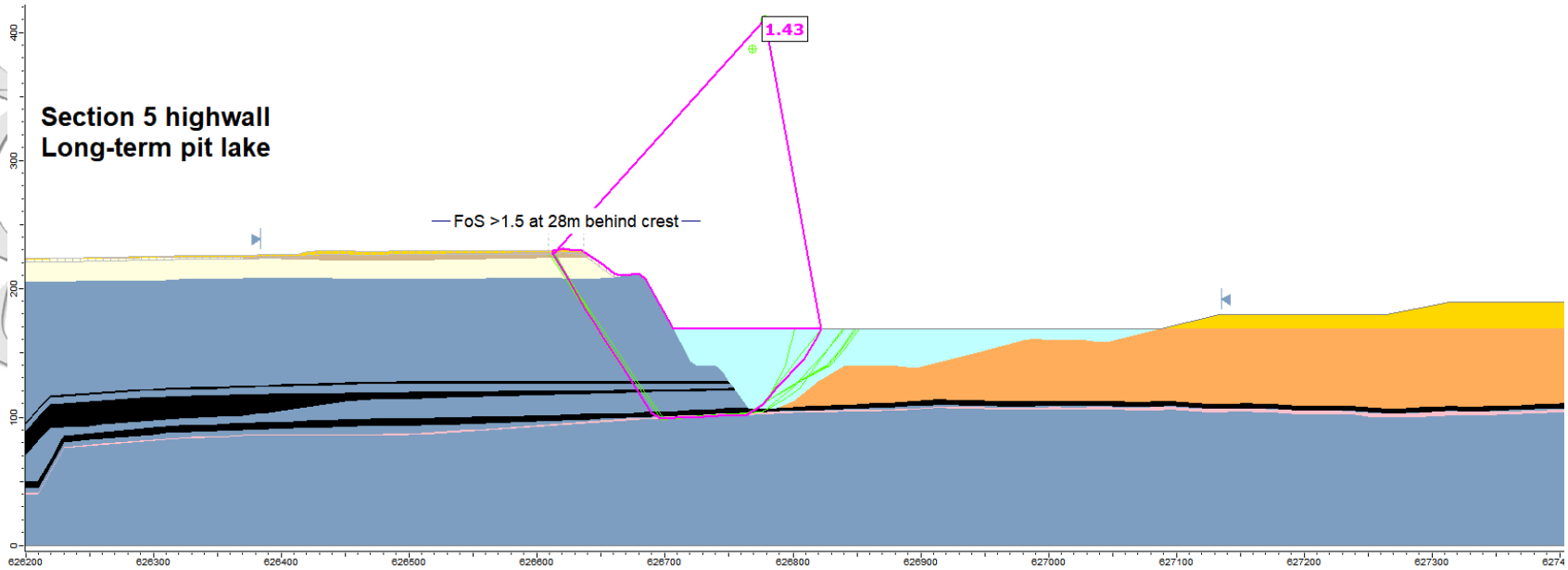
Section 5 highwall
Long-term pit lake
1.43
FoS >1.5 at 28m behind crest
400
300
200
100
0
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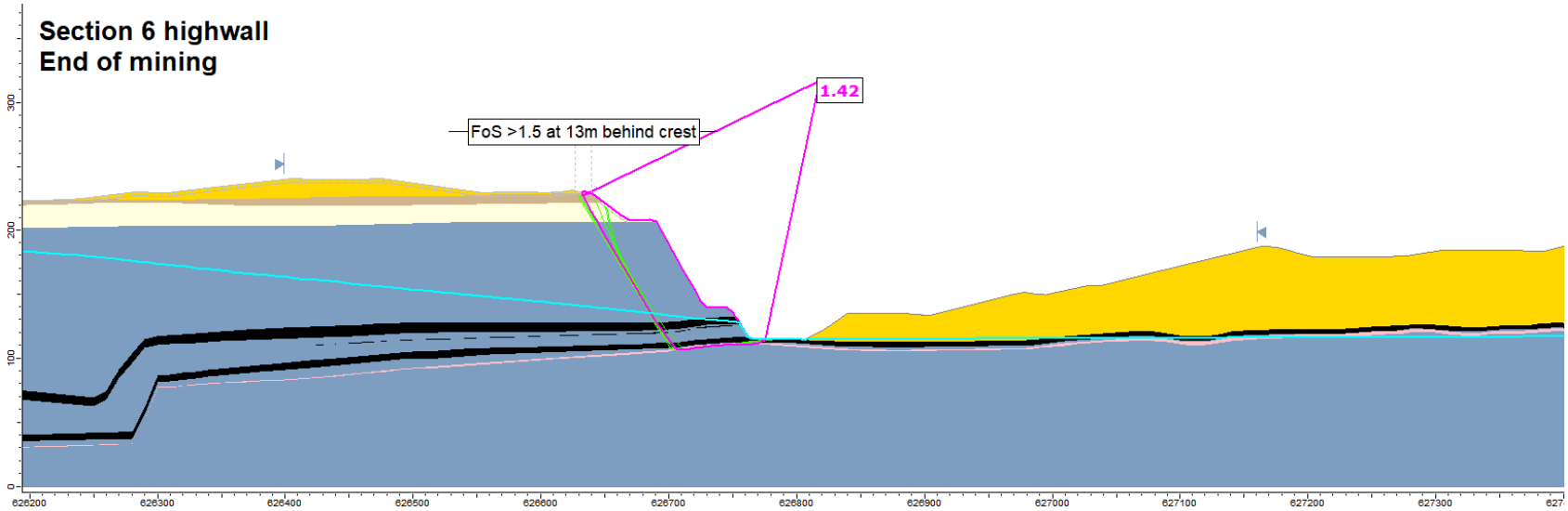
Section 6 highwall
End of mining
1.42
FoS >1.5 at 13m behind crest
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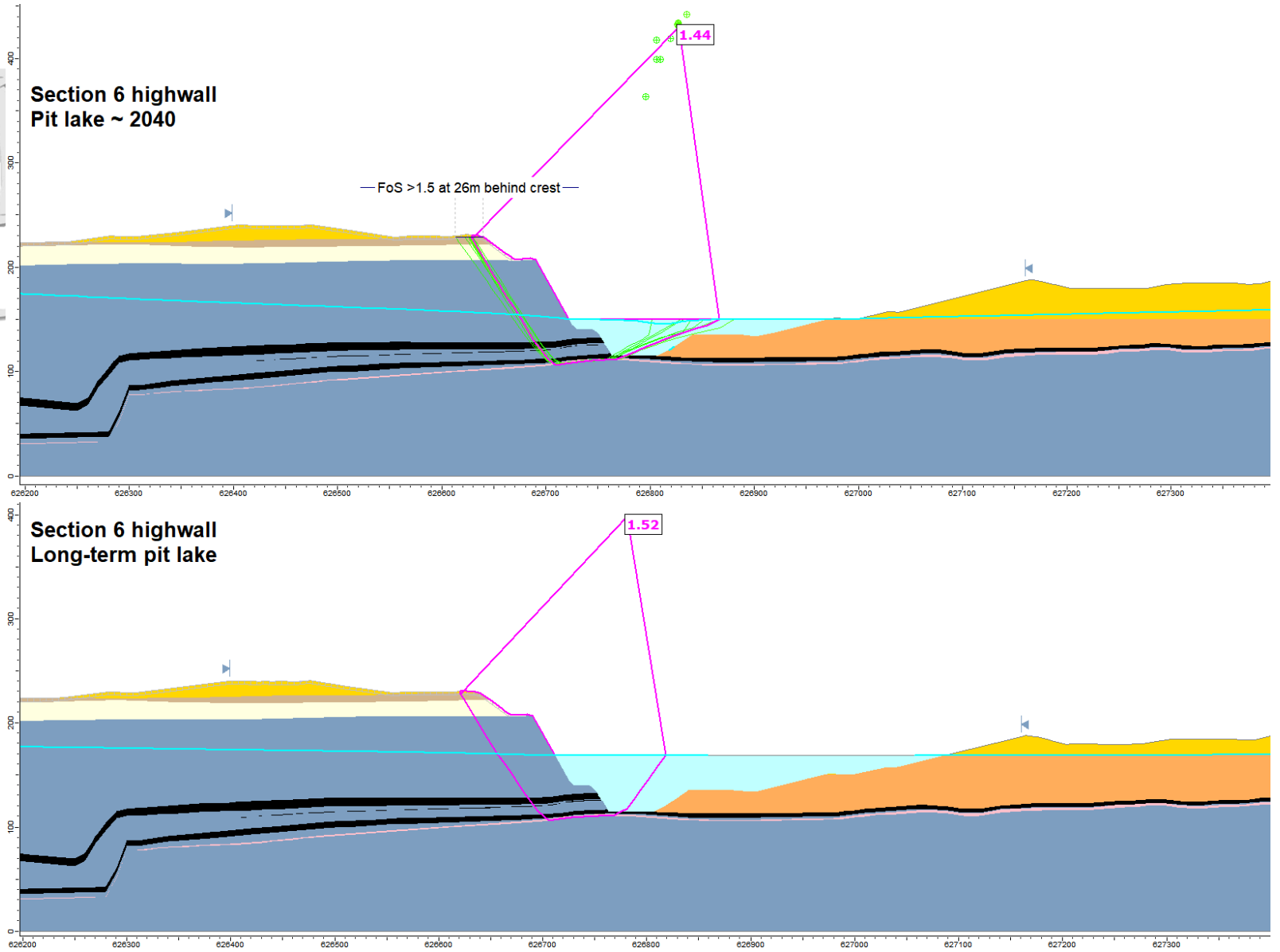
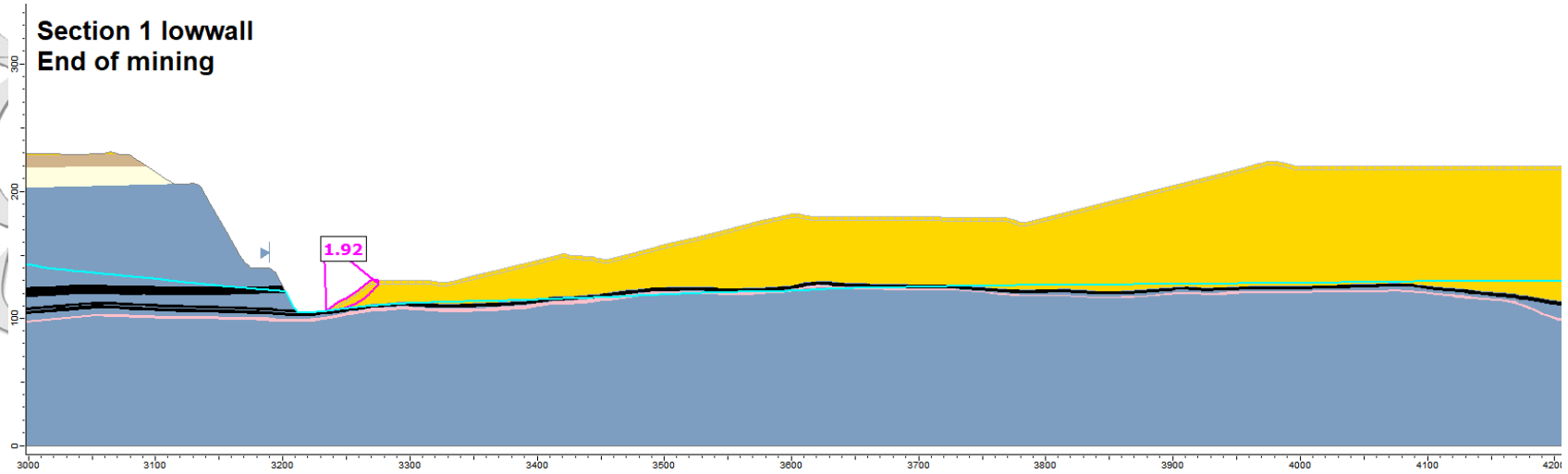
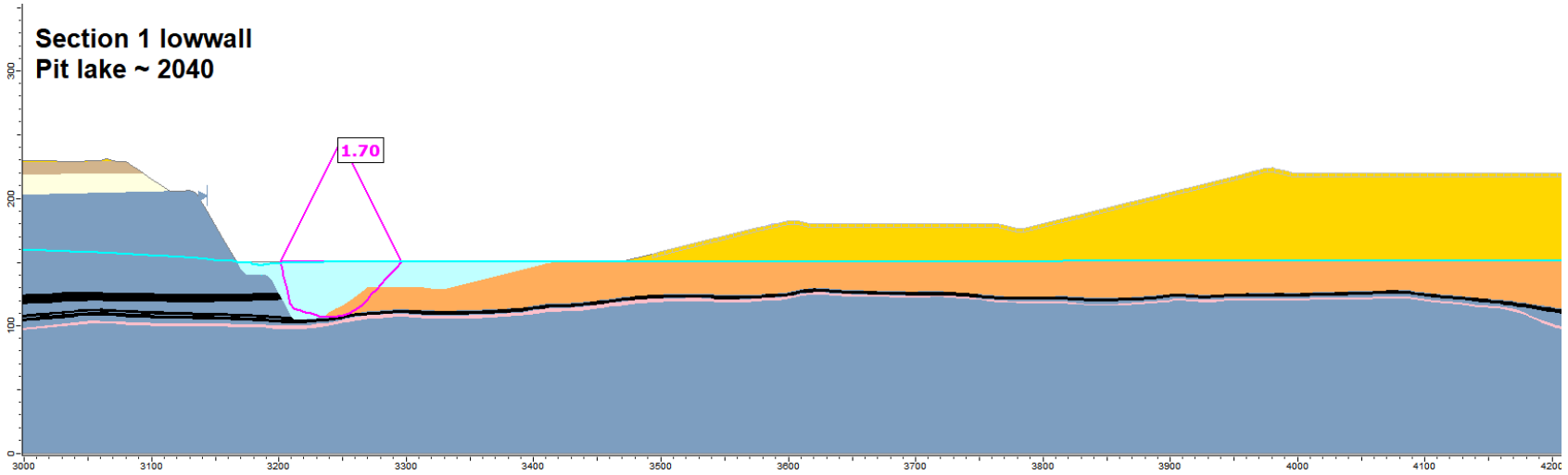

Section 6 highwall
Pit lake ~ 2040
1.44
FoS >1.5 at 26m behind crest
Section 6 highwall
Long-term pit lake
1.52

Lowwalls


Section 1 lowwall
End of mining
1.92
0
100
200
300
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100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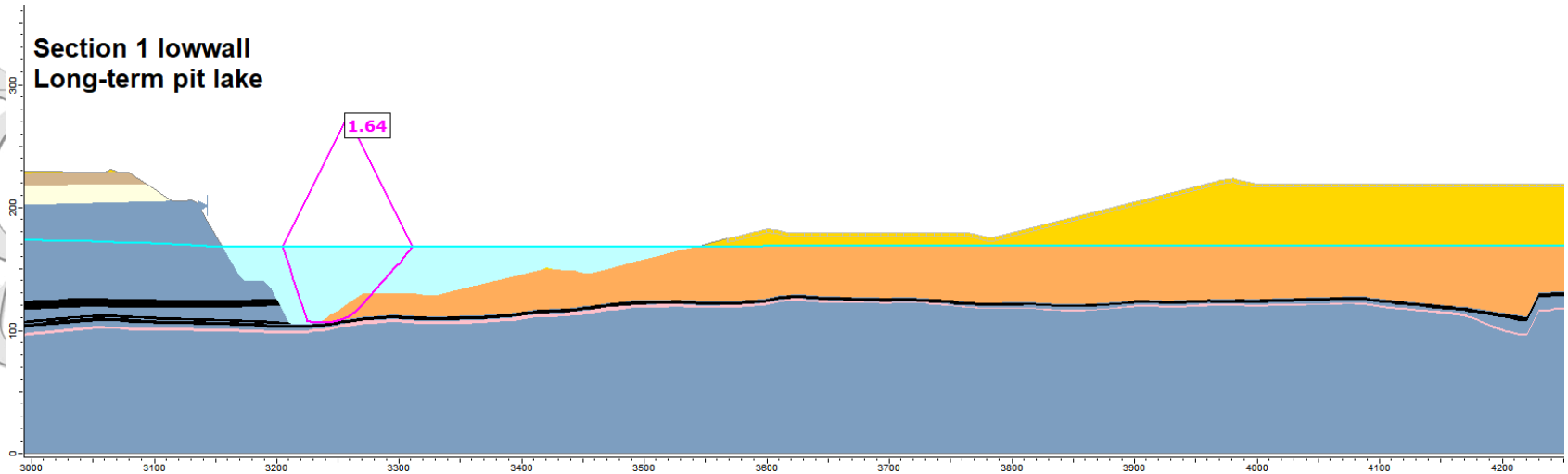
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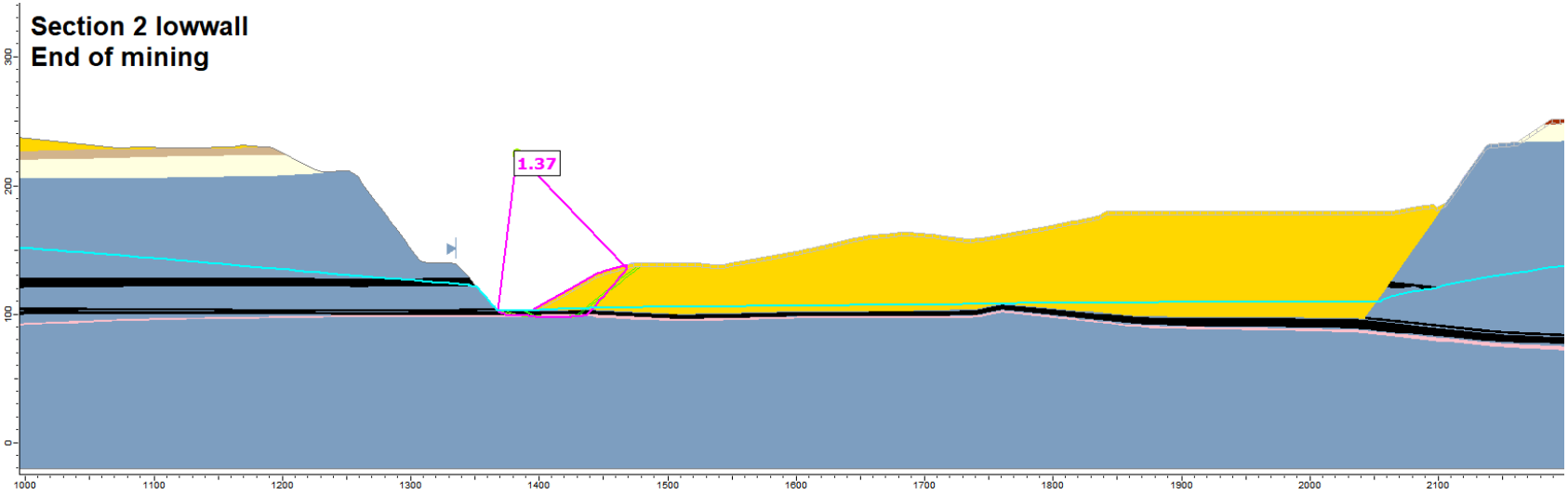
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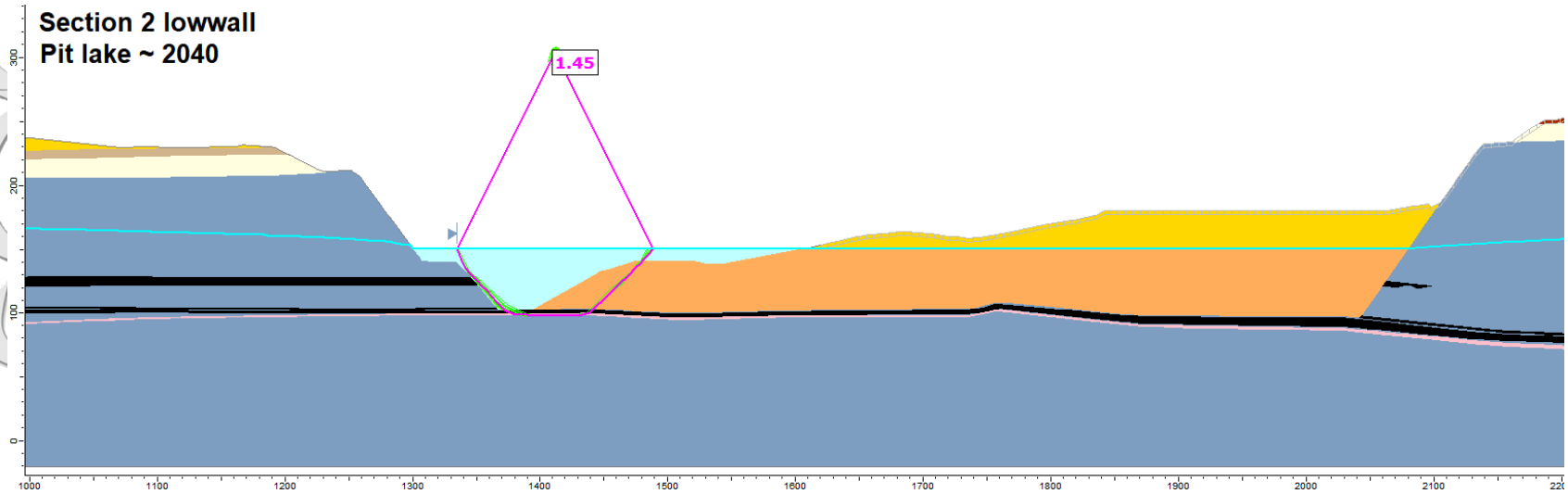
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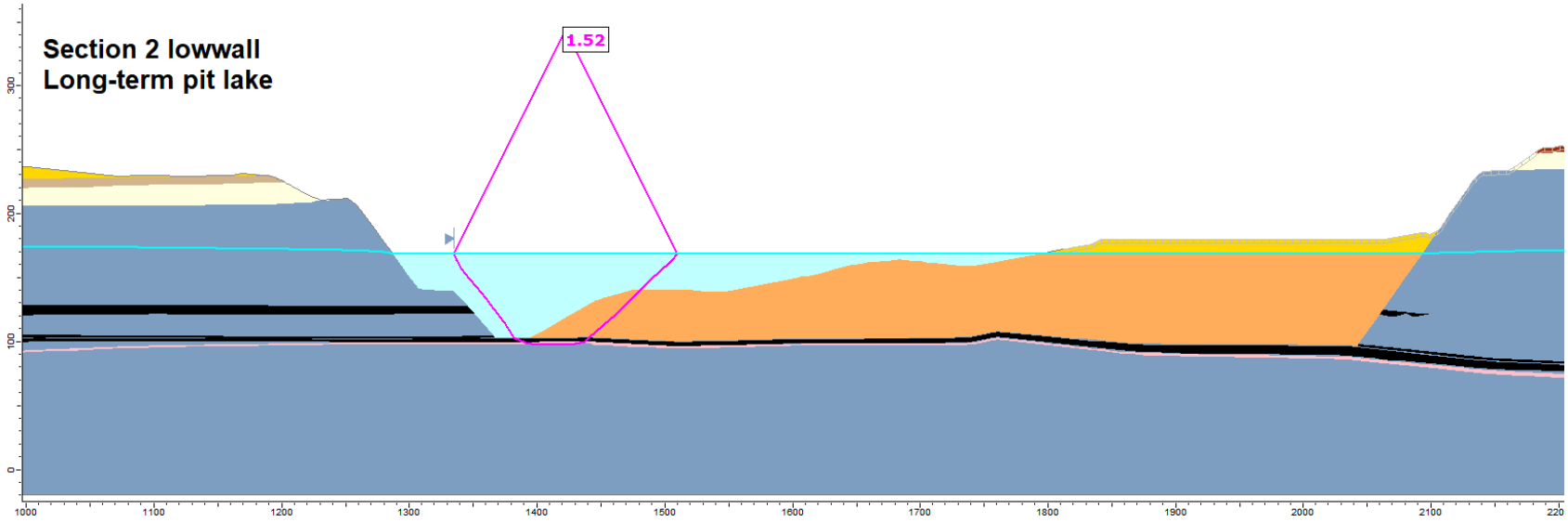
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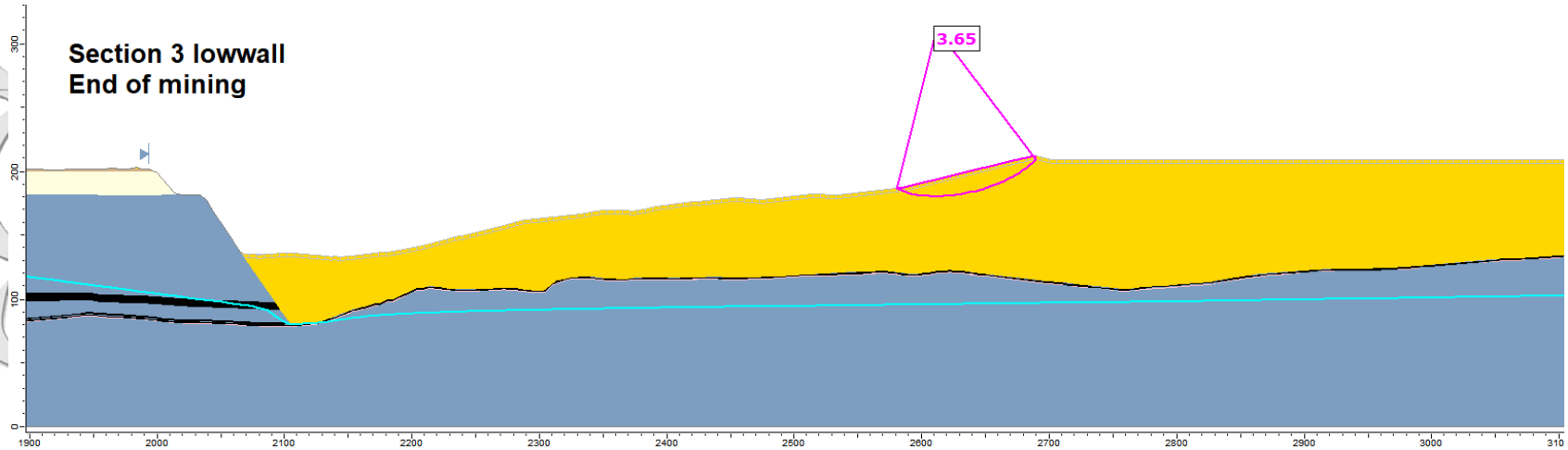
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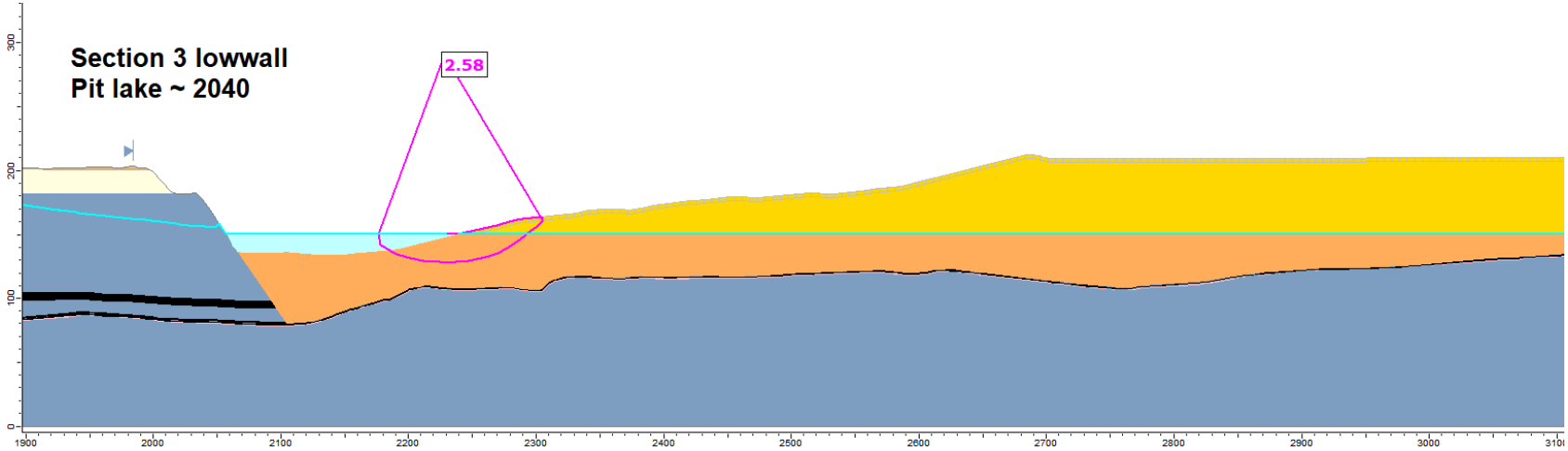
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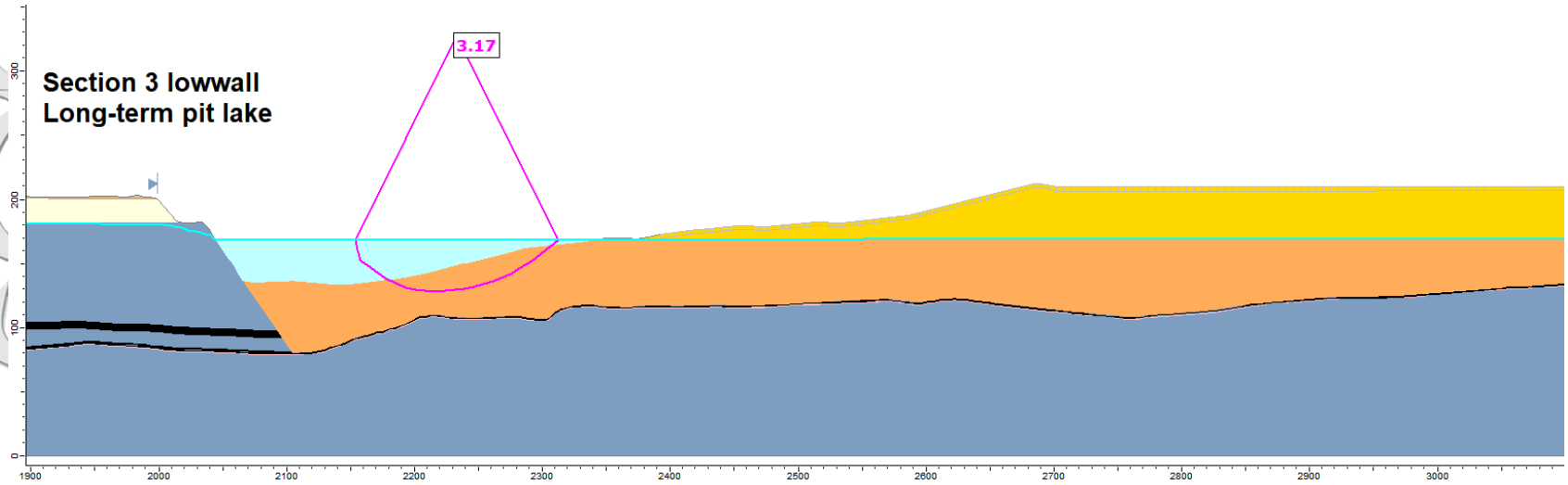
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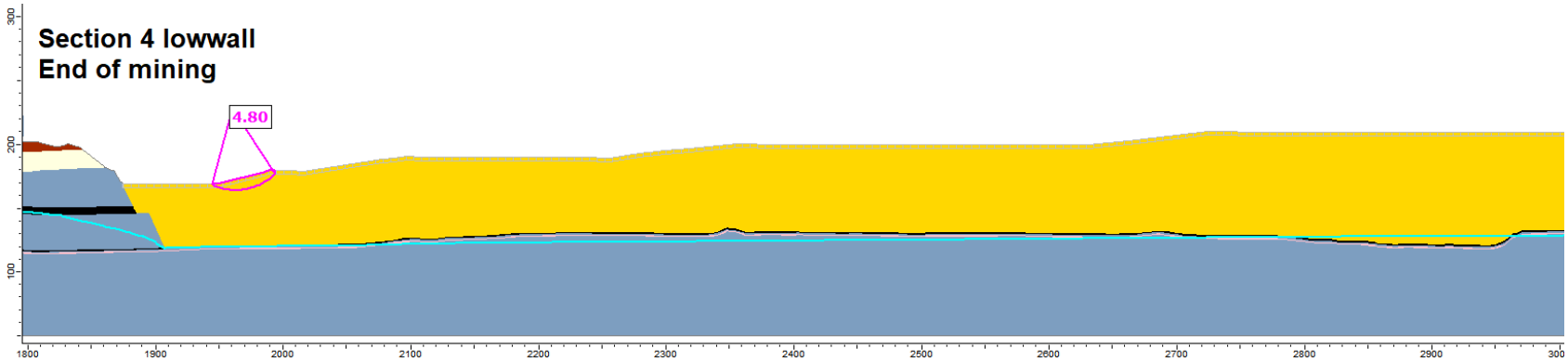
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End of mining
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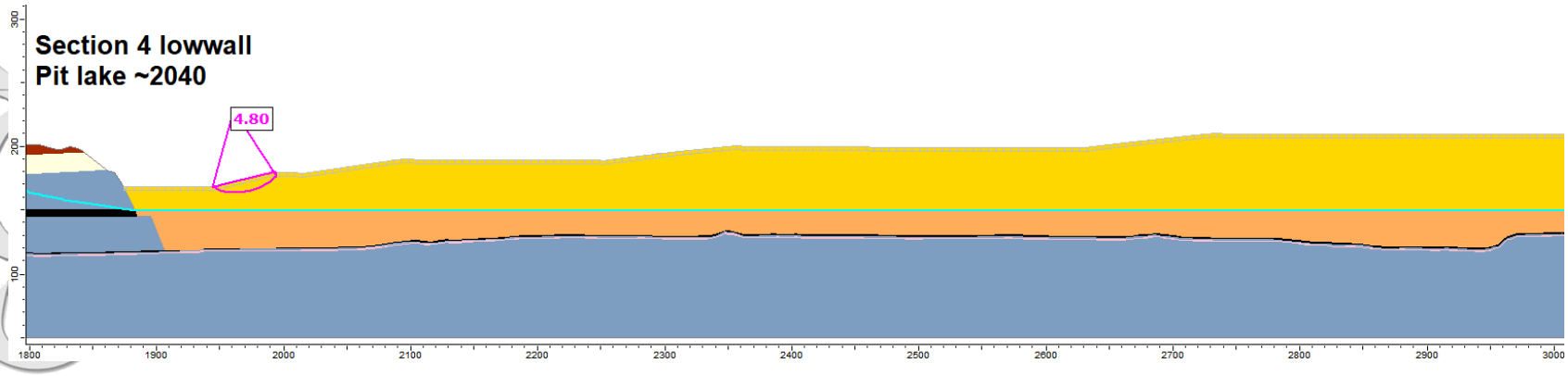
300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2800
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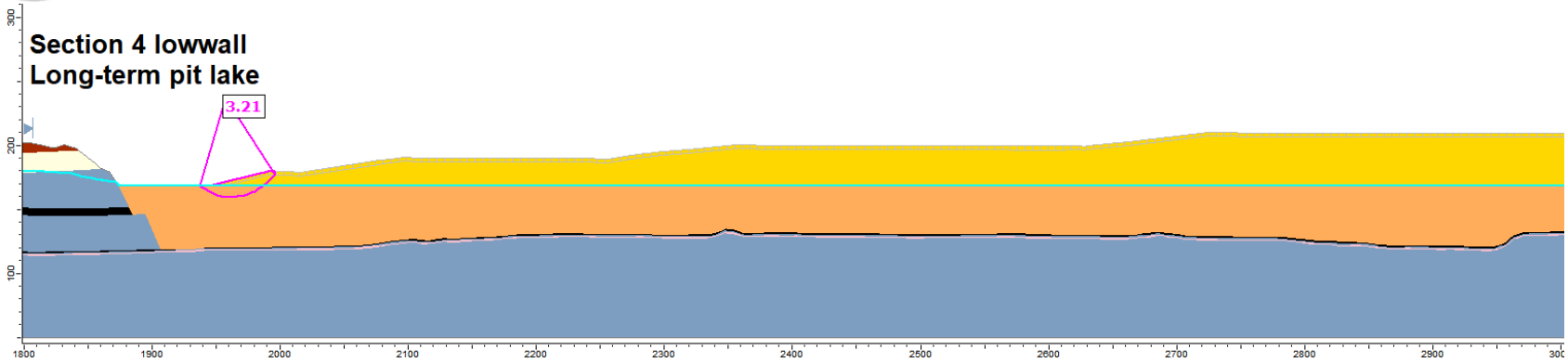
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3.21
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2800
2900

APPENDIX D SAFETY RISK ASSESSMENT

Safety (Risk) Assessment Matrix (from Simmons et al, 2024)

		Consequence		
		High	Medium	Low
Likelihood	High	High Risk	Medium Risk	Medium Risk
	Medium	Medium Risk	Medium Risk	Low Risk
	Low	Medium Risk	Low Risk	Low Risk

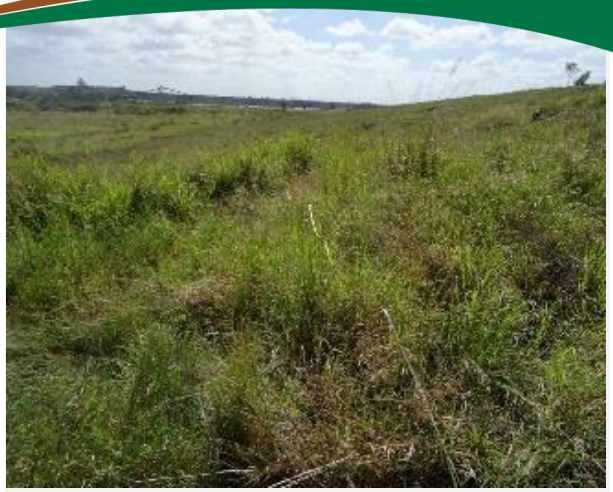
Hazard	**Potential consequence**	**Factors affecting likelihood**	**Risk rating of design**	**Additional mitigation measures**
Arc- or wedge- slip instability of highwall	Person falls on rough ground (long-term injury)	Grazing PMLU is set-back from crest, but unauthorised person might access area	M-L = Low	Construct exclusion bunds at edge of grazing PMLU. Note function of bunds and need for maintenance in Land Management Plan. Note implications of future river channel mobility in Land Management Plan
	Damage to fencing or exclusion bunds	Bunds will be set back from crest but area in front of bund might not be regularly inspected	L-L = Low	
	Damage to vegetation and change of overland flow paths could increase erosion		L-L = Low	
	Isaac River breaks into void	Factors of Safety for instability near river are high but future channel movements might reduce the separation	M-L = Low	

Hazard	Potential consequence	Factors affecting likelihood	Risk rating of design	Additional mitigation measures
Fall of rock fragments from degrading/eroding highwall	Person struck by falling rock (long-term injury)	Void is a NUMA, so there will be no authorised access	M-L = Low	Fence NUMA on all sides to prevent unauthorised access
	Minor damage to colonised vegetation		L-L = Low	Rely on natural recovery processes
	No infrastructure		n/a	
Arc- or wedge- slip instability of lowwall	Person falls on rough ground that is not steeply sloping (medium-term injury)	Unauthorised person might access lowwall side of void	L-L = Low	Fence NUMA on all sides to prevent unauthorised access. Locate lowwall fences outside the extent of the long term pit-lake Note function of exclusion fencing in Land Management Plan
	Damage to fencing		L-L = Low	
	Damage to vegetation		L-L = Low	Rely on natural recovery processes

Note: Lowwall slopes outside the long-term pit lake level are not steep enough to generate a rockfall hazard.

Appendix 12 Revegetation Plan (28 June 2024)

REVEGETATION PLAN: POITREL MINE



Stanmore Resources

June 2024

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Client: Stanmore Resources

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1 INTRODUCTION

1.1 Background

Queensland legislation requires all mines with a site-specific Environmental Authority (EA) to prepare a Progressive Rehabilitation and Closure Plan (PRC plan). The PRC plan must be developed in accordance with the Guideline – Progressive Rehabilitation and Closure Plans (DES 2023) (ESR/2019/4964) (Guideline).

The primary purpose of the PRC plan is for the holder of an EA to plan for how and where activities will be carried out on land in a way that maximises progressive rehabilitation to a stable condition and to provide for the condition to which the holder must rehabilitate the land before the EA is surrendered.

Stanmore SMC Pty Ltd, a wholly owned entity of Stanmore Resources Ltd (Stanmore) are the holders of an EA for a mining activity relating to the mining leases (MLs) at the Poitrel Mine (PTM, the Mine) (EA reference: EPML00963013).

Stanmore commissioned Landloch Pty Ltd to develop a revegetation plan (this document) for inclusion in the PRC plan.

1.2 Requirements of the revegetation plan

The PRC plan Guideline (DES 2023) states that the revegetation plan must, "*propose activities that will establish self-sustaining vegetation communities that are appropriate for the intended post-mining land use (PMLU).*" Revegetation must also consider the establishment of appropriate fauna habitat if appropriate. The revegetation plan must:

- Outline the:
    - Revegetation objectives for the site that are consistent with the PMLUs, NUMAs, and
    - Rehabilitation milestones identified in the PRCP schedule.
- Identify key vegetation species for the proposed PMLU.
- Identify any species of conservation significance relevant to the mine's approval.
- Identify any fauna habitat and use requirements.
- Include evidence and justification for any analogue sites of the monitoring plan.
- Describe the works for establishing and managing the revegetation.
- Identify what plant/seed mixes are appropriate for the PMLU and where the mixes will be sourced.
- Identify seed density application rate and timing of seeding.
- Identify the proposed location of any infrastructure required to protect revegetation.
- Identify the growth media that would be suitable to sustain the PMLU.
- Identify primary growth media depth requirements for revegetation success and sustainable PMLU.

1.3 EA conditions

The EA conditions listed in Table 1 have guided the contents of this revegetation plan.

Table 1: EA conditions that have guided this revegetation plan.

Condition	Condition Wording
A4	Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than five (5) years.
A5	Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person(s).
A6	Upon request from the administering authority, copies of monitoring results, records, registers, management plans and reports required by the conditions of this environmental authority must be made available and provided to the administering authority within ten (10) business days or an alternative timeframe agreed between the administering authority and the environmental authority holder.
E3	Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with Schedule E Table E1 (Rehabilitation Requirements).
E4	Progressive rehabilitation must commence within three (3) years when areas become available within the mining leases.

1.4 Scope

The aim of the revegetation plan is to provide sufficient technical detail to achieve a safe, stable, and non-polluting landform, with a suitable self-sustaining vegetation cover in accordance with the rehabilitation requirements set out in the EA and in consideration of the PMLU requirements. The revegetation plan objectives include:

- Outline the revegetation objectives;
- Identify vegetation species associated with the PMLU;
- Establish self-sustaining vegetation that incorporates appropriate fauna habitats;
- Develop soil properties that will support the desired PMLU;
- Establish land with comparable management requirements to similarly used non-mining land; and
- Describe the work required to establish and maintain the vegetation.

The revegetation plan does not consider the measurement or monitoring of the following aspects that are also considered as part of the PRC plan:

- Air;
- Surface water;
- Groundwater;
- Noise; and
- Waste management.

2 BACKGROUND

2.1 Location

PTM is an open cut coal mine in the Bowen Basin, located approximately 20 km east of Moranbah, and is situated in the Isaac Regional Council Local Government Area.

Mining at PTM commenced in 2006 and uses open cut strip mining techniques with an excavator, truck and dozer fleet. Run-of-mine (ROM) coal is transported to Red Mountain Joint Venture (RNJV) Coal Handling and Processing Plant (CHPP) located on the adjoining infrastructure Mining Lease (ML) 70312. The coal forms part of the Leichhardt and Vermont Seams.

2.2 Vegetation communities

2.2.1 Regional ecosystems

A desktop assessment and review of previous ground-truthed ecological studies, environmental databases, maps, and associated literature was conducted by BAAM in 2021 (BAAM Ecological Consultants, 2021). The study area for this assessment focused on undisturbed areas within the EA approved surface disturbance footprint. The assessment identified 11 Regional Ecosystems (REs) within the EA approved disturbance area and broader MLs. Table 2 describes the REs in the mining leases and EA approved disturbance area. Maps showing the survey locations and REs at PTM are presented in Appendix C.

Table 2: Regional Ecosystems in the PTM EA approved disturbance footprint and MLs (Source: BAAM Ecological Consultants, 2021).

RE Code	Short description	BD status[1]	VM Act Status[2]	Area in MLs (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	E	E	28
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	OC	OC	14
11.3.25	*Eucalyptus tereticornis or E. camaldulensis* woodland fringing drainage lines	OC	LC	45
11.3.27	Freshwater Wetlands. Occurs in a variety of situations including lakes, billabongs, oxbows, and depressions on floodplains. Palustrine	OC	LC	3
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plain	OC	OC	12
11.3.4a	*Corymbia tessellaris* woodland. On alluvial sand ridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict	OC	OC	16

RE Code	Short description	BD status[1]	VM Act Status[2]	Area in MLs (ha)
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	E	E	8
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	E	E	149
11.5.3	*Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	NC	LC	6
11.7.2	*Acacia spp.* woodland on Cainozoic lateritic duricrust. Scarp retreat zone	NC	LC	16
11.7.3	*Eucalyptus persistens, Triodia mitchellii* open woodland on stripped margins of Cainozoic lateritic duricrust	NC	LC	8

[1]E = endangered, OC = of concern, NC = no concern [2]E= endangered, OC = of concern, LC = least concern

2.2.2 Species of conservation significance

Species of conservation significance are identified in Table 2. Areas adjoining undisturbed 'Endangered' or 'Of Concern' regional ecosystems or threatened species habitats will be rehabilitated to a woodland habitat PMLU wherever possible. This approach will provide connectivity between rehabilitated areas and existing vegetation and habitat values. Similarly, areas rehabilitated to a watercourse PMLU will connect existing riparian habitat values for several conservation significant species.

2.2.3 Weed species

Weed surveys conducted at PTM identified several weed species as being present on the MLs and the surrounding areas. Weeds have the potential to impact on the ecological values of the rehabilitated areas. The surveys identified three dominant weed species on site: these being.

- Prickly pear *(Opunitia spp.)*;
- Bellyache bush *(Jatropha gossypifolia)*;
- Harrisia cactus (*Harrisia martinii, Harrisia tortuosa* and *Harrisia pomanensis*);
- Parthenium (*Parthenium hysterophorus*);
- Lantana *(Lantana camara)*.

All weeds listed above are classified as 'Restricted Invasive Plants' under the Biosecurity Act 2014. The Act requires that all reasonable and practical steps be taken to minimise the risks associated with invasive plants.

2.3 Fauna

The bulk of PTM MLs and EA approved disturbance area is comprised of woodlands, pastures, and areas disturbed by mining.

A total of five conservation significant fauna (based on current legislation) that have been recorded within or adjacent to PTM MLs or that were assessed as likely to occur (BAAM Ecological Consultants, 2021), are given in Table 3 and habitat maps are presented in Appendix C. Other species that have the potential to occur include a range of reptiles, birds, amphibians and mammals and these species, if present, may benefit from rehabilitation activities in general.

Table 3: Conservation-significant fauna recorded or likely to occur within or adjacent to PTM MLs (Sources: BAAM Ecological Consultants, 2021).

Species	EPBC Act status	NC Act status	Likelihood of Occurrence
Squatter pigeon *Geophaps scripta scripta*	Vulnerable	Vulnerable	Likely to Occur
Koala *Phascolarctos cinereus*	Endangered	Vulnerable	Likely to Occur
Ornamental Snake *Denisonia maculata*	Vulnerable	Vulnerable	Known to Occur
Southern Greater Glider *Petauroides volans*	Endangered	Endangered	Known to Occur
Grey Falcon *Falco hypoleucos*	Vulnerable	Vulnerable	Potential

3 POST MINING LAND USE

Appendix A shows locations of the different proposed PMLUs across the mine. The PMLUs include:

- Cattle grazing;
- Woodland habitat;
- Watercourse.

This revegetation plan will focus on land to be rehabilitated to cattle grazing, woodland habitat and watercourse PMLUs. The associated areas for these PMLUs are:

- Cattle grazing:
  - Infrastructure to be decommissioned.
  - Infrastructure to be retained (dams for stock use)
  - Spoil dump with pasture vegetation (<15% slope).
- Woodland habitat:
  - Riparian buffer landform embankment
  - Spoil dump with native vegetation (>15% slope).
- Watercourse:
  - Diversion.

4 REVEGETATION PLAN

4.1 Overview

The revegetation plan for PTM is based on a rehabilitation approach that seeks to establish similar vegetation, rather than a restoration approach that seeks to restore completely what was present prior to mining. The rehabilitation approach is most suitable for disturbed areas with modified or disturbed soil, depleted soil seed banks, and the potential for weed species that prevent natural regeneration of the pre-disturbance ecological community.

The plan is aimed at establishing a safe, stable, and non-polluting landform, with a self-sustaining vegetation cover consistent with the proposed PMLUs. The revegetation plan does not aim to restore the exact conditions of the target REs in their remnant or undisturbed state.

Revegetation activities for the woodland habitat and watercourse PMLUs will focus on the establishment of groundcover to facilitate stability and soil retention and shrub and tree cover to enable the return of fauna habitat. Native seed mixtures will contain a variety of perennial grass, shrub, and tree species introduced by direct seeding to establish a self-sustaining woodland ecosystem. Revegetation activities for the grazing PMLU will focus on establishment of a stable and productive pasture to facilitate stability and soil retention, and to enable the return of grazing and fauna habitat.

4.2 Rehabilitation areas and actions

Appendix A shows the location of the different PMLUs, and Appendix B shows the location of different rehabilitation areas (RAs). A summary of the rehabilitation actions for each rehabilitation area is given in Table 4. Figures showing the landform design are given in Appendix D.

Table 4: Summary of rehabilitation actions for each rehabilitation area.

Rehabilitation Area*	Rehabilitation Activities
Spoil Dumps (Woodland and Grazing)	Reshape with dozers/prestrip to undulating landforms. Slope gradients and cover levels are outlined in the Rehabilitation Landform Design report prepared for the PRC Plan (Landlloch 2024). No slopes to exceed 25%. Up to 15% grazing PMLU and the remaining area woodland habitat PMLU. Primary growth media placed at a depth range dependent on PMLU. Erosion control structures are to be installed at vertical intervals not to exceed 10m. Deep contour ripping and seeding. Revegetation will include a range of species consistent with those proposed for each PMLU. Not all plants need be present, but rehabilitation must contain a range of these species.

Rehabilitation Area*	Rehabilitation Activities
Infrastructure	Treated on a case-by-case basis in consultation with stakeholders. Facilities to be either left for future users or sold for removal with the site to support grazing. If rehabilitated, the area will be contour ripped to a depth of 0.5m to relieve compaction and primary growth media placed at a depth range dependant on PMLU. Revegetation will include a range of species consistent with those proposed for each PMLU. Not all plants need be present, but rehabilitation must contain a range of these species.
Coal waste	Coarse and fine reject material is co-disposed within spoil dumps. This material with be capped to a minimum of 2.0m with adjoining spoil sufficient to break capillary rise of solutes. Drying cells will be backfilled to approximate pre mine surface levels, contour ripped to 0.5m and primary growth media placed at a depth range dependent on PMLU.
Exploration works	All exploration works and drill holes will be rehabilitated in accordance with the eligibility criteria and standard conditions for exploration and mineral development projects – V2 (EHP, 2016)

*See Appendix B for the location of these areas.

4.3 Revegetation specifications

4.3.1 Spoil dumps

Final rehabilitation will be undertaken progressively on the spoil dumps as mining operations progress. The general sequence of works during each progressive rehabilitation campaign includes:

1. Reshape wastes when placement has been completed and the mine pit has progressed. Reshape to the final design shape (Appendix D).
2. Conduct sampling and testing of the surface 2m of waste to confirm the material is waste and non-acid-forming.
3. Conduct sampling of the primary growth media to confirm fertiliser requirements.
4. Rip waste to approximately 0.5m to reduce compaction and allow adequate water and root penetration into this layer.
5. Spread primary growth media to a depth between 0.1–0.15 m, dependent on the PMLU.
6. Apply ameliorants (e.g. fertiliser) as required.
7. Scarify the primary growth media to incorporate soil ameliorants but not to a depth that will bring waste to the surface.
8. Apply seed and till on the contour with a tyned implement with tyne spacing no greater than 0.5m.

4.3.2 Primary growth media quality

Target primary growth media properties based on material characterisation (Landloch, 2022) to support the desired PMLU will have:

- Cation exchange capacity of above 14 meq/100g for clays and 6 meq/100g for loams.
- Major macronutrient concentrations in root zone (0–0.3m):
  - Total nitrogen (N) above 1000 mg/kg.
  - Available phosphorus (P) above 10 mg/kg.
  - Potassium (K) above 160 mg/kg.
  - Total organic carbon (TOC) above 1%.
- pH_w range of soil is between 6.0–9.0 to at least 0.3m.
- Primary growth media (0–0.3m) salinity ($EC_{1:5}$) is less than 0.75dS/m.

Where the initial primary growth media properties are outside of the above values, amendments should be applied to address any limitations. Further details on the primary growth media characteristics are given in Landloch (2022).

Given the time period between the development of this revegetation plan and the point at which implementation may occur, it is recommended that fertiliser requirements be assessed according to RM 4 of the PTM PRCP Schedule approximately 6 months prior to rehabilitation being progressively implemented.

4.3.3 Plant species

4.3.3.1 Pasture species

Areas of cattle grazing are predominately planned for the lower gradient areas disturbed by mining activities, areas that require shallow rooted species and/or areas where there was significant clearing prior to mining.

The recommended revegetation species mix for cattle grazing PMLU is based on seeding preferred, palatable and productive (3P) pasture species and legumes cognisant of grazing best management practice. Suitable pasture species are provided in Table 5. These species have been recommended based on a combination of 3P species recorded during PTM baseline surveys, as well as a selection of 3P species suitable for the dominant clay and/or loam soils at the mine.

Table 5: Recommended species to be established in the grazing PMLU.

Common Name	Scientific Name	Sowing Rate (kg/ha)	Comment
Rhodes grass	*Chloris gayana cvv. Callide*[1]	3*	3P grass Tolerate a range of soils
	cvv. Katambora[1]	4*	3P grass Tolerate a range of soils Salt tolerant
Bisset Creeping Bluegrass	*Bothriochloa insculpta cvv. Bisset*	4*	3P grass Drought tolerant

Common Name	Scientific Name	Sowing Rate (kg/ha)	Comment
Qld Blue grass	*Dicanthium sericeum*	2	3P grass Suitable for clay soils
Bambatsi panic	*Panicum coloratum cvv. makarikariense*	3*	3P grass
Purple pigeon	*Setaria incrassata*	2	3P grass
Burgundy bean[2]	*Macroptilium bracteatum*	2	Legume requires specific rhizobium inoculum strain CB1717
Stylo[2]	*Stylosanthes seabrana cvv. caatinga*	2	Legume requires specific rhizobium inoculum strain CB3481
Shirohie millet	*(e.g. Echinochloa esculenta[1])*	5	Cover crop for soil protection
Total		27	

*1: Exotic species; 2: Must be sown within 28 days of inoculation; *: Assumes seed is coated. If not coated, use half prescribed rate.*

4.3.3.2 Woodland habitat species

Creation of a native ecosystem is likely to achieve species richness in line with the habitat values and establishment of a sustainable ecosystem identified by indicators of success in Table E1 of the EA. As such, the species selection has been expanded from a the restrictive RE 11.10.1 species list to include as many species as possible from the relevant broad vegetation groups (BVG). The relevant BVG for RE 11.10.1 located on the anthropogenic rocky landform is BVG 10a.

The total recommended seeding rates for upper-story tree species is 5kg/ha, mid and lower story tree and shrub species is 5kg/ha, and ground cover is 5kg/ha. Selection of seeds will be based on species outlined in Table 6 with a species richness that results in achievement of the respective success criteria (Table 12).

Table 6: Recommended species to be established in the woodland habitat PMLU.

BVG	Upper-storey tree species	Mid and lower storey tree and shrub species	Groundcover species
10a	*Corymbia citriodora* *Eucalyptus crebra* *Eucalyptus fibrosa* *Corymbia hendersonii* *Corymbia clarksoniana* *Angophora leiocarpa thozetiana* *Eucalyptus cambageana* *Eucalyptus crebra* *Acacia harpophylla* *Acacia cambagei* *Casuarina cristata*	*Alphitonia excelsa* *Acacia leiocalyx* *Acacia cretata* *Acacia longispicata* *Petalostigma pubescens* *Breynia oblongifolia* *Capparis canescens*	*Cymbopogon refractus* *Themeda triandra* *Eremochloa bimaculate* *Arundinella nepalensis* *Panicum effusum* *Desmodium varians,* *Brunoniella australis Cyanthillium cinereum* *Chrysocephalum apiculatum* *Eustrephus latifolius* *Dianella revoluta* *Phyllanthus virgatus* *Evolvulus alsinoides* *Lomandra confertifolia subsp. Pallida* *Lomandra multiflora subsp. Multiflora* *Glossocardia bidens.*

4.3.3.3 Open woodland habitat species

Open woodland rehabilitation will act as a transitional ecosystem between the native woodland PMLU and the grazing PMLU. The open woodland will represent properties of both PMLUs. The area will consist of upper-story tree species from BVG 10a and a mix of native and productive exotic pasture species (Table 7). The transitional ecosystem aims to complement both exiting PMLUs with the presence of scattered trees to aid species diversity and act as bedding and shade areas for livestock while maintaining grazing productivity, although to a lesser extent to a dedicated pasture. The outcome is likely to result in a more natural looking final landform.

The total recommended seeding rates for upper-story tree species is 2.5kg/ha and ground cover are 20kg/ha.

Table 7: Recommended species to be established in the woodland habitat PMLU.

Vegetation layer	Species	Sowing Rate (kg/ha)
Upper and mid storey	*Corymbia citriodora* *Eucalyptus crebra* *Corymbia hendersonii* *Corymbia clarksoniana* *Angophora leiocarpa thozetiana* *Eucalyptus cambageana* *Acacia cambagei* *Alphitonia excelsa* *Acacia leiocalyx* *Petalostigma pubescens*	2.5 (combined)
Groundcover	*Themeda triandra*	3
	Cymbopogon refractus	3
	Panicum effusum	1
	Chloris gayana cvv. Callide[1]	3*
	cvv. Katambora[1]	3*
	Bothriochloa insculpta cvv. Bisset	2*
	Dicanthium sericeum	2
	Stylosanthes seabrana cvv. Caatinga [2]	3

*1: Exotic species; 2: Must be sown within 28 days of inoculation; *: Assumes seed is coated. If not coated, use half prescribed rate.*

4.3.3.4 Watercourse habitat species

The majority of the New Chum Creek diversion has been previously rehabilitated post its construction. Therefore, the revegetation specifications below relate to any additional rehabilitation requirements for the New Chum Creek diversion (rock removal in downstream reach).

Generally, PTM watercourses is associated with riparian vegetation which includes species adapted to upper-, mid- and lower banks (revegetation zones) as illustrated in Figure 1.

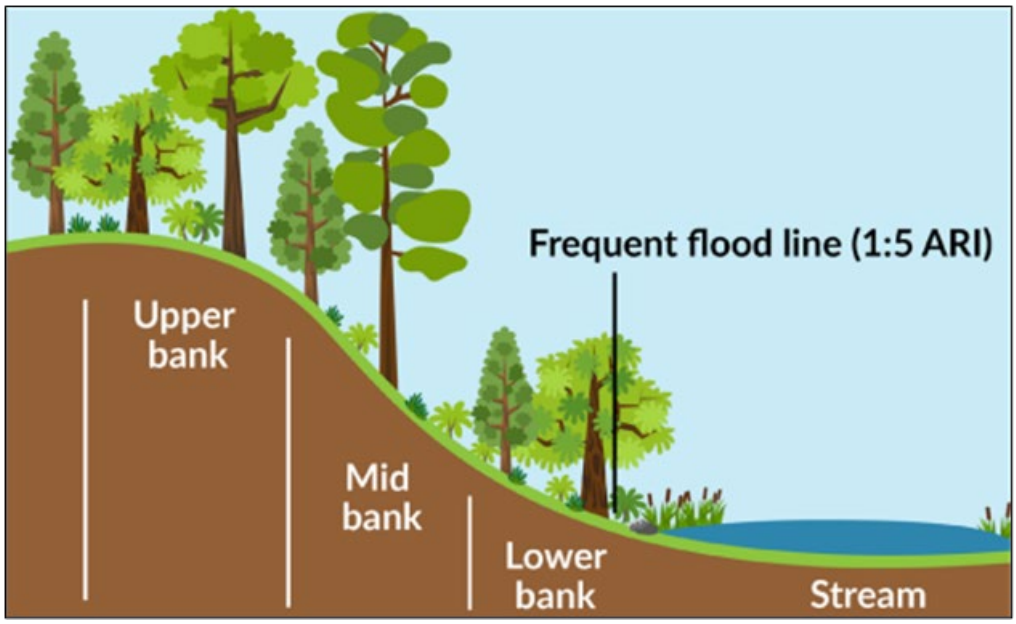

Figure 1: Typical Riparian Revegetation Plantings Zone (BCCA 2014).

Previous ecological studies conducted at PTM (Table 2) indicate that watercourse habitat species is akin to RE 11.3.25. This provides a degree of confidence that the proposed species will establish successfully on site. However, creation of a native ecosystem is more likely to achieve successful rehabilitation to a sustainable ecosystem that has habitat values. As such, the species selection has been expanded from a restrictive RE species list to include as many species as possible from the relevant broad vegetation group (BVG). The relevant BVGs for RE 11.3.25 is 16a.

The Index of Diversion Condition (IDC) assessment will be utilised to track revegetation success, in line with existing water licence requirements. The IDC assessment monitors a range of riparian factors and comparison of these factors with natural reaches of New Chum Creek is aligned with EA Table E1 rehabilitation success criteria.

The total recommended seeding rates for upper-story tree species is 5kg/ha, mid and lower story tree and shrub species is 5kg/ha, and groundcover is 5kg/ha. Selection of seeds will be based on species outlined in Table 8 with a species richness that results in achievement of the respective success criteria (Table 12).

Table 8: Recommended species to be established in the watercourse PMLU.

BVG	Upper-storey tree species	Groundcover species
16a	*Eucalyptus camaldulensis* *Eucalyptus tereticornis* *Eucalyptus coolabah* *Melaluca sp.* *Corymbia tessallaris* *Angophora spp.* *Casuarina cunninghamiana*	*Heteropogon contortus* *Themeda triandra* *Chrysopogon fallax* *Imperata cylindrica* *Eulalia aurea* *Cyanthillium cinereum* *Phyllanthus virgatus* *Eustrephus latifolius* *Brunoniella australis* *Crotalaria montana* *Rostellularia adscendens* *Evolvulus alsinoides Sida spp*

4.3.4 Planting rates and timing

The recommended sowing rate for seeded plant species will be based on the rates recommended by the seed supplier unless stated in this plan. In addition to this amount, a contingency of +20% will be adopted to account for plant mortality. The composition of the different seeds will be guided by species richness criteria in respective modified BioCondition criteria.

Care should be taken to not overseed tree and shrub species and cause very high densities of trees and shrubs to develop. This will have an adverse impact on the establishment of groundcover species that are critical for managing the erosion potential of the final landform.

Timing for seeding will typically be targeted for late summer or early autumn when soil moisture is high, and temperatures are milder.

4.3.5 Seed collection and procurement

If required, and where possible, native seed could be collected from populations on or near PTM to maintain regional tolerances. Seed collection could occur in the years prior to commencement of rehabilitation, and then on an ongoing basis as rehabilitation occurs progressively through to the end of mining.

In the case where seed collection cannot supply sufficient seed (e.g. future dry periods that reduce seed set), species planted from seed may need to be purchased from local suppliers up to six months in advance, in quantities sufficient to undertake direct seeding operations. An appropriate temporary storage will be set up on site in advance of receiving the collected/bought seed.

4.3.6 Vegetation establishment methods

Direct seeding will be preferred to achieve an even, continuous cover of vegetation for the Grazing, Native woodland and Watercourse PMLUs. Seeding may be undertaken using conventional broadacre seeding equipment (e.g. combine seeder, spread with harrows or spinner).

In most cases, *Acacia* spp. seeds have a hard coat which is impermeable to water and germination will not normally occur unless some sort of pre-treatment is conducted. In nature this hard coat leads to seed dormancy until it is broken down over time or by the heat of bushfire. Approximately half of the hard-coated *Acacia* spp. seeds should be scarified prior to sowing. This will allow scarified seeds to imbibe and germinate. By only scarifying half of the seeds additional reserve are maintained in the soil seed bank. Seed scarification can be required from the supplier prior to delivery however needs to be sown as soon as possible after scarification.

4.3.7 Weed control

Establishment of a self-sustaining ecosystem with comparable management requirements to similarly regional ecosystem will require weed management.

It is suggested that:

- Weed density and diversity will not exceed 110% of baseline survey results; and
- No declared weeds are to be present in rehabilitation.

Weed management operations will use controls that include:

- Conduct employee awareness training in scheduled tool-box talks directed at weeds and feral pests.
- Provision of, and requirements for vehicle wash down facilities.
- Wash down bays will collect seeds that are washed from the vehicles to prevent ingress to drainage lines.
- The Mine will maintain regular weed monitoring and control programs.

4.3.8 Planting success

Monitoring of newly seeded rehabilitation will commence immediately after planting and continue until plants have established. Plant health and mortality will be recorded, and any damaged or distressed plants will be attended to (e.g. watered, fertilised). If the mortality rate exceeds 30% of total plants, supplementary planting will be undertaken.

4.3.9 Fauna control

Over grazing activity from native animals (e.g. kangaroos and wallabies), livestock (cattle, sheep, etc), and feral pests (e.g. pigs, goats, and mice) have the potential to impact rehabilitation success.

Grazing activity that impacts rehabilitation will be recorded during annual rehabilitation monitoring assessments. Where damage exceeds acceptable levels, grazing reduction treatments are to be engaged. Feral pest controls (e.g. trapping and shooting) will be instigated if they are found to be damaging revegetated areas. Damage from other animals may need to be managed through the establishment of exclusion areas (e.g. fencing) until rehabilitation has recovered.

5 REVEGETATION MONITORING

Monitoring is an integral part of the overall management strategy, enabling early detection of risks to rehabilitation and an indicator to commence effective risk management actions.

Key objectives of the monitoring program are to:

- Track the progress of rehabilitation activities with respect to milestones and benchmarks for comparable communities (at analogue sites);
- Identify problems affecting the progress or success of rehabilitation, which can then be addressed through management actions;
- Identify key site-specific success factors for successful rehabilitation and apply these more broadly throughout PTM; and
- Collect data to objectively assess compliance with the PTM PRCP Schedule, relating to the creation of ecological values that are self-sustaining.

The timescales over which rehabilitation activities will be conducted can be expected to vary considerably between woodland and pasture communities. The establishment of functional woodland ecosystems may take decades, due to the slow growth rates of canopy vegetation. However, a range of incremental benefits in habitat value for ecosystem services can be expected throughout this period. In contrast, pastures can be expected to form functional ecosystems over shorter timeframes of 6–10 years. The shorter timeframes for rehabilitation relate to the fast growth rate of grasses.

A summary of key stages expected in the rehabilitation of woodland and pasture ecosystems at PTM is provided in Table 9.

Table 9: Summary of anticipated phases in the progress of rehabilitation of woodland habitat and grazing pastures

Revegetation Phase	Definition	Anticipated Timeframe	
		Woodland	Pasture
Initiation	Preparation of rehabilitated landform (primary growth media, surface preparation and ameliorants) and seeding.	0–6 months	0–6 months
Establishment	The period required for rehabilitation to become self-reliant in normal seasonal conditions. Maintenance works may be required to maintain weeds and replace vegetation loses.	6 years	3–6 years
Maintenance	The period of growth post establishment until the time that the rehabilitation becomes dominant and self-sustaining on site.	6–15 years	6–10 years
Completion	Final vegetation community and associated fauna habitats establish.	15+ years	10+ years

5.1 Monitoring program

The monitoring program allows for assessment of ecological values through time. In this way the assessment can track trends in ecological values with the intent that values trending towards those present in analogue sites or consistent with published benchmarks but that may take long periods to reach (30+ years) can be used to demonstrate revegetation success in shorter periods of time (not less than 5 years).

Comparisons of ecological indicators will be made with those at analogue sites and with respect to published benchmarks for relevant ecosystem indicators (e.g. RE benchmarks and water quality guidelines). In addition to ecological indicators, soil indicators are also to be assessed against those present in analogue sites or those consistent with published benchmarks.

The rehabilitation monitoring methodology for the project, including rehabilitation success indicators and reporting requirements is provided in Appendix E.

5.1.1 Monitoring frequency

Rehabilitation monitoring assessments are to be staged as per the mines monitoring methodology. Implementation of each component of the rehabilitation monitoring program will be in accordance with Figure 2.

Initial monitoring will be undertaken at newly established rehabilitation monitoring sites to categorise the site, develop baseline data and identify any risks to rehabilitation success.

Minor monitoring will be conducted one year after the initial monitoring phase and will provide a snapshot of rehabilitation performance and identify risks to rehabilitation success that require remediation in the short term.

Major monitoring will be conducted approximately two years after initial monitoring and will provide a detailed assessment of the current state of rehabilitation.

Once initial (year 0), minor (year 1) and major (year 2) monitoring has been undertaken for newly established rehabilitation, ongoing monitoring is then undertaken in accordance with the regular minor and major monitoring cycle for all rehabilitation at that mine site. Ongoing minor and major monitoring assessments are conducted on an alternate two-yearly cycle for the duration of rehabilitation monitoring.

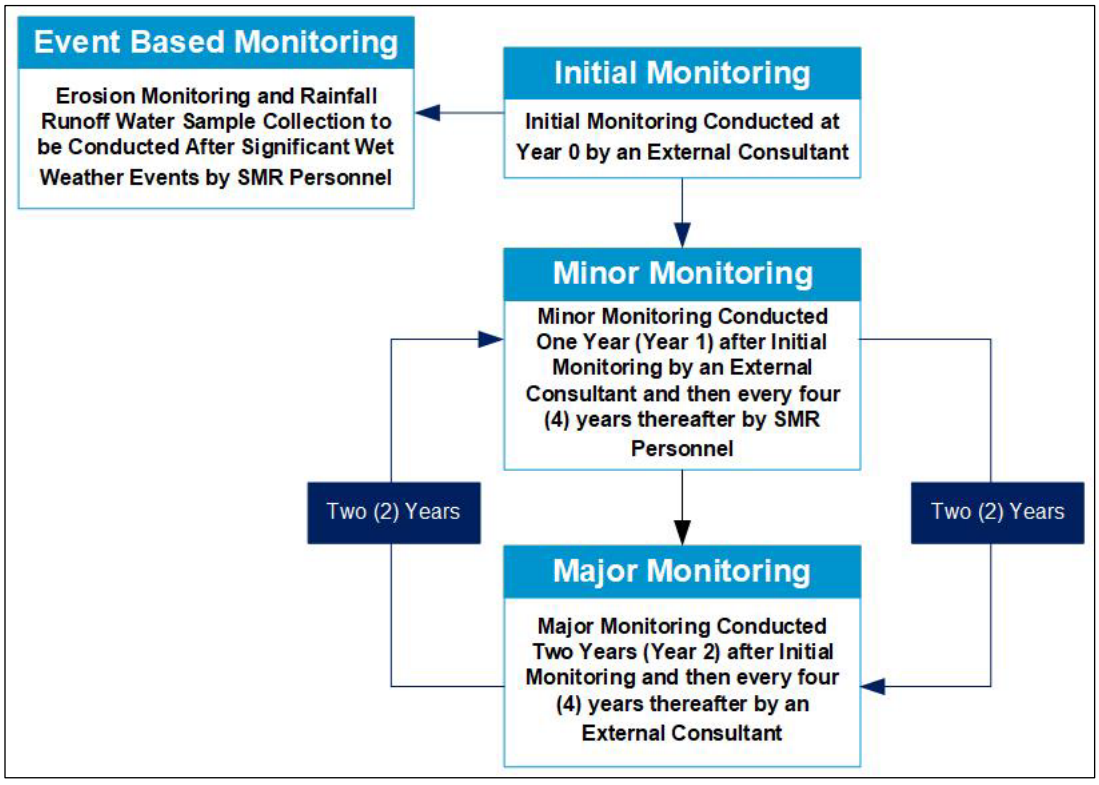

Figure 2: Rehabilitation monitoring protocol and frequency (BHP 2019).

5.1.2 Contingency strategies

Where monitoring assessments indicate rehabilitation is not progressing towards completion milestones contingency steps will follow those outlined in Figure 3.

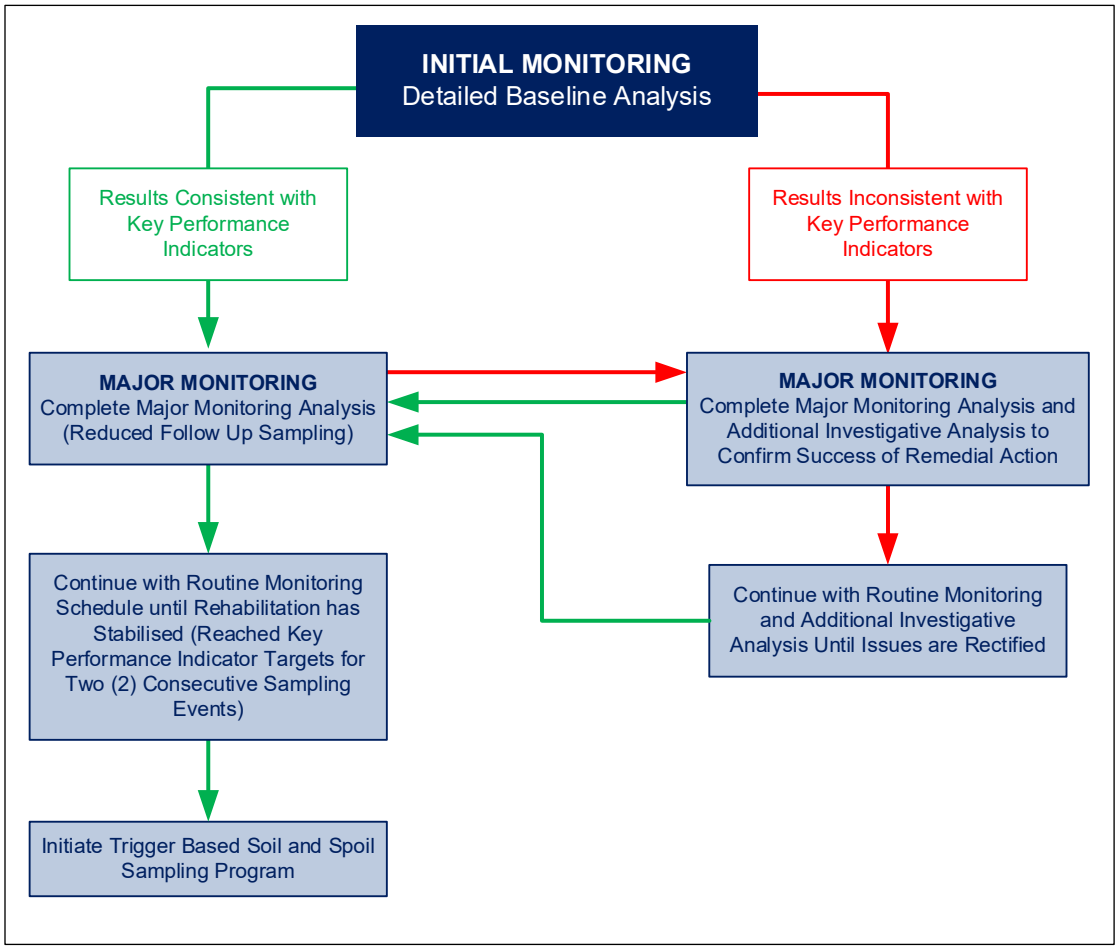

Figure 3: Rehabilitation contingency steps when rehabilitation results are inconsistent with the key performance indicators (BHP, 2019).

5.2 Analogue reference sites

5.2.1 Analogue transects

Vegetation analogue sites were established at the project during initial rehabilitation monitoring assessments to provide comparable data for rehabilitated sites. These vegetation analogue sites were chosen based on their representative features of the respective land disturbances such as topography, soil characteristics and vegetation type and structure. Analogue sites were also selected based on their representation of the REs surrounding PTM.

Summary details of the analogue sites are included in Table 10, images in Figures 4 and 5 and a map showing the locations is given in Figure 6.

Table 10: Rehabilitation monitoring analogue site locations (coordinates in GDA94).

Site ID	Easting (m)	Northing (m)	Period	Status
PTM07	630,298	7,554,734	~10 years	Current
PTM08	627,125	7,560,462	~10 years	Current

Figure 4: Reference Site PTM07 (SLR, 2014).

Figure 5: Reference Site PTM08 (SLR, 2014).

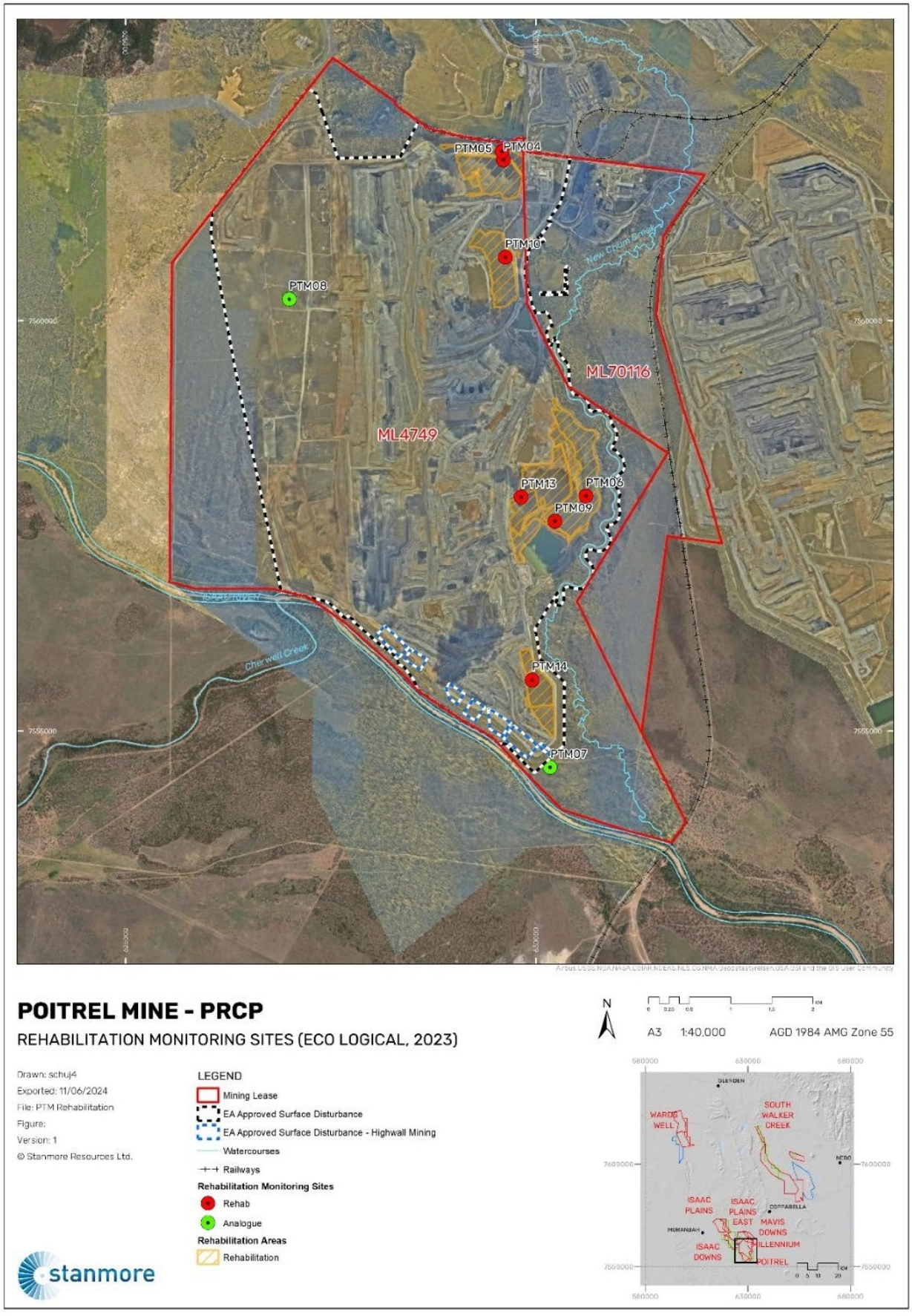

Figure 6: Locations of rehabilitation monitoring sites including reference site locations.

5.2.2 RE (woodland PMLU) benchmarks

Additional to analogue data, woodland rehabilitation will be assessed against representative published RE benchmark data with considerations given for the revegetation potential of reconstructed soil profiles at PTM.

Proposed assessable attributes and weightings for deriving the final BioCondition score are outlined in Table 11 for RA4 and 5. Proposed rehabilitation completion criteria which incorporate BioCondition scoring is outlined below:

- For RA4 and 5, the BioCondition assessment demonstrates achievement of 50% of total maximum BioCondition score of undisturbed regional ecosystem 11.10.1
- Table 11 contains BioCondition benchmark data for the nominated Regional Ecosystems that represent the native woodland planted for RA4 and 5. Data is derived from Queensland Government BioCondition benchmark database. A revised PRCP benchmark is identified from the remnant vegetation benchmark, and only a subset of BioCondition assessable attributes are used, as some (i.e., large trees, course woody debris) would not be achievable in the timeframe from revegetation to achievement of the post-mining land use.
- It is noted that Table 11 does not contain BioCondition benchmark scores for mid story (shrubs) species. This is consistent with that stated on the Queensland Government Website which states that shrubs may form a conspicuous layer. This is also consistent with the departments BVG 10a description which states 'that a shrub layer is very sparse'.

BioCondition benchmark data for the nominated RE (11.10.1) that represents open woodland habitat is outlined in Table 12. Assessable attributes and weightings for deriving the final PRCP BioCondition Benchmark score is also provided in Table 12.

PRCP rehabilitation completion criteria which incorporates BioCondition scoring is proposed below:

- A BioCondition assessment completed by an appropriately qualified person using the methodology outlined in the Queensland Herbarium's BioCondition Assessment will be undertaken to verify that the achievement of the woodland habitat.
- The BioCondition assessment demonstrates achievement of 50% of total maximum BioCondition score of undisturbed regional ecosystem 11.10.1, including pasture grass species.
- It is noted that the PTM PRCP open woodland species selection is based on BVG however BioCondition monitoring assessment described by the Queensland Herbarium is based on undisturbed regional ecosystems. As such, RE 11.10.1 is used for the purposes of establishing PRCP milestone completion criteria as this is the target RE based pre-mining and reference site ecological investigations (Table 2). The assessment criteria will be modified slightly to include pasture grass species along with the traditional woodland species, so it is representative of an open woodland community.
- A revised PRCP benchmark is identified from the remnant vegetation benchmark, and only a subset of BioCondition assessable attributes are used, as some (i.e., large trees, course woody debris) would not be achievable in the timeframe from revegetation to achievement of the post-mining land use.

Table 11: BioCondition benchmark data for the nominated RE (11.10.1) that represents woodland habitat for RA4 and RA5.

Regional Ecosystem	11.10.1 Benchmark	11.10.1 Revised PRCP Benchmark
Short description	*Corymbia citriodora* +/- Eucalyptus crebra +/- *Corymbia clarksoniana* woodland	*Corymbia citriodora* +/- Eucalyptus crebra +/- *Corymbia clarksoniana* woodland
Recruitment	100%	100%
Non-native plant cover	0	≤ 10%
Tree species richness	4	≥ 3 (inc. *Corymbia citriodora*)
Native shrub species richness	4	≥ 3
Native grass species richness	9	≥ 4
Native forb other species richness	17	≥ 5
Tree canopy cover	30%	≥ 15%
Shrub canopy cover	13%	N/A
Native perennial grass	16%	≥ 10%
Litter grid cover	50%	≥ 10%

Table 12: BioCondition benchmark data for the nominated RE (11.10.1) that represents woodland habitat for RA8.

Regional Ecosystem	11.10.1 Benchmark	11.10.1 Revised PRCP Benchmark
Short description	*Corymbia citriodora +/- Eucalyptus crebra +/- Corymbia clarksoniana woodland*	*Corymbia citriodora +/- Eucalyptus crebra +/- Corymbia clarksoniana woodland*
Recruitment	100%	100%
Non-native plant cover not including pasture grasses species	0	≤ 10%
Tree species richness	4	≥ 3 (inc. Corymbia *citriodora*)
Native shrub species richness	4	≥ 3
Native grass species richness	9	≥ 4
Native forb other species richness	17	≥ 5
Tree canopy cover	30%	≥ 15%
Shrub canopy cover	13%	N/A
Native perennial grass and pasture grass species	16%	≥ 10%
Litter grid cover	50%	≥ 10%

5.2.3 Grazing PMLU benchmarks

Pasture rehabilitation will be assessed by an AQP to certify that pasture meets a pasture condition rating of class ≤3, based on the Pasture Condition Assessment Table outlined in "*Stocktake: Balancing Supply and Demand*" (developed by FutureBeef – futurebeef.com.au) and provided in Table 13. A summary of key assessable attributes includes:

- Certification that pasture achieves a condition rating class ≤3.
    - Preferred pasture species (3P grasses) diversity of ≤2 species.
    - Preferred pasture (3P grasses) % dry matter yield ≤10%.
    - Annual grass species dry matter yield <70%.
    - Grasses other than 3P grasses and other weeds dry matter yield <80%.
    - Crown cover (3P grasses) – at worst, moderate to low density and some plants dead.
- Leucaena stem density <250 stems per ha (1 per 40m^2)
- Certification from an AQP that rehabilitation is resilient to fire and grazing pressures.
- Stocking rates are to be equal to or above surrounding natural pastures.

Table 13: Pasture condition assessment table (FutureBeef –futurebeef.com.au).

Condition rating	Condition indicators				
	Preferred pasture species		Annual grass % DM yield	Undesirable grasses and other weeds % DM yield	Preferred pasture species diversity
	% DM yield	Crown cover			
1	>80	Dense and plants healthy	<20	<20	>5 species
2	60 – 80	High to moderate density and some plants unhealthy	20 – 40	20 – 30	3 – 5 species
3	10 – 60	Moderate to low density and some plants dead	40 – 70	30 – 80	2 – 3 species
4	<10%	Sparse and many plants dead	>70	>80	0 or 1 species

6 REVEGETATION CRITERIA AND MILESTONES

Revegetation activities are implemented to meet specific objectives and success criteria (revegetation milestones) are set as a way of determining whether success has been achieved. These are consistent with the EA conditions found in *Section E, Table E1 (Land)*.

The EA rehabilitation criteria is provided in Tables 14, of which many have been transitioned into the PRCP. Refer to the Planning Part for details. Similarly, rehabilitation milestone timeframes are outlined in the PRCP Planning Part.

Table 14: Summary of relevant success criteria for rehabilitation at the mine (extract from PTM EA).

PMLU	Goal	Objective	Indicator	Acceptance Criteria
Cattle grazing	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5 unless an alternative is justified by an appropriately qualified person
		Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover >50% 2. 70% of slopes ≤20%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland)* unless otherwise agreed in writing between the administering authority and the environmental authority holder.
			Leucaena stem density	<250 stems >2m height per ha (1 per 40m2), mean total area
Woodland habitat	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to	Hazard assessment	No significant difference

PMLU	Goal	Objective	Indicator	Acceptance Criteria
		surrounding unmined landscapes subject to the same land use		
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5 unless an alternative is justified by an appropriately qualified person
		Rehabilitation is erosionally stable	Groundcover (steep slopes, >15%)	80%
			Groundcover (lesser slopes, ≤15%)	50%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Native bushland characteristics	Species richness: Trees Shrubs Grasses	 ≥2 ≥3 ≥4
			Tree canopy cover	≥16%
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
		Rehabilitation is erosionally stable (banks and immediate surrounds)	Groundcover	>50%
	Non-polluting	Rainfall runoff from rehabilitation achieves	pH EC	Not significantly different to upstream values

PMLU	Goal	Objective	Indicator	Acceptance Criteria
		relevant water quality objectives for receiving waters	Turbidity	
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation retains water that is a potential resource for cattle grazing, with quality according to ANZECC guidelines version October 2000	TDS Calcium Magnesium Nitrate Nitrite Sulphate	≤5,000mg/L ≤1,000mg/L ≤2,000mg/L ≤400mg/L ≤30mg/L ≤1,000mg/L
Watercourse	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is erosionally stable	Geomorphic index (IDC method)	Greater or equal to upstream or downstream values.
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
	Able to sustain the agreed post-mining land use	Riparian vegetation	Riparian vegetation index (IDC method)	Greater or equal to upstream or downstream values.

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Landloch Pty Ltd (Landloch) (2024) *Rehabilitation Landform Desing: Poitrel Mine,* Prepared for Stanmore Resources.

Landloch Pty Ltd (Landloch) (2022) *Poitrel Mine (PTM) – Material Characterisation Study,* Prepared for Stanmore Resources.

APPENDIX A: POST MINING LAND USE MAP

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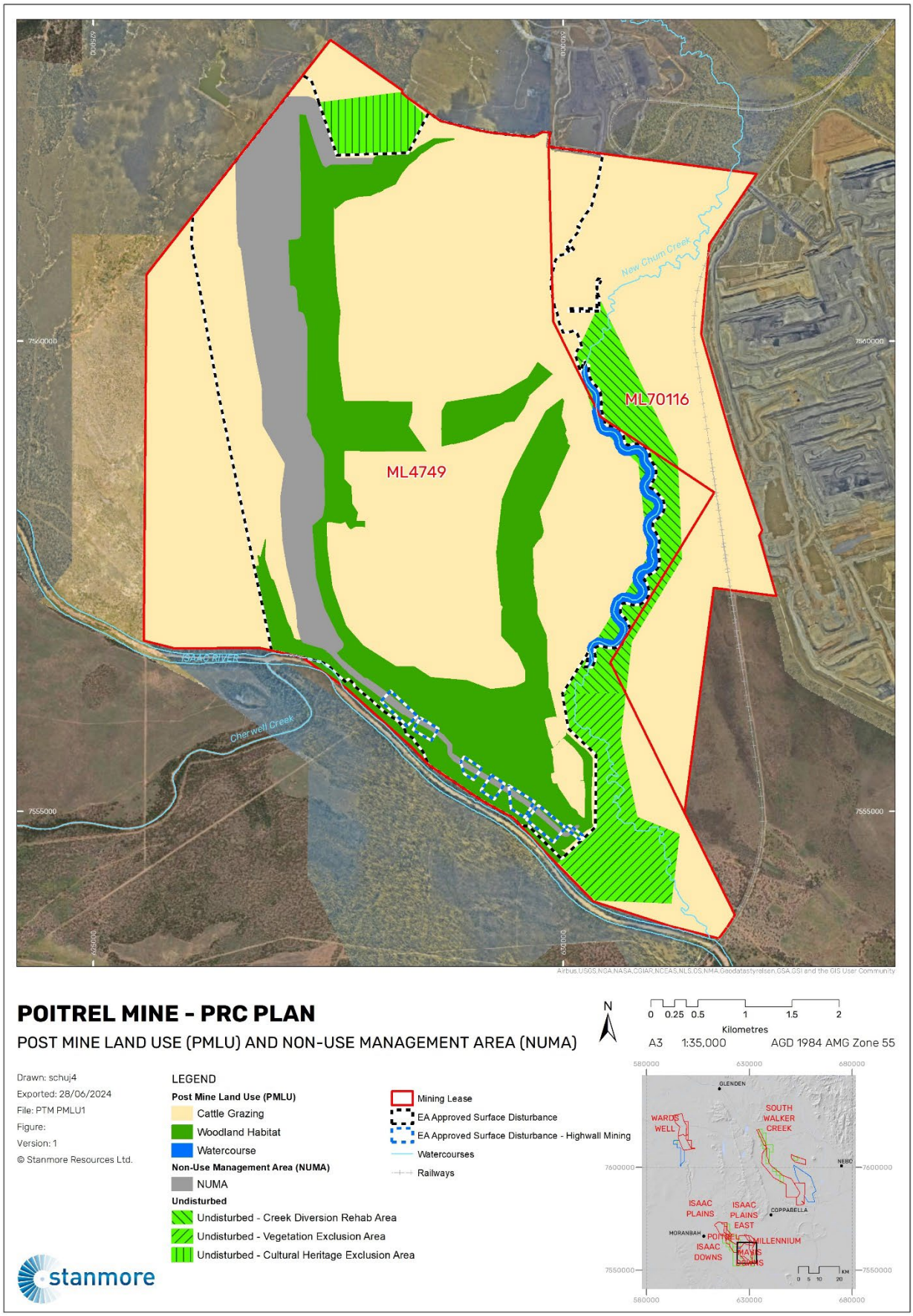

Figure A-1: Proposed PMLU mapping at PTM.

APPENDIX B: REHABILITATION AREAS

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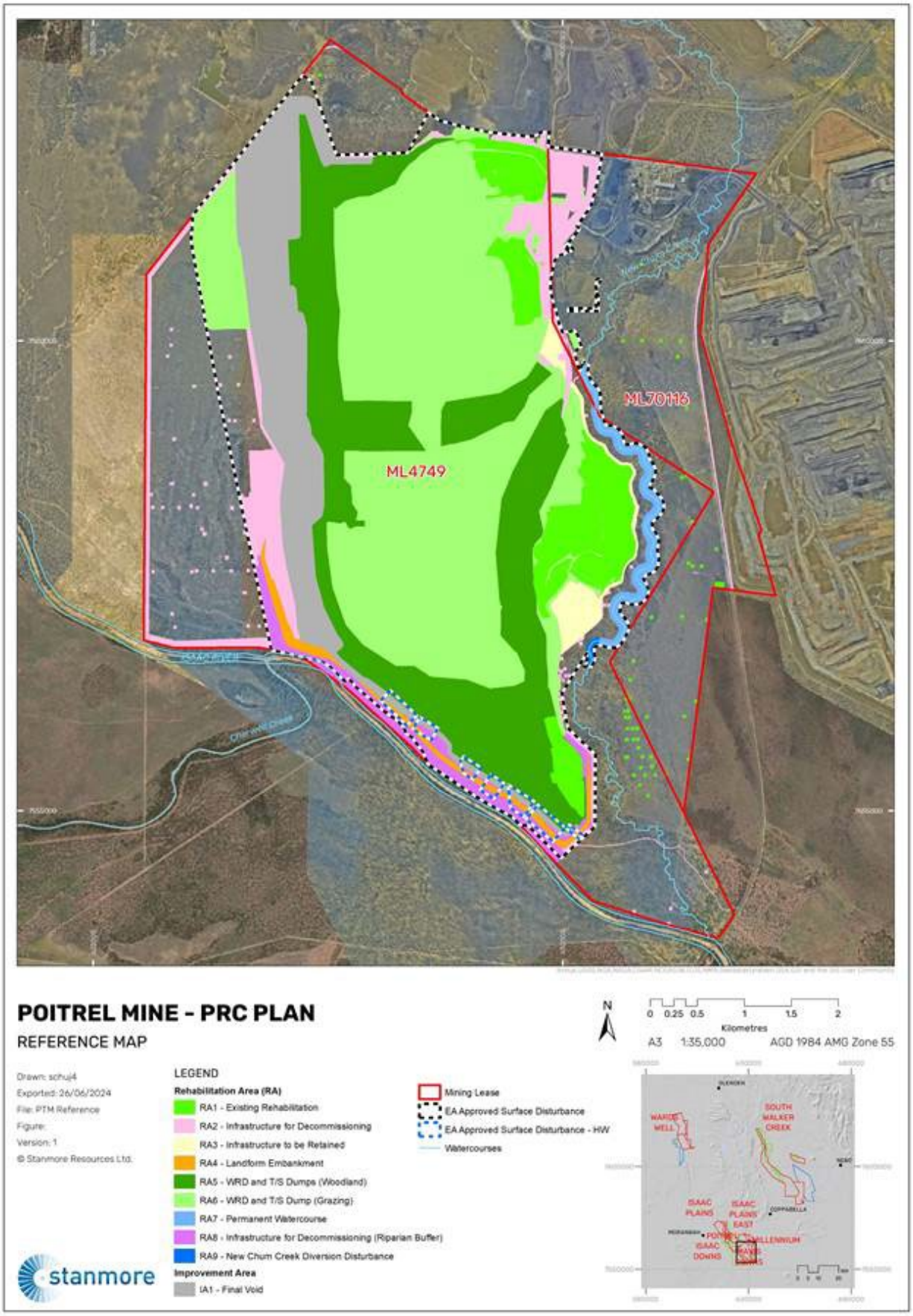

Figure B-1: Rehabilitation area mapping at PTM.

APPENDIX C: ECOLOGICAL MAPPING

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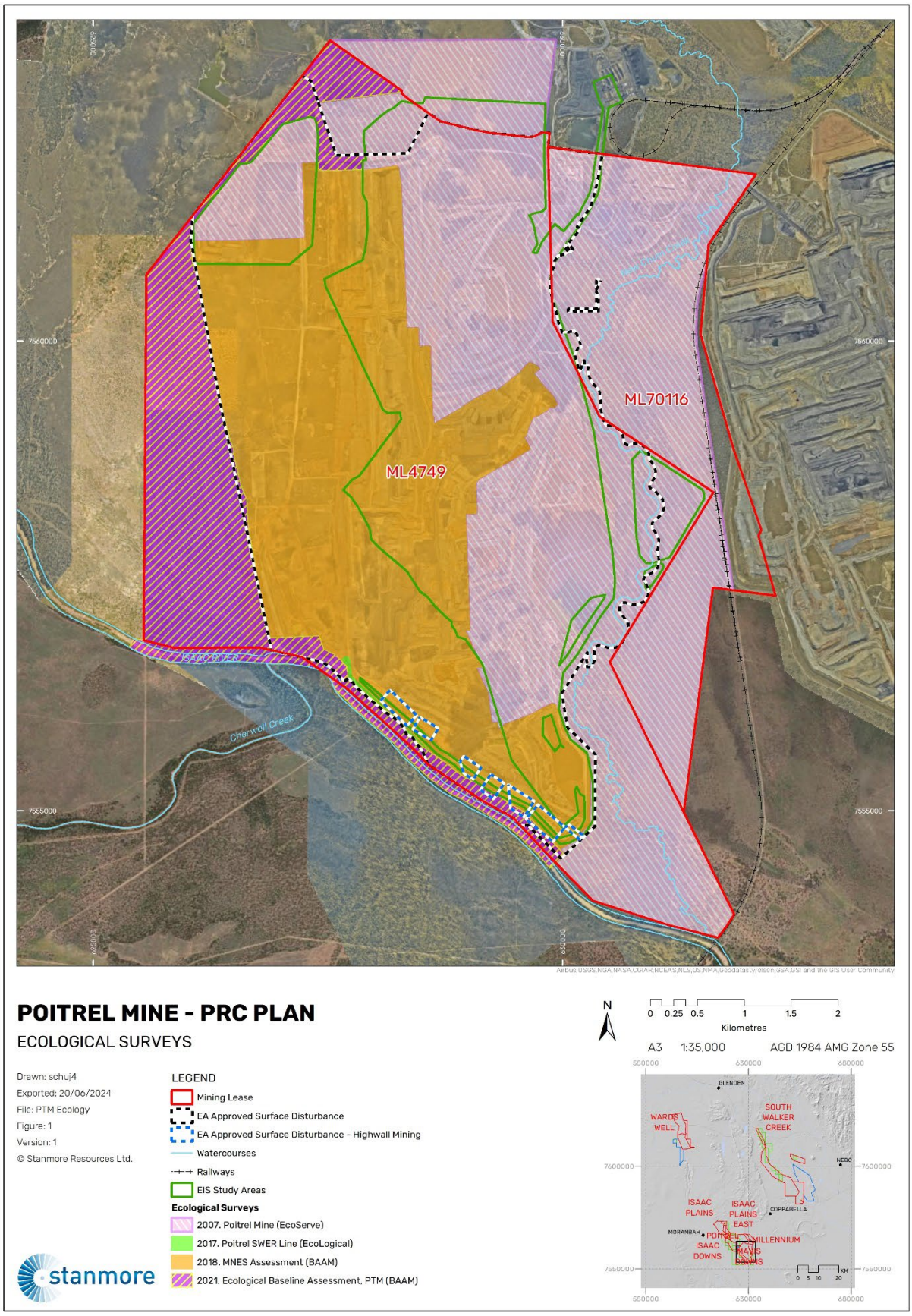

Figure C-1: Locations of Ecological surveys conducted at PTM.

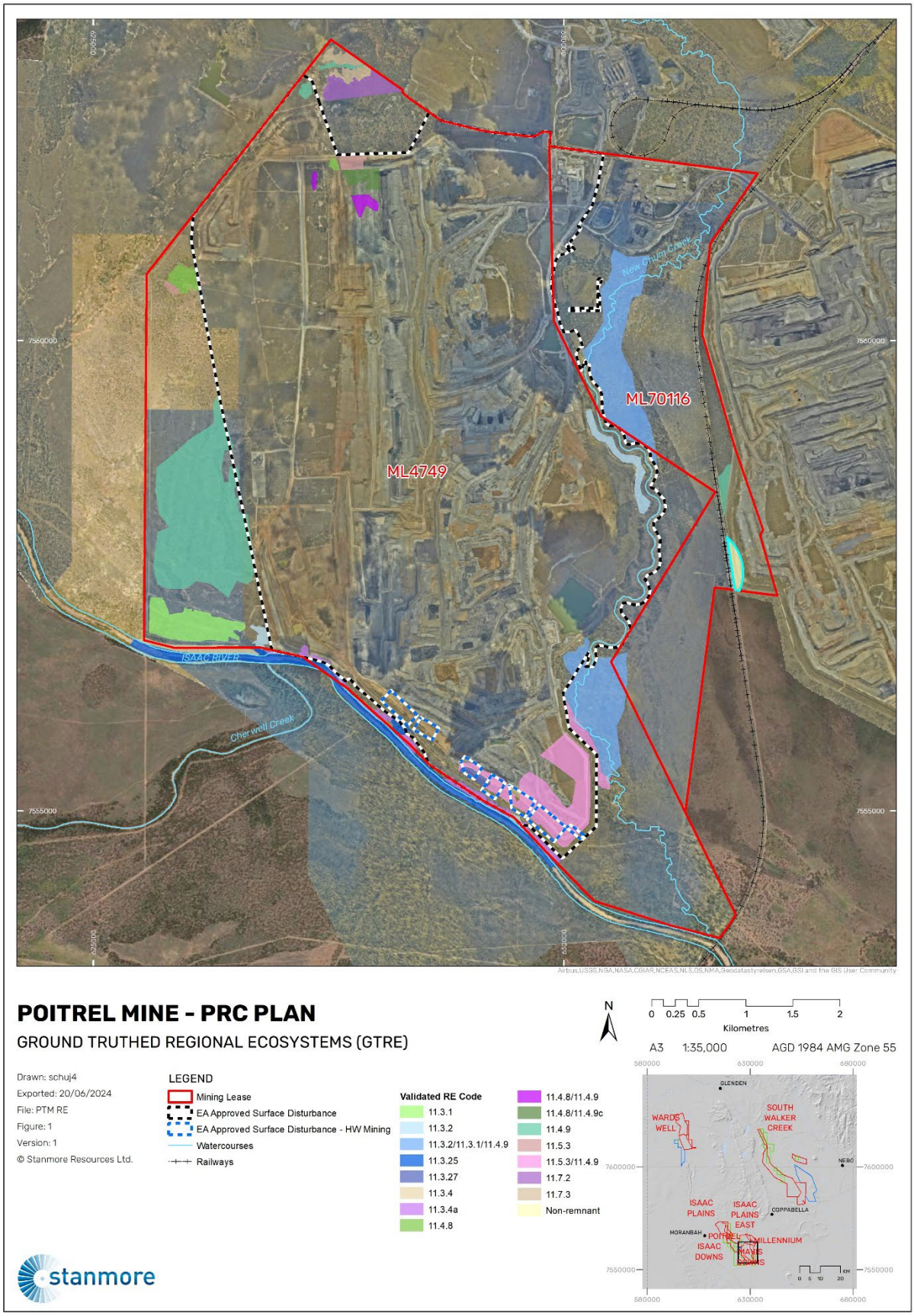

Figure C-2: Ground truthed Regional Ecosystems survey areas at PTM.

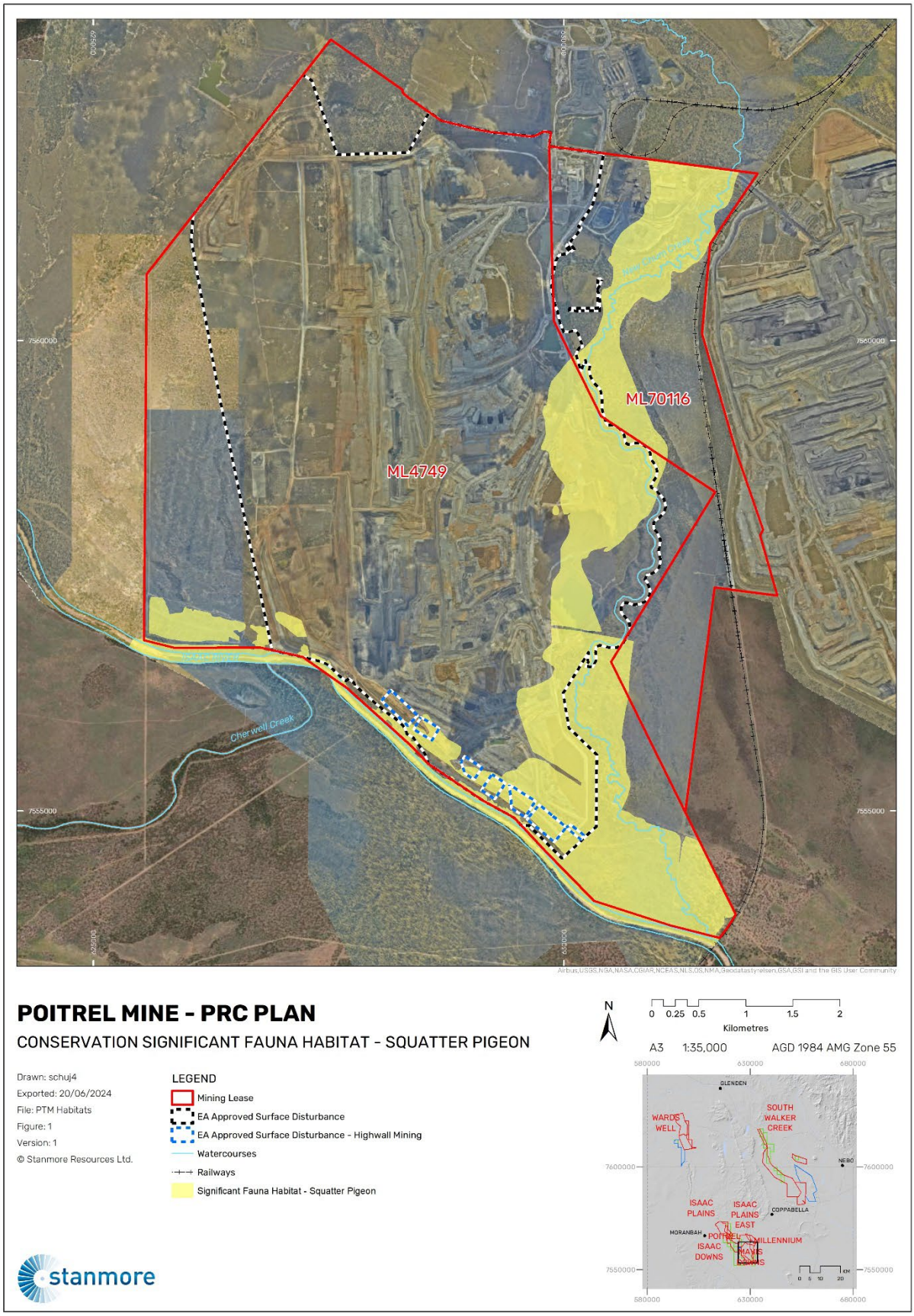

Figure C-3: Conservation significant fauna (Squatter Pigeon) habitat present at PTM.

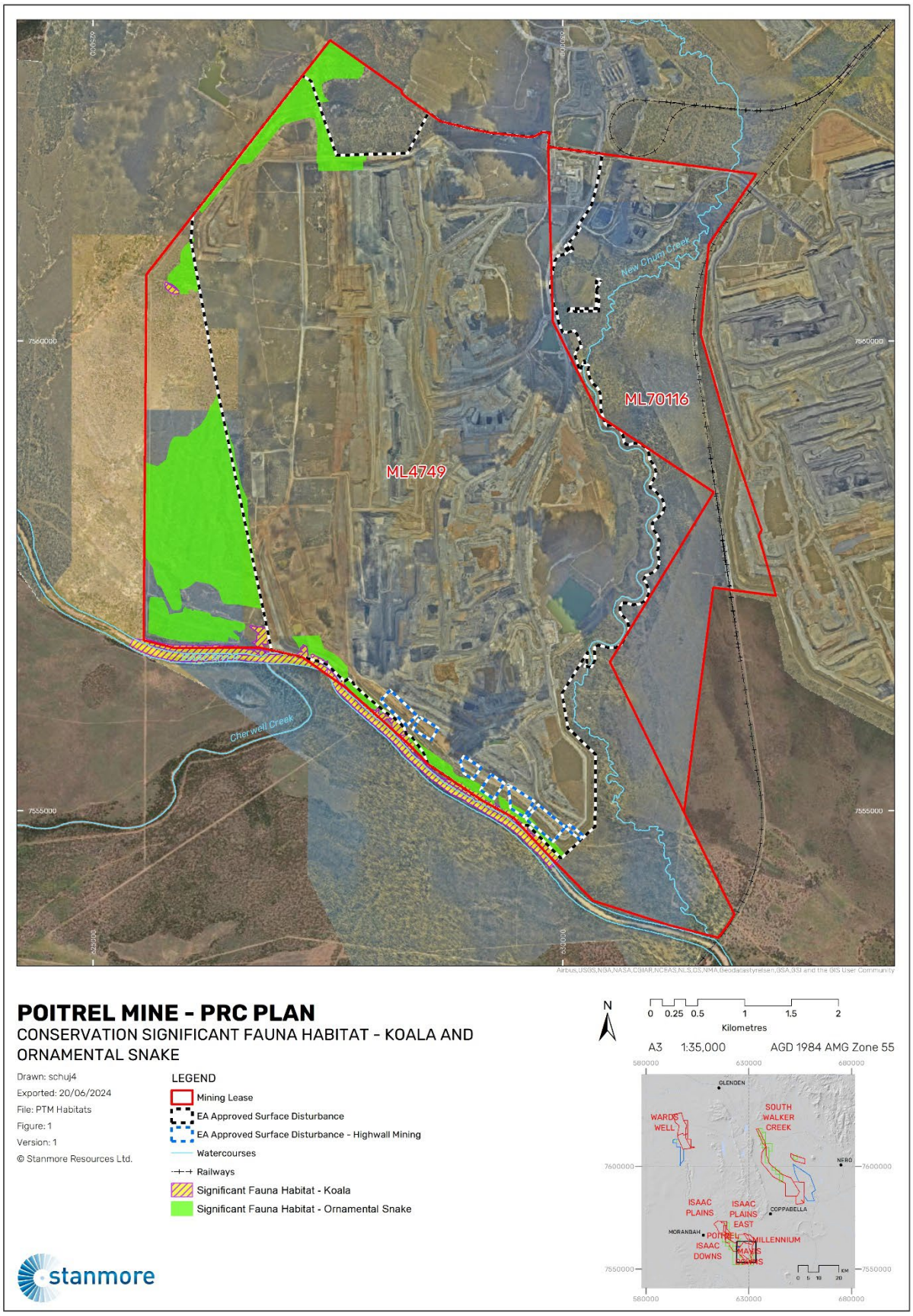

Figure C-4: Conservation significant fauna (Koala and Ornamental Snake) habitat present at PTM.

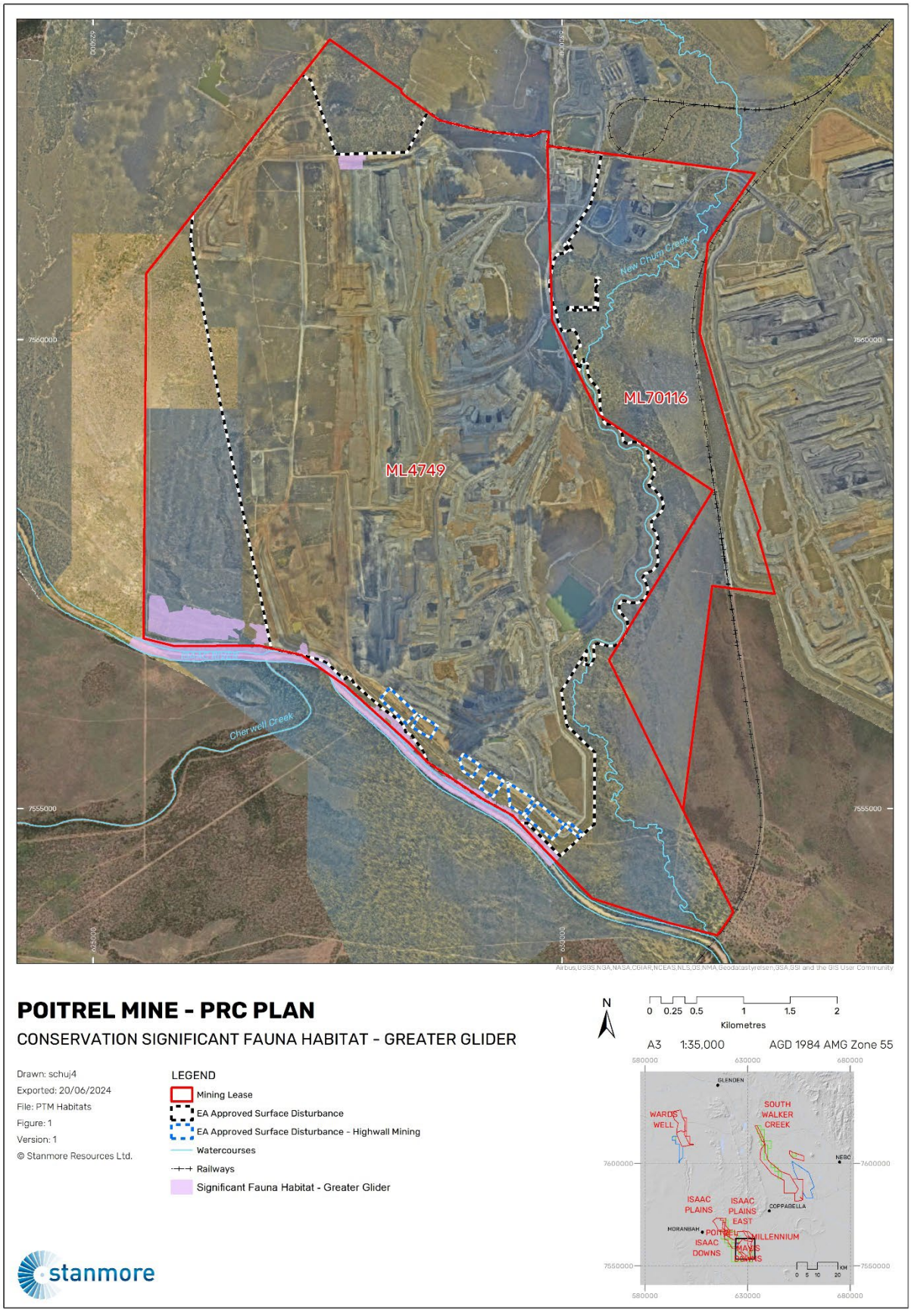

Figure C-5: Conservation significant fauna (Greater Glider) habitat present at PTM.

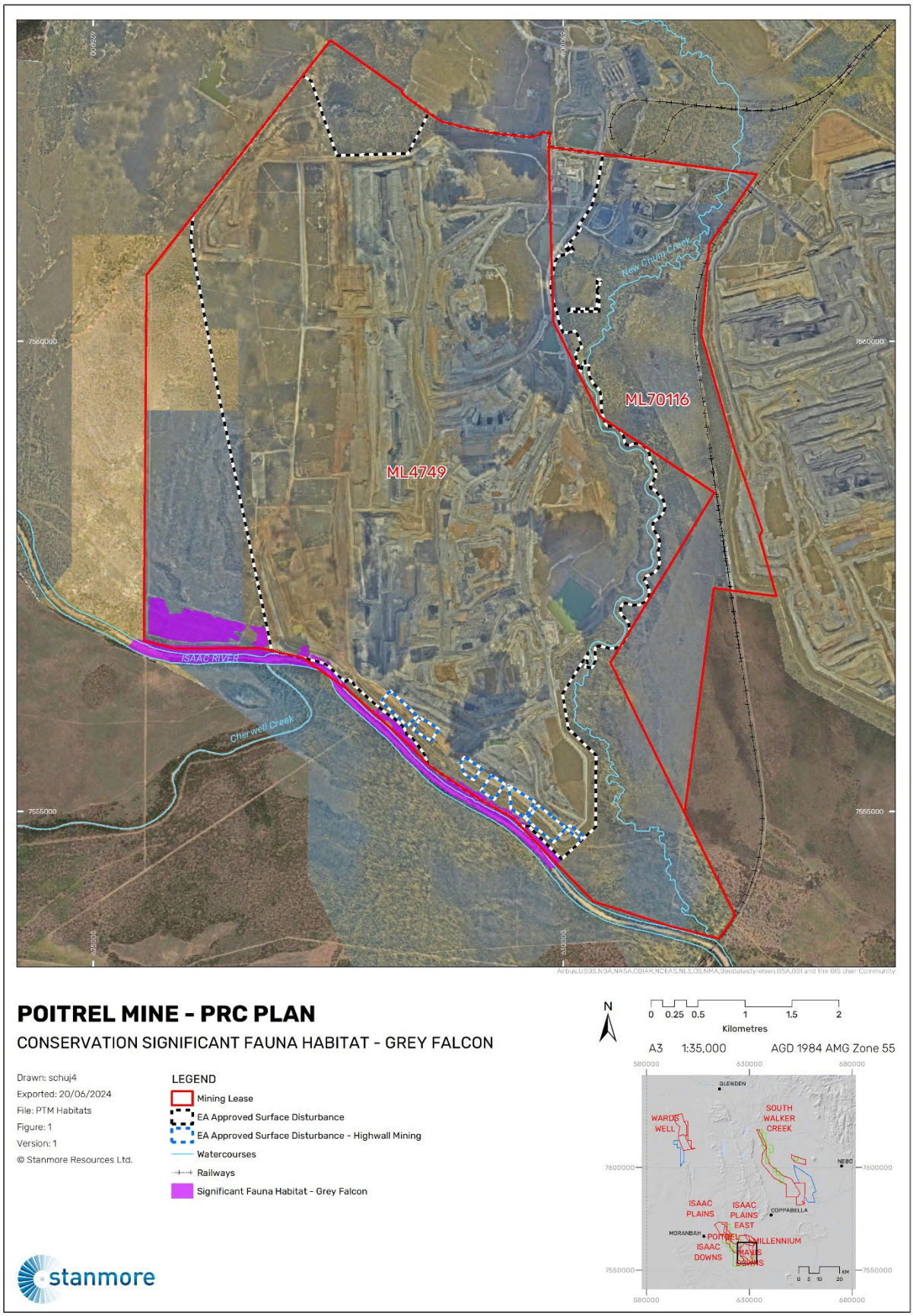

Figure C-6: Conservation significant fauna (Grey Falcon) habitat present at PTM.

APPENDIX D: LANDFORM DESIGN

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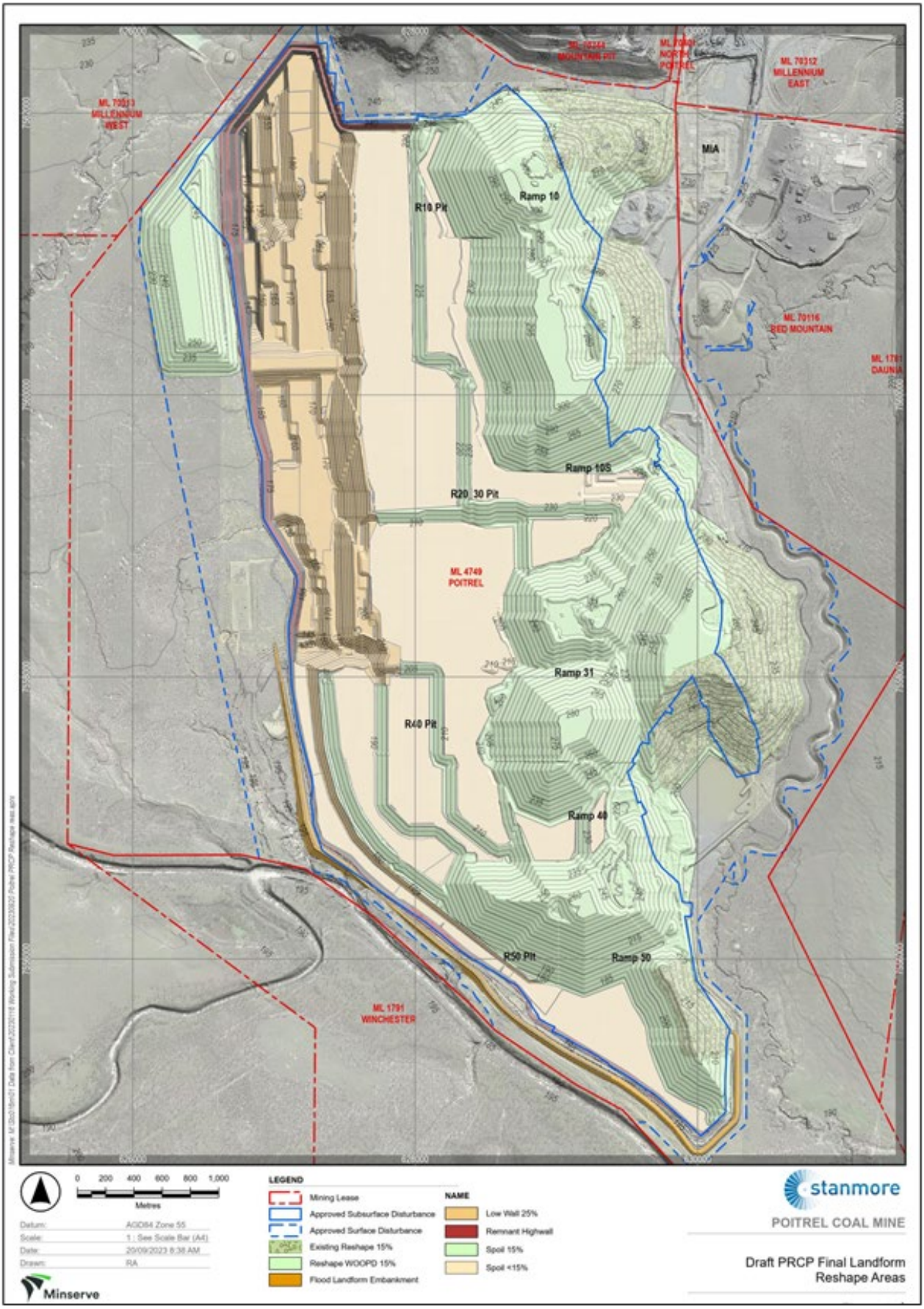

Figure D-1: Rehabilitation landform design for the Project.

APPENDIX E: PTM REHABILITATION MONITORING PROGRAM

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BHP

QLD Coal Rehabilitation Monitoring Program

Initial & Major Monitoring Methodology

Document Number BHP-TEM-0001

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1. Introduction

1 BHP's coal operations in Queensland include seven mines operated by BHP Mitsubishi Alliance (BMA) and two mines operated by BHP Mitsui Coal (BMC) (**Table 1**). Each mine is operated in accordance with an Environmental Authority (EA) issued under the *Environmental Protection Act 1994* (EP Act). Prior to issuing an EA for a mining project, the Department of Environment and Science (DES) require the proponent to provide details on the proposed rehabilitation of the land post mining. This information is then used to inform the EA conditions for the project. The EA for each BMA and BMC mine site includes conditions relating to the progressive rehabilitation of disturbed areas. Specification of how this is to be conducted and monitored is outlined in a prepared Rehabilitation Management Plan that has been conditioned by the EA or in the EA itself.

2 Progressive rehabilitation across BHP's operations typically involves reshaping and recontouring the spoil piles to specified design slopes, replacement of stockpiled topsoil, deep ripping and seeding with a mix of species targeted at the end land use. The conditions in each EA vary slightly, however, all sites are required to conduct rehabilitation monitoring periodically. Once issued, the EA can only be relinquished when DES accepts the final rehabilitation outcomes. The Queensland Government has identified four general rehabilitation goals that areas disturbed by mining must achieve. These goals are outlined in the *DES Guideline – Rehabilitation requirements for mining resource activities* (EM1122) and require a rehabilitated site to be:

- **a** Safe to humans and wildlife
- **b** Non-polluting
- **c** Stable
- **d** Able to sustain an agreed post-mining land use

3 BHP have also developed specific completion criteria relevant to the nine Queensland coal operations. The completion criteria have been developed for each proposed post-mining land use in consultation with DES. The aim of rehabilitation monitoring is to ensure that rehabilitation is tracking towards achieving the completion criteria and the four general rehabilitation goals, leading to eventual relinquishment.

Table 1: BMA and BMC operations

Operation	Mining method	Operational status
Blackwater	Open-cut	Operating
Caval Ridge	Open-cut	Operating
Daunia	Open-cut	Operating
Goonyella Riverside & Broadmeadow	Open-cut & underground	Operating
Norwich Park	Open-cut	Care & maintenance
Peak Downs	Open-cut	Operating
Poitrel	Open-cut	Operating
Saraji	Open-cut	Operating
South Walker Creek	Open-cut	Operating

1.1. Monitoring objectives

4 The objective of the BHP Coal rehabilitation monitoring program is to validate if the current state of mine rehabilitation is progressing towards achieving the intended post mining land use and relevant completion criteria. This is achieved by assessing a range of rehabilitation functional characteristics. These characteristics are then assessed against key performance indicators to provide a detailed

understanding of current rehabilitation performance and trajectory, i.e. is rehabilitation condition likely to improve or decline over time.

5 The purpose of this monitoring is to assess and ensure the rehabilitation strategies, designs and treatments achieve acceptable rehabilitation outcomes, including fulfilling statutory and corporate compliance requirements. In addition, implementation of the rehabilitation monitoring program provides an opportunity to identify improvements of both rehabilitation processes, execution and monitoring methodology.

1.2. Monitoring approach

6 The BHP Coal rehabilitation monitoring program has been developed as a standardised program for implementation across all nine BMA and BMC sites. The monitoring program has been split into phases, to allow for a more staged implementation of monitoring, and ensure greater accuracy and efficiency in data collection. The four phases of the monitoring program are:

a Initial monitoring

b Event based monitoring (erosion and rainfall run-off)

c Minor monitoring

d Major monitoring

7 Implementation of each component of the rehabilitation monitoring program will be in accordance with **Figure 1**.

8 Initial monitoring will be undertaken at newly established rehabilitation monitoring sites to categorise the site, develop baseline data and identify any risks to rehabilitation success. Minor monitoring will be conducted one year after the initial monitoring phase and will provide a snapshot of rehabilitation performance and identify risks to rehabilitation success that require remediation in the short term. Major monitoring will be conducted approximately two years after initial monitoring and will provide a detailed assessment of the current state of rehabilitation. Once initial (year 0), minor (year 1) and major (year 2) monitoring has been undertaken for newly established rehabilitation, ongoing monitoring is then undertaken in accordance with the regular minor and major monitoring cycle for all rehabilitation at that mine site. Ongoing minor and major monitoring is conducted on an alternate two-yearly cycle for the duration of rehabilitation monitoring.

9 Event based monitoring will be undertaken in response to disturbance events on an ongoing, as needs basis. Event based monitoring includes erosion assessment and rainfall run-off water sample collection. The erosion monitoring component is an event based assessment targeting the structural performance of rehabilitation slopes after rainfall or other disturbance events and will be implemented in response to these events. The rainfall run-off component will allow assessment of run-off water quality against upstream water quality values to ensure that rehabilitation is meeting the overarching goal of being non-polluting. The methodology for event based monitoring is outlined in ***Coal Rehabilitation Monitoring Program - Minor Monitoring Field Guide*** and will be conducted internally by BHP.

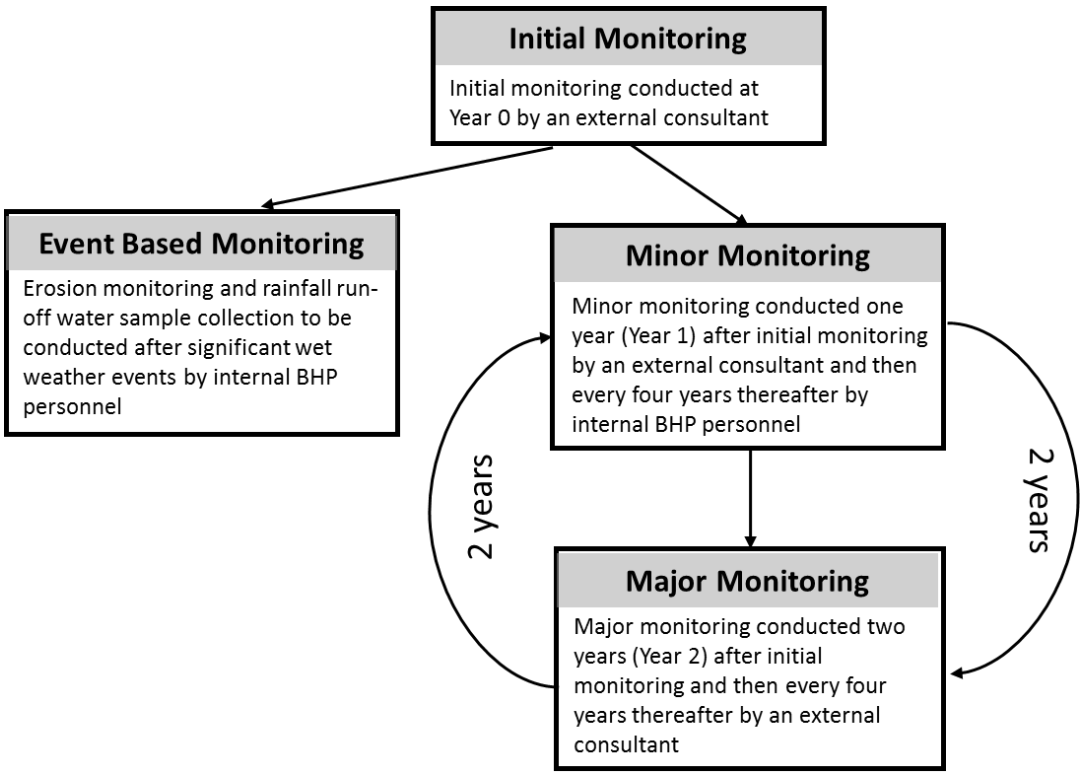

Figure 1: Rehabilitation monitoring protocol

10 Each monitoring phase fulfils a particular requirement of the monitoring program and all four phases are designed to work together holistically to achieve the aims and objectives of the program. The initial, minor and major components are structured around the assessment of three key indicators:

a Vegetation

b Soil (including soil profile development and surface and spoil geochemistry)

c Erosion / Landform

11 Initial monitoring should be conducted within 12 months of rehabilitation being completed. Rehabilitation is considered complete when the recontoured slope has been topsoiled (where planned) and seeded to plan. Initial, major and minor monitoring should be performed after the wet season to ensure that vegetation and soil condition comparisons are consistent between monitoring events and to mitigate the impact of seasonal variability in the data, as far as practically achievable.

1.3. Purpose of this document

12 This document represents the current BHP Coal rehabilitation monitoring program for initial and major monitoring that is to be implemented at all BMA and BMC mine sites. This document presents a detailed monitoring methodology for both phases to enable the implementation of a standardised, streamlined and replicable monitoring program.

13 The initial and major monitoring program has been developed to comply with the EA requirements of each site and to provide data suitable for the assessment of rehabilitation performance against the ***BHP Queensland Coal Rehabilitation Completion Criteria***. This monitoring program has been designed to provide accurate and meaningful data that provides a snapshot of current rehabilitation performance. The data is sufficient to provide feedback to operational personnel on the effectiveness of rehabilitation construction methods, identify rehabilitation remediation and maintenance requirements, develop and continually refine performance criteria, provide an understanding of the trajectory of rehabilitation and to satisfy regulator assessment requirements. Natural variation in climatic/seasonable conditions and events are expected to influence the rehabilitation landforms and the responses to these situations. This will likely result in a gradual evolution of acceptable performance criteria over time.

14 This document details the standardised methodology and data collection techniques for the implementation of initial and major rehabilitation monitoring phases. It is intended as a protocol for the implementation of the field based components of the monitoring program as well as the data analysis and interpretation of results / performance rating. Specific information relating to the rehabilitation monitoring site locations and target final land use is contained in each mine site's environmental documentation. Completion criteria relevant to all BHP coal mines in Queensland are documented in the ***BHP Queensland Coal Rehabilitation Completion Criteria***.

2. Initial Monitoring Methodology

1 The initial monitoring methodology has been designed to provide a comprehensive analysis of rehabilitation condition. The purpose of initial monitoring is to create baseline data for the monitoring site and to identify any potential design non-conformances and issues affecting the rehabilitation that will require additional investigation and monitoring during future monitoring. The initial monitoring component includes identification of vegetation to species level, where vegetation is present if identification possible. The initial monitoring methodology addresses the following factors:

- **a** Selection of suitable reference and rehabilitation monitoring sites
- **b** A guideline for establishment of monitoring sites, including permanent site markers
- **c** Soil and spoil monitoring methodology
- **d** Landform assessment methodology
- **e** Vegetation assessment methodology

2 Initial monitoring will be undertaken in two stages:

- **a** The first stage will involve a desktop review of the rehabilitation design plans as captured in the relevant workpack and stored in GIS and an audit against the design using LiDAR data of the final constructed slope. This design audit will be followed by a desktop erosion assessment using LiDAR and aerial imagery. This assessment will be used to identify areas requiring field based erosion assessment.
- **b** The second stage is a field based assessment and includes a soil and spoil profile and geochemical analysis and erosion assessment if field validation is required.

2.1. Rehabilitation and reference site selection and establishment

2.1.1. Site selection

3 The number and location of rehabilitation and reference monitoring sites across a particular mine site will be determined by a range of factors including the diversity of soil and spoil types present within the site, the range of rehabilitation methodologies implemented and the target final land use. New rehabilitation monitoring sites should be selected using the following process.

- **a** Delineate new rehabilitation areas based on the following factors:
  - **i** substrate type
  - **ii** landform design (differing slope angles / presence of batters / berms)
  - **iii** rehabilitation methodology (rock armouring / seed mix / topsoil depth)
  - **iv** target final land use (grazing / woodland habitat)
  - **v** age of rehabilitation
- **b** Establish a minimum of one representative monitoring site within each delineated rehabilitation type in accordance with the criteria in **Table 2**.

4 If reference sites are a requirement of the EA, a representative reference site should be selected for each intended final rehabilitation land use. For example, if a portion of the rehabilitation on the mine site will be returned to a grazing land use and a portion will be returned to woodland habitat then a minimum of two reference sites should be selected, one representative of a current grazing land use and one representative of woodland habitat. Additional reference sites may be required to comply with Environmental Authority conditions.

Table 2: Rehabilitation and reference site selection

Rehabilitation site	Reference site
Representative of rehabilitation slope	Representative of target final land use of corresponding rehabilitation site(s) (comparable vegetation, soil type and aspect)
Located in a lower slope position to capture maximum hydrologic and erosion processes	Located away from disturbance such as cattle water point, roads
Accessible (vehicle access preferred)	Accessible (vehicle access preferred)
Located on mining lease or BHP owned land	Located on mining lease or BHP owned land
Low risk of site being disturbed by mining activity in the future	Low risk of site being disturbed by mining or landholder activity in the future

2.1.2. Monitoring site establishment

5 Permanent monitoring sites (plots) are to be established at each site for both rehabilitation and reference sites. Each monitoring site should be established as per **Figure 2**. The monitoring plot is to be positioned at an angle to the slope and permanently established by installing two star pickets (or equivalent), one at each end of the central 10m transect. The GPS location of each of the pegs must be recorded. The rest of the plot is established at the time of monitoring using a 50m and 20m tape measure.

6 At the commencement of each monitoring event general data will be collected at the site including:

a Photographs are to be taken towards the north, south, east and west from the centre of the central 10m transect. Photos should be taken using a GPS camera or the photo number and direction recorded.

b Note any disturbance to the site (e.g. vehicle activity, fire, storm events)

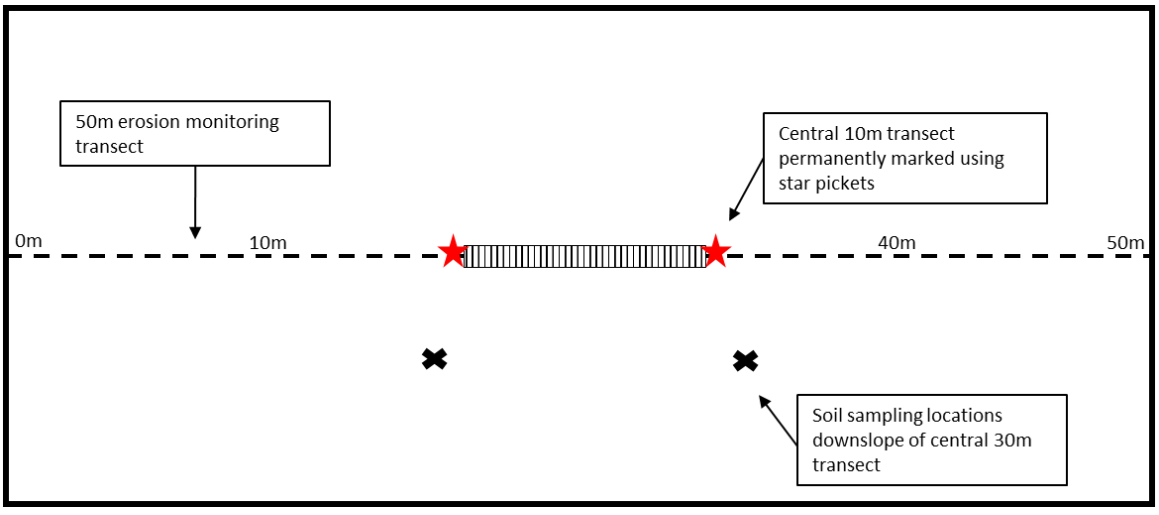

Figure 2: Initial monitoring plot

2.2. Soil and spoil monitoring

2.2.1. Surface soil characteristics

7 The following surface soil and spoil characteristics are assessed at each monitoring site. The average condition of these characteristics across the rehabilitation slope should be noted if the

characteristics of the monitoring site location do not appear to be representative of the slope as a whole. The soil characteristics to be assessed include:

a Soil structure – assessment of the coarseness of the surface structure (note ped size, presence of surface crusting)

b Rockiness – assess percentage cover of the following size classes:

i Gravel (20 – 60mm)

ii Cobble (60 – 200mm)

iii Stone (200mm – 600mm)

iv Boulder

v Rock outcrop

c Microrelief – measure average vertical depth of surface deep ripping

8 Soil structure and rockiness are assessed for the surface of the soil profile (0 - 10cm) and the actual depth of any surface microrelief is recorded.

2.2.2. Soil and spoil sample collection

9 Sampling of the soil and spoil at rehabilitation sites is to be undertaken in two locations at least 5m downslope of the central 10m of the transect as per **Figure 2**, with care being taken to avoid areas disturbed by previous monitoring. At reference sites, one sampling location is sufficient.

10 Soil and spoil samples are to be collected using handheld soil core sampling equipment. If handheld coring is not possible, digging a pit using machinery such a backhoe or excavator can be undertaken, however this is not preferred. If machinery is used, sampling points should be spread across the full 50m transect and located a minimum of 10m downslope of the transect.

11 Soil and spoil samples are to be collected by trained personnel and in accordance with best practice methods. Samples will be packaged for transportation in jars or bags supplied by the laboratory. For initial sampling, soil and spoil samples are to be taken at four depths in the soil profile (**Figure 3**) and analysed as specified in **Table 3**.

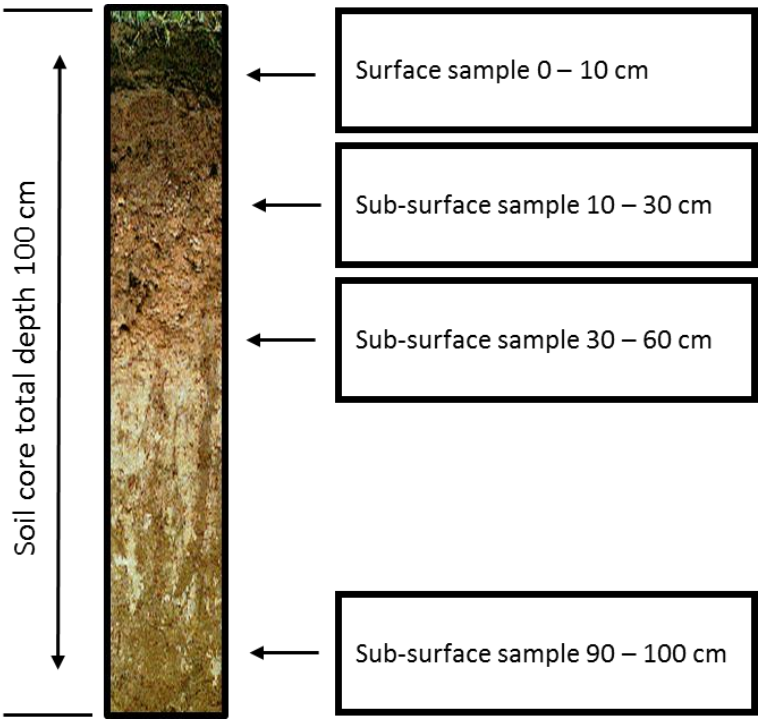

Figure 3: Soil sample depths

12 A total of eight samples (four depth samples across two cores) will be collected at each rehabilitation monitoring site and a total of four samples will be collected at each reference site.

2.2.3. Soil and spoil profile classification

13 A brief soil and spoil profile assessment should be undertaken for each sample in accordance with the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, Australia). The soil core or pit should be assessed and the following attributes recorded:

- **a** Horizon depths
- **b** Field colour
- **c** Field texture
- **d** Structure
- **e** Root density and depth
- **f** Soil plant available water capacity (PAWC)

14 **Calculation of Plant Available Water Capacity (cattle grazing land use only)**

An estimate of the soil water storage capacity within the effective rooting depth (ERD) of the soil profile is used to determine PAWC. An ERD of 0.6m is generally assumed for pasture species and has been adopted for the estimate of PAWC in this methodology.

15 Published guidelines for the estimate of PAWC based on the texture of the soil profile are considered suitable for managing soils for rehabilitation. The Queensland Department of Infrastructure, Local Government and Planning *RPI Act Statutory Guideline 08/14*, *2017* provides the soil water storage capacity for a range of soil textures. The soil textures and corresponding soil water storage capacities are summarised in Error! Reference source not found..

16 To calculate PAWC, the texture and depth of each layer of the soil profile within the ERD (0.6m) is determined and the total soil water capacity of each layer calculated. The soil water storage capacity of each layer of the profile is then summed to calculate the PAWC.

Table 3: Soil texture and water storage capacity

Soil texture	Soil water storage capacity
Sand, clayey sand, loamy sand	4 mm / 100 mm
Sandy loam	5 mm / 100 mm
Loam, silty loam, sandy clay loam	6 mm / 100 mm
Clay loam, clay loam – sandy, silty clay loam	8 mm / 100 mm
Silty clay, clays with < 45 % clay fraction	10 mm / 100 mm
Clays with > 45% clay fraction	12 mm / 100 mm

2.2.4. Soil and spoil laboratory analysis

17 A full analysis of samples taken at four depths within the soil profile is to be undertaken by a NATA accredited laboratory. The analytes to be tested for and the purpose of each analysis is presented in Error! Reference source not found..

Table 4: Initial monitoring soil and spoil analysis

Category	Analyte	Purpose of analyte	Depth	
			Surface (0 - 10cm)	Sub-surface (> 10cm)
Acidity / alkalinity	pH	Identify anomalies that may affect plant growth and sustainability.	✓	✓
Salinity	EC	Identify leaching profile. High salinity can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓
	Chloride	Identify leaching profile. High chloride can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓
Exchangeable cations	Cation exchange capacity (CEC)	Major factor in soil fertility. Controls soil stability, nutrient availability and buffers soil's chemical properties.	✓	✓
	Exchangeable cations	Exchangeable Calcium is linked to soil stability. High levels of exchangeable Magnesium can cause clay dispersion, instability when wet and hard setting.	✓	✓
	Exchangeable Sodium Percentage (ESP)	ESP is a measure of the dominance of sodium ions on the soil's cation exchange complex. Sodicity in soils can lead to slaking and dispersion which impact soil structure and stability.	✓	✓
Organic matter	Organic carbon	An indicator of soil nutrient stores and a contributor to improvements in soil structure. Changes through time in organic carbon are a key indicator of rehabilitation success.	✓	
Major elements	Total Nitrogen	Indicator of soil nutrient store and is also a major plant nutrient.	✓	
	Extractable Phosphorous (Colwell method)	Indicator of Phosphorous readily available to plants.	✓	
	Total Phosphorous	Indicator of total store of Phosphorous, some of which is readily available. Key indicator of potential for long-term success or failure of rehabilitation.	✓	
	Potassium	Important plant nutrient.	✓	
	Total Sulphur	Indicator of potential for development of Acid Mine Drainage.	✓	
	Sulphate	Important plant nutrient, and can be an indicator of development of Acid Mine Drainage.	✓	
	Calcium	Important plant nutrient.	✓	
	Magnesium	Important plant nutrient.	✓	
Trace elements	Manganese	Trace element with minor importance for vegetation success.	✓	
	Iron	Trace element with minor importance for vegetation success.	✓	

	Zinc	Trace element important for vegetation success.	✓	
	Copper	Trace element important for vegetation success.	✓	
Physical parameters	Particle Size (PSA)	Soil texture strongly affects water entry and storage. Soil texture will impact erosion and vegetation success, and should be considered when planning species mixes for planting.	✓	✓
	Emerson Aggregate Test	Indicator of clay dispersion. Should be interpreted in conjunction with ESP and EC data.	✓	✓
Heavy metals	As per spoil characterisation	Heavy metals that have been identified as occurring at elevated levels during spoil characterisation analysis should be tested for during initial monitoring.	✓	✓

2.3. Landform assessment

2.3.1. LiDAR analysis

18 LiDAR data and aerial imagery are routinely collected across each mine site for the purpose of monitoring progression of mining. For rehabilitation monitoring, ground-based LiDAR should be used to scan an area of rehabilitation from both the toe and crest of the slope. It is recommended that LiDAR data (ground only points) be captured at a maximum spacing of 0.5 m. Multiple scans may be required to obtain adequate coverage of the slope. LiDAR and aerial imagery can then be used to assess the final landform design and identify and quantify erosional features and sediment loss from the slope.

19 **Confirmation of rehabilitation design**

20 Ground only LiDAR point cloud data collected for rehabilitation areas is to be used to develop a Digital Elevation Model (DEM). The DEM can then be used to compare the rehabilitation slope to the original landform design. An analysis of the landform design should include assessment of the following elements that influence the stability and function of the slope:

a Elevation of batters

b Batter and berm slope and length

c Areas of potential water ponding (concavity) and run-off (convexity)

d Contour ripping depth

21 **Identification of erosional features and sediment loss**

22 The DEM will be used to create a slope model for each monitoring site (**Plate 1**). The slope model will be classified to identify areas of high risk of erosion (i.e. particularly steep slopes). The level of detail contained in the DEM will allow the identification of even very small erosional features such as developing rills and gullies. Areas of erosion can also be identified by viewing the DEM in a 3D viewer (**Plate 2**).

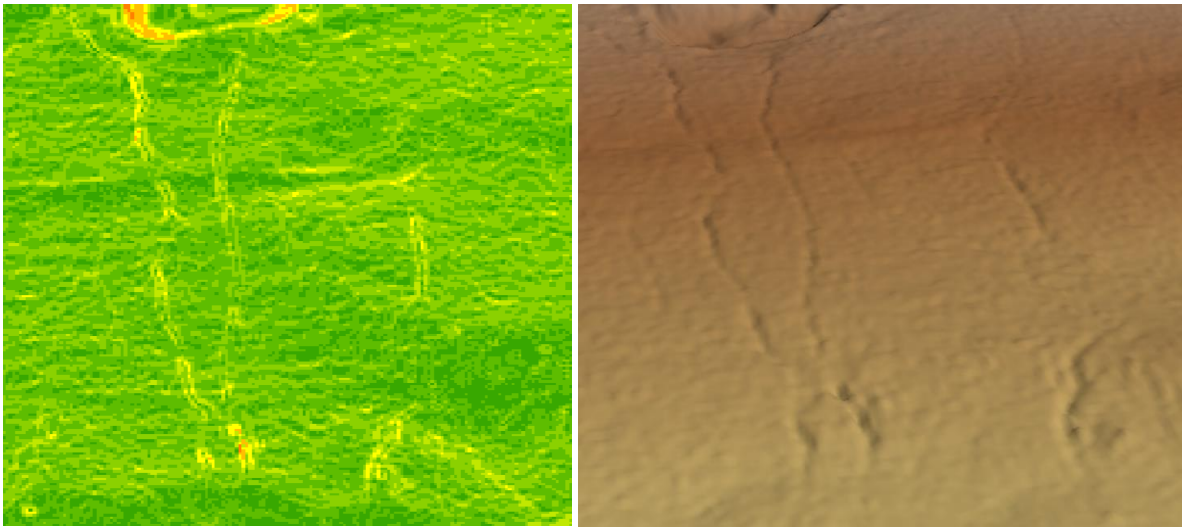

Plate 1 and 2: DEM Slope model (left) and DEM slope model in 3D viewer (right) showing changes in slope with linear pattern indicating potential gully erosion

2.3.2. Field survey

23 In some circumstances, field survey may be required to validate the results of LiDAR erosion analysis. If the desktop LiDAR and aerial imagery analysis identifies areas of developing rill or gully erosion, field validation of these areas is required. Early detection and rectification of drainage and run-off issues can prevent more widespread erosion issues that can lead to rehabilitation failure.

24 The field survey involves establishing an erosion monitoring transect by running a 50m tape at an angle perpendicular to the slope across the identified erosion feature (i.e. approximately on the contour). If the erosion monitoring is being conducted at an existing rehabilitation monitoring site, then the central 10m transect should be used as the centre of the erosion transect, with the tape run 20m upslope and 20m downslope. Erosion transects should be located to capture erosional activity identified during LiDAR analysis, this may mean that erosion transects are in a different location at each monitoring event.

25 The field survey should record the following information:

- **a** General observations, GPS coordinates of the ends of the transect and photographs of the site
- **b** Frequency of rills (<0.3m deep), gullies (>0.3m deep), sheet erosion and tunnels / mass movement along the 50m transect (1m on either side)
- **c** For each erosion feature (sheet, rill, gully or tunnel/mass movement) record the following:
  - **i** dimensions (width and depth for rills/gullies, diameter and depth for tunnel/mass movement)
  - **ii** severity (maximum width/length/depth)
  - **iii** state (active, partially stabilised, stabilised)

2.4. Vegetation monitoring

26 As initial monitoring is conducted within 12 months of rehabilitation being established, vegetation establishment is expected to be limited. Where possible, all germinants present at the time of monitoring should be identified to species level. The purpose of this is to provide information on the relative germination success rates of each species in the rehabilitation seed mix. Vegetation monitoring is undertaken within the 50m x 20m initial monitoring quadrat (**Figure 2**).

3. Major Monitoring Methodology

1 The major monitoring methodology has been designed to provide a detailed assessment of rehabilitation performance. The purpose of major monitoring is to identify any risks to rehabilitation success and to evaluate the progress of rehabilitation towards completion criteria and eventual relinquishment. The major monitoring methodology includes guidelines for the assessment of the following indicators:

- **a** Soil and spoil monitoring methodology
- **b** Landform assessment methodology
- **c** Vegetation monitoring methodology

2 Major monitoring will be undertaken in two stages:

- **a** The first stage will involve a desktop review of previous monitoring reports to identify key issues associated with each monitoring site and a desktop erosion assessment using LiDAR and aerial imagery. This assessment will be used to identify areas requiring field based erosion assessment.
- **b** The second stage is a field based assessment and includes a soil and spoil profile and geochemical analysis, erosion assessment and vegetation monitoring.

3.1. Soil and spoil monitoring

3.1.1. Surface soil characteristics

3 Surface soil and spoil characteristics are assessed in accordance with the methodology described in the Initial Monitoring Methodology (see **Section 2**).

3.1.2. Soil and spoil sample collection

4 Soil and spoil sample collection is to be undertaken as per the methodology for collection of surface samples described in the Initial Monitoring Methodology. However, for reference sites, after the initial monitoring, samples should only be taken from the 0-10cm depth, and assessed only for pH, EC, Chloride, total nitrogen and available phosphorus. (These surface soil attributes can vary with time and with variations in climatic conditions, whereas the other soil depths and properties are unlikely to show significant change through time.)

5 For rehabilitation sites, if the results of initial and any previous major monitoring indicate that sub-surface material below 30cm (i.e. the 30 – 60cm and 90-100cm sampling depths) is within an acceptable range for all parameters then additional sampling at these depths is not required. Results are deemed to be within an acceptable range if they meet accepted published benchmarks or standards, within natural ranges as indicated by comparable reference sites or are determined to be acceptable by a suitably qualified person. If results indicated any parameters are outside of an acceptable range, then further testing at the same sub-surface profiles as for initial monitoring is required.

3.1.3. Soil and spoil profile classification

6 A brief soil and spoil profile assessment should be undertaken in accordance with the methodology described in the Initial Monitoring Methodology, with the exception of PAWC which does not need to be reassessed.

3.1.4. Soil and spoil laboratory analysis

7 Analysis of soil samples is to be undertaken by a NATA accredited laboratory. The analytes to be tested for and the purpose of each analysis are presented in Error! Reference source not found..

Additional analyses may be required if initial, minor and erosion monitoring events have identified specific issues with soil and spoil chemical characteristics or physical structure.

Table 5: Major monitoring soil and spoil analysis

Category	Analyte	Purpose of analyte	Rehabilitation sites		Reference sites
			Depth		Depth
			Surface (0 - 10cm)	Sub-surface (> 10cm)	Surface (0 - 10cm)
Acidity / alkalinity	pH	Identify anomalies that may affect plant growth and sustainability.	✓	✓	✓
Salinity	EC	Identify leaching profile. High salinity can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓	✓
	Chloride	Identify leaching profile. High chloride can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	✓	✓	✓
Exchangeable cations	Cation exchange capacity (CEC)	Major factor in soil fertility. Controls soil stability, nutrient availability and buffers soil's chemical properties.	✓	✓	
	Exchangeable cations	Exchangeable Calcium is linked to soil stability. High levels of exchangeable Magnesium can cause clay dispersion, instability when wet and hard setting.	✓	✓	
	Exchangeable Sodium Percentage (ESP)	ESP is a measure of the dominance of sodium ions on the soil's cation exchange complex. Sodicity in soils can lead to slaking and dispersion which impact soil structure and stability.	✓	✓	
Organic matter	Organic carbon	An indicator of soil nutrient stores and a contributor to improvements in soil structure. Changes through time in organic carbon are a key indicator of rehabilitation success.	✓		
Major elements	Total Nitrogen	Indicator of soil nutrient store and is also a major plant nutrient.	✓		✓
	Extractable Phosphorous (Colwell method)	Indicator of Phosphorous readily available to plants.	✓		✓
	Total Phosphorous	Indicator of total store of Phosphorous, some of which is readily available. Key indicator of potential for long-term success or failure of rehabilitation.	✓		
	Potassium	Important plant nutrient.	✓		
	Total Sulphur	Indicator of potential for development of Acid Mine Drainage.	✓		

	Sulphate	Important plant nutrient, and can be an indicator of development of Acid Mine Drainage.	✓		
	Calcium	Important plant nutrient.	✓		
	Magnesium	Important plant nutrient.	✓		
Trace elements	Manganese	Trace element with minor importance for vegetation success.	✓		
	Iron	Trace element with minor importance for vegetation success.	✓		
	Zinc	Trace element important for vegetation success.	✓		
	Copper	Trace element important for vegetation success.	✓		
Heavy metals	As per spoil characterisation	Heavy metals that have been identified as occurring at elevated levels during spoil characterisation analysis should be tested for during initial monitoring.	✓	✓	

3.1.5. Sampling frequency

8 The full soil and spoil analysis that is undertaken during initial monitoring will provide baseline data for each monitoring site. Once a baseline has been established, a reduced monitoring suite is to be analysed during each major monitoring event until rehabilitation has stabilised. Rehabilitation is considered stable when soil and spoil monitoring results have reached completion criteria targets for two consecutive major monitoring assessments.

9 Once rehabilitation has stabilised, routine soil and spoil analysis is suspended and a trigger based program is implemented. The trigger based soil and spoil sampling program should be designed to target identified rehabilitation issues. Trigger based soil and spoil analysis will be undertaken in response to changes in rehabilitation condition which may include:

a Erosion identified by LiDAR analysis or field survey

b Vegetation failure

c Poor downstream water quality

10 **Figure 4** provides an overview of the soil and spoil sampling protocol.

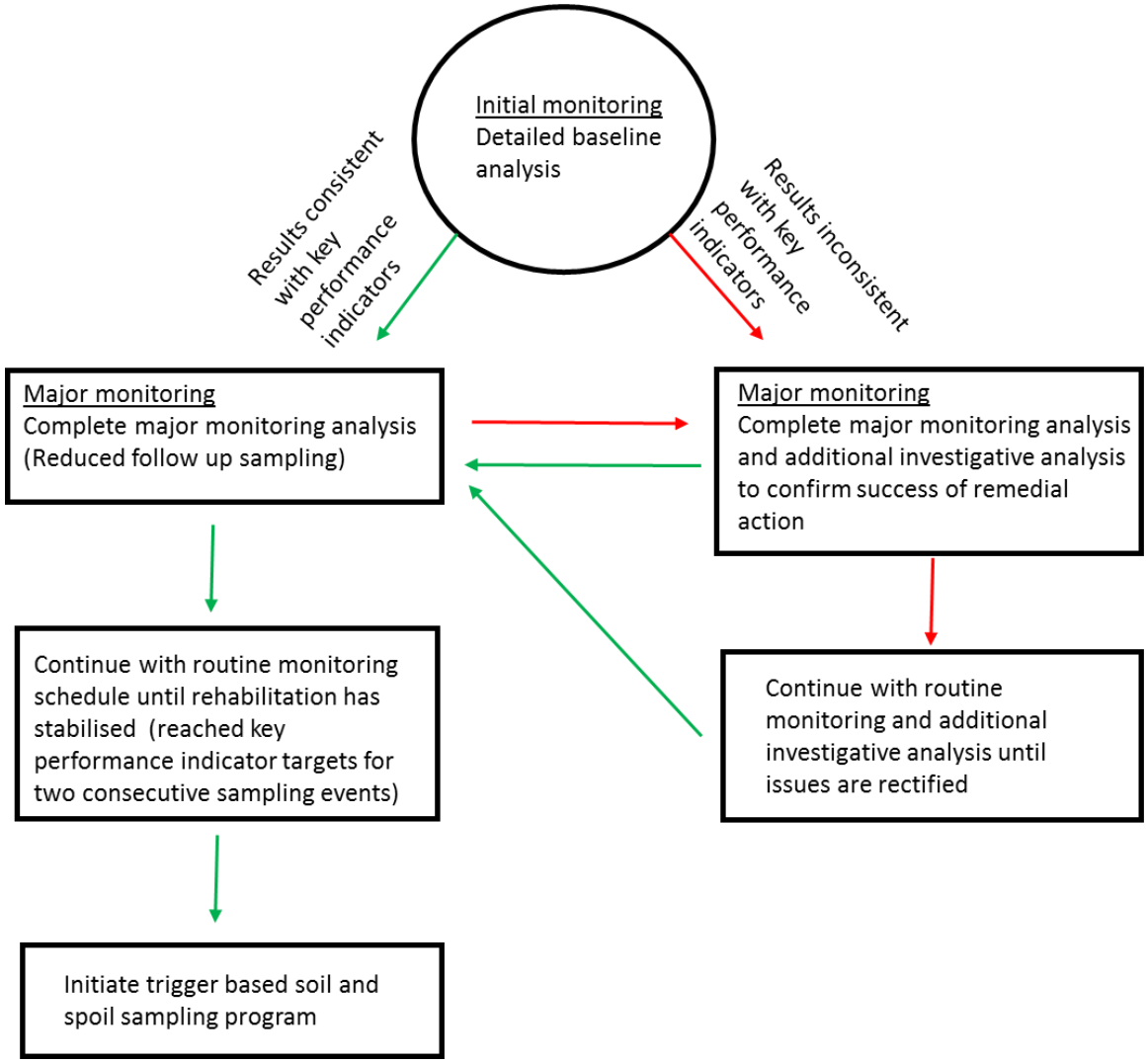

Figure 4: Soil and spoil sampling protocol

3.2. Landform assessment

3.2.1. LiDAR analysis

11 Recent LiDAR data should be used to update the DEM created during initial rehabilitation monitoring. The updated DEM slope model can be used to identify current areas of erosion and deposition by performing a change detection analysis.

12 The change detection analysis involves creating a DEM for multiple consecutive years of LiDAR data and undertaking a comparison. The analysis will identify potential areas of settlement (where the ground level has decreased over time), areas of deposition (where the ground level has increased over time) and the progression of erosion features, which can be identified by mapping classes of height difference over time. Areas of high risk identified by the change detection analysis can be further analysed by generating cross-sections and volume calculations to determine the extent of erosion.

3.2.2. Field survey

13 In some circumstances, field survey may be required to validate the results of LiDAR erosion analysis. Field survey is required where LiDAR erosion analysis has identified areas that have

changed significantly since the last monitoring or areas that appear to have significant active erosion, evidence of soil degradation or vegetation failure.

14 The erosion monitoring transect is established by running a 50m tape at an angle perpendicular to the slope (i.e. approximately on the contour). If the erosion monitoring is being conducted at an existing rehabilitation monitoring site, then the central 10m transect should be used as the centre of the erosion transect, with the tape run 20m upslope and 20m downslope. Erosion transects should be located to capture erosional activity identified during LiDAR analysis, this may mean that erosion transects are in a different location at each monitoring event.

15 The field survey should record the following information:

- **a** General observations and photographs of the site
- **b** Frequency and dimensions of rills (<0.3m deep), gullies (>0.3m deep), sheet erosion and piping or mass movement along the 50m transect (1m on either side)
- **c** For each erosion feature (sheet, rill, gully or tunnel/mass movement) record the following:
  - **i** dimensions (width and depth for rills/gullies, diameter and depth for tunnel/mass movement)
  - **ii** severity (maximum width/length/depth)
  - **iii** state (active, partially stabilised, stabilised)

3.3. Vegetation monitoring

16 Vegetation monitoring is introduced in the minor and major monitoring components, once vegetation has established on the rehabilitation. Vegetation monitoring is to take place within a 50m x 20m quadrat set up at each site (**Figure 5**). Vegetation monitoring within the quadrat includes ground cover, species diversity, invasive plant cover and vegetation composition, including a complete species list for the site. The additional parameters tree density, basal area and canopy cover are recorded for rehabilitation sites with an intended final land use of woodland habitat and woodland habitat reference sites. Rehabilitation monitoring sites with an intended final land use of grazing land and the relevant reference sites will also be assessed for pasture yield and condition and Leucaena (*Leucaena leucocephala*) stem density.

17 Photographs of the monitoring site are to be taken towards the north, south, east and west from the centre of the central 10m transect. Photos should be taken using a GPS camera or the photo number and direction recorded.

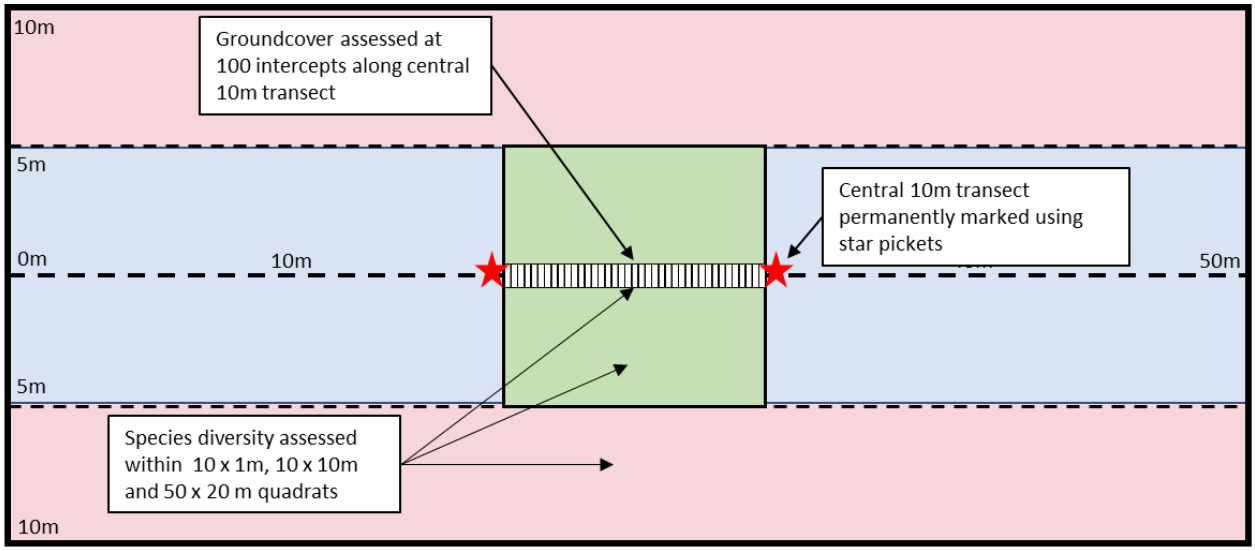

Figure 4: Major monitoring vegetation monitoring plot

3.3.1. Grazing land use rehabilitation and reference sites

18 **Ground cover analysis**

19 Ground cover is assessed along the central permanent 10m transect (between the 20m and 30m points on the 50m transect) (**Figure 5**). Ground cover type is recorded every 10cm along the 10m transect (100 vertical intercepts) using a laser mounted to a stake 1m from ground level. Ground cover type is recorded at each interval as either live cover (species recorded), standing dry cover, litter, rock, fallen woody debris or bare ground.

20 **Species diversity and vegetation composition**

21 Species diversity is assessed by recording the number of flora species within incremental areas of the quadrat, being 10 x 1m (10m2), 10 x 10m (100 m2) and 50 x 20m (1,000m2) quadrats (**Figure 5**). Each increase in area incorporates the previously sampled area and only additional species are added to the counts for larger plots. A total species list is generated for the monitoring site (i.e. total number of species within the 1,000m2 quadrat).

22 If vegetation composition across the rehabilitation slope appears to have a high degree of spatial variability it is likely that the monitoring quadrat may not capture a representative species richness for canopy species (trees). In this case, it may be necessary to establish additional vegetation assessment quadrats across the rehabilitation slope. It is recommended that a minimum of three vegetation quadrats are assessed.

23 **Leucaena stem density assessment**

24 Non-ground LiDAR data will be used to create a vegetation height model for each rehabilitation slope. This model will be used to identify all vegetation > 2m in height.

25 Field validation will be undertaken to determine the presence / absence of Leucaena within the > 2m height class across each rehabilitation slope. Where Leucaena is identified, a stem density assessment will be undertaken in locations representative of the different Leucaena densities across the rehabilitation area. For example, if the height model and aerial imagery indicate areas of dense Leucaena infestation and areas with scattered Leucaena plants, then at least two stem density assessments need to be undertaken, one in each density category.

26 The Leucaena stem density assessment is undertaken by counting the number of Leucaena stems > 2m in height within a 50 x 20m (1,000m^2) quadrat. Where Leucaena is extremely dense, it may be practical to undertake a direct count of stems within a series of sub-plots and extrapolate the data to calculate stem density / ha. Leucaena stem density must not exceed one stem per 40m^2. Each individual Leucaena stem rising from the ground is counted, even if the stems may form part of the same plant. Any stem branching above ground level is counted as one stem.

27 The vegetation height model, aerial photographic interpretation and results of the Leucaena stem density field assessments will be used to develop a map of indicative Leucaena density across the rehabilitation slope. This map will be a tool to inform corrective management actions.

28 Additional detailed Leucaena stem density assessments may be required prior to progressive certification to confirm compliance with completion criteria.

29 **Invasive plants**

30 The presence and percent cover of invasive plants is measured within the 100m^2 quadrat (**Figure 5**). An invasive plant is a prohibited and restricted matter under the Queensland *Biosecurity Act 2014*, and is defined as a species that has, or is likely to have an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of the species in an area. A complete list of invasive plant species is outlined in schedule 4 of *the Biosecurity Regulations 2016*.

31 The cover of each invasive plant is calculated as a percentage of the total vegetation cover within the 100m^2 quadrat. Where more than one invasive plants is identified within the 100m^2 quadrat, the percent cover of each species identified should be recorded. The total percent cover of invasive plants within the quadrat is calculated by summing the percent cover of each species recorded.

32 **Pasture analysis**

33 The pasture analysis includes an assessment of pasture yield and pasture condition. Pasture yield is assessed using percentage dry matter yield for preferred pasture species as well as the proportion of dry matter yield for annual grasses and undesirable grasses and weeds. Pasture condition is assessed by measuring preferred species diversity and health. Preferred pasture species are identified as perennial grasses that are productive and palatable to stock. A list of common preferred and undesirable pasture species is provided in **Table 6**.

34 Pasture yield and pasture condition data is then used to assign pasture a ranking between 1 and 4, according to the criteria in **Table 7**.

35 A detailed description of how each component of the pasture analysis is measured is provided in the following sections.

Table 6: Preferred, intermediate and undesirable pasture species

Preferred species		Intermediate species		Undesirable species	
Scientific name	**Common name**	**Scientific name**	**Common name**	**Scientific name**	**Common name**
Cenchrus ciliaris	Buffel Grass	*Bothriochloa decipiens*	Pitted Bluegrass	*Aristida spp.*	Wire Grasses
Heteropogon contortus	Black Spear Grass	*Cynodon dactylon*	Green Couch	*Sporobolus spp.*	Native Rat's Tail Grasses
Chloris gayana	Rhodes Grass	*Panicum decompositum*	Native millet	*Chloris divaricata*	Slender Chloris
Bothriochloa bladhii	Forest Bluegrass	*Cymbopogon refractus*	Barbwire Grass		
Themeda triandra	Kangaroo Grass	*Melinis repens*	Red Natal Grass		
Dichanthium sericeum	Queensland Bluegrass				

Table 7: Pasture condition assessment table

Preferred species		Intermediate species		Undesirable species	
Scientific name	**Common name**	**Scientific name**	**Common name**	**Scientific name**	**Common name**
Cenchrus ciliaris	Buffel Grass	*Bothriochloa decipiens*	Pitted Bluegrass	*Aristida spp.*	Wire Grasses
Heteropogon contortus	Black Spear Grass	*Cynodon dactylon*	Green Couch	*Sporobolus spp.*	Native Rat's Tail Grasses
Chloris gayana	Rhodes Grass	*Panicum decompositum*	Native millet	*Chloris divaricata*	Slender Chloris
Bothriochloa bladhii	Forest Bluegrass	*Cymbopogon refractus*	Barbwire Grass		
Themeda triandra	Kangaroo Grass	*Melinis repens*	Red Natal Grass		
Dichanthium sericeum	Queensland Bluegrass				

Reference: Stocktake – Balancing supply and demand Manual, Department of Primary Industries and Fisheries 2004

36 **Pasture yield**

37 Pasture yield is assessed by measuring the dry weight of pasture within three randomly placed 1m^2 quadrats at each monitoring site. Pasture is removed from the quadrat by cutting vegetation to approximately 50mm in height and weighing in the field. It is important to record total sample weight for the quadrat and then separate the sample into preferred pasture species, annual grasses and undesirable grass species and weeds. These are all weighed separately to collect data on initial weight.

38 The separated cuttings from the three quadrats are then placed in paper sample collection bags and sent to the laboratory for drying and weighing. The final dry matter weight for preferred pasture species, annual grasses and undesirable grass species and weeds is converted to percentage of dry matter yield and assessed against the indicators in Error! Reference source not found..

39 **Pasture condition**

40 Pasture condition is assessed within the largest vegetation monitoring plot (1,000m^2 quadrat). Pasture condition is assessed by recording the number of preferred pasture species and inspecting tussocks for health indicators such as:

a Basal area

b Presence of disease and pests

c New growth shoots

41 Diversity levels and health of preferred pasture species is then assessed in conjunction with the results of the pasture yield to provide an overall pasture condition ranking as outlined in Error! Reference source not found..

3.3.2. Woodland habitat land use rehabilitation and reference sites

42 **Ground cover analysis**

43 Ground cover is assessed along the central permanent 10m transect (between the 20m and 30m points on the 50m transect). Ground cover type is assessed every 10cm along the 10m transect (100 vertical intercepts) using a laser mounted to a stake 1m from ground level. Ground cover type is recorded at each interval as either live (species recorded), standing dry cover, litter, rock, fallen timber or bare ground. Species dominance (Simpson's Index) is calculated using this data (See **Data analysis** section below).

44 **Species diversity and vegetation composition**

45 Species diversity is assessed by recording the number of flora species within incremental areas of the quadrat, being 10 x 1m (10m^2), 10 x 10m (100m^2) and 50 x 20m (1,000m^2) quadrats (**Figure 5**).

Each increase in area incorporates the previously sampled area and only additional species were added to the counts for larger plots. A total species list is generated for the monitoring site (i.e. within the 1,000m2 quadrat).

46 If vegetation composition across the rehabilitation slope appears to have a high degree of spatial variability it is likely that the monitoring quadrat may not capture a representative species richness for canopy species (trees). In this case, it may be necessary to establish additional vegetation assessment quadrats across the rehabilitation slope. It is recommended that a minimum of three vegetation quadrats are assessed.

47 Invasive plants

48 The presence and percent cover of invasive plants is measured within the 100m^2 quadrat (**Figure 5**). The cover of each invasive plant is calculated as a percentage of the total vegetation cover within the 100m^2 quadrat. Where more than one invasive plants is identified within the 100m^2 quadrat, the percent cover of each species identified should be recorded. The total percent cover of invasive plants within the quadrat is calculated by summing the percent cover of each species recorded.

49 Tree and shrub canopy cover

50 Across the 50m transect the start and finish distance (m) of each tree (single-stemmed woody plant greater than 2 meters tall) and shrub (multi-stemmed woody plant or single stemmed woody plant less than 2 metres tall) crown is recorded and summed as a total canopy distance. Canopy intercepts are converted to tree and shrub crown cover % as a proportion of the transect.

51 Recruitment

52 Recruitment is recorded within the 1000m^2 quadrat (**Figure 5**). Recruitment is assessed as the proportion of woody perennial canopy (<10cm DBH) and shrub species that are regenerating. To complete this assessment, the dominant canopy and shrub species are identified and then the proportion of these species which are observed to be present in a juvenile state within the quadrat are recorded

4. Data Analysis and Reporting Requirements

4.1. Data analysis and management protocol

1 Rehabilitation monitoring data should be assessed against the Queensland Coal Rehabilitation Completion Criteria, accepted published benchmarks or standards and reference site data to determine whether or not it is meeting rehabilitation objectives. Historical rehabilitation data should be used to identify changes, trends and map the trajectory of rehabilitation to identify whether it is on track for relinquishment.

2 All field data is to be entered into the ***BHP Coal Rehabilitation Monitoring Database***. Laboratory reports from soil and spoil analysis are to be attached to the monitoring report as an Appendix and stored in the BHP document management system.

4.1.1. Land suitability assessment

3 The land suitability assessment (LSA) is undertaken for rehabilitation with a cattle grazing final land use only, at the following times:

a Assessment 1: undertaken during major monitoring in Year 6 (second time major monitoring is undertaken)

b Assessment 2: undertaken prior to progressive certification of the rehabilitation area

4 The LSA is undertaken for the first time in Year 6 to ensure vegetation has had time to establish. If the rehabilitation fails to meet the completion criteria for LSA at Assessment 1, then LSA assessment will be undertaken during the next scheduled major monitoring (4 years later). If the rehabilitation area fails to meet LSA completion criteria again a remediation plan should be developed, detailing any required corrective actions. The remediation plan should include any required for additional LSA assessments.

5 This land suitability assessment methodology is based on the Queensland land suitability scheme as described in the *Guidelines for agricultural land evaluation in Queensland* (Department of Science, Information Technology and Innovation and the Department of Natural Resources and Mines, 2015) and in *A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin, Queensland* (Short, in draft).

6 Five land suitability classes are defined for use in Queensland, with land suitability decreasing progressively from class 1 to class 5. Error! Reference source not found. presents the land suitability classes for cattle grazing on rehabilitation as proposed in Short (in draft).

Table 8: Land suitability classes for cattle grazing on rehabilitation

Class	Suitability	Grazing system	Description
1	Suitable	Fattening / finishing	Rehabilitation capable of attaining maximum grazing productivity, i.e production of young, finished, grass fed, export quality cattle in most seasons.
2	Suitable	Growing	Rehabilitation on which younger cattle perform well but may be difficult finish at a young age, depending on seasonal conditions.
3	Suitable	Breeding	Rehabilitation able to carry breeding stock all year round depending on seasons.
4	Unsuitable	Sometimes suitable for grazing	Rehabilitation that is unsuitable most of the time but may be grazed in better seasons for short periods in conjunction with other country.
5	Unsuitable	Never suitable for grazing	Rehabilitation that is not suitable for cattle grazing.

7 The land suitability classes for cattle grazing on rehabilitation have been developed based on nine land use limitations identified as relevant to this land use. These limitations and their assessment methodology are described in the sections below. Each limitation is individually allocated a land suitability class according to the land suitability framework for cattle grazing on rehabilitation (**Table 4**). The overall land suitability class is determined by the most severe limitation. For example, if water availability falls within the framework parameters for class 3, nutrient supply fall within the framework parameters for class 4 and all other limitations fall into class 2, the overall land suitability class will be class 4 because nutrient supply is the most severe land use limitation.

8 **Water availability**

9 Water availability is assessed by analysing PAWC data collected in the field (see Soil and Spoil Monitoring - soil and spoil profile classification section).

10 **Nutrient supply**

11 Nutrient supply is assessed by analysing Phosphorus and pH data from surface samples collected in the field (see **Soil and Spoil Monitoring - soil and spoil laboratory analysis** section). Phosphorus (Colwell) is used as a surrogate for general soil fertility. Soil pH is assessed due to its role in influencing the availability of nutrients, toxic elements and chemical species.

12 **Soil physical factors**

13 Soil physical factors is assessed using soil surface characteristic data collected in the field (see **Soil and Spoil Monitoring – surface soil characteristics** section). This limitation involves classifying the degree of coarseness of the surface structure of the soil. Factors including soil ped size and presence of surface crusting are assessed.

14 **Salinity**

15 Salinity is assessed by analysing EC data from samples collected in the field (see **Soil and Spoil Monitoring - soil and spoil laboratory analysis** section). Salinity is assessed by determining soil salinity within the pasture ERD (0.6m). Salinity must be within the suitability class range for samples taken at surface (0 – 10cm), 10 – 30cm and 30 – 60cm depth.

16 **Rockiness**

17 Rockiness is assessed using soil surface characteristic data collected in the field (see **Soil and Spoil Monitoring – surface soil characteristics** section). Rockiness is assessed as the presence of gravel, cobble or stone on the soil surface. The percentage cover of the following size classes is assessed:

a Gravel (20 – 60mm)

b Cobble (60 – 200mm)

c Stone (200 – 600mm)

d Boulder

e Rock outcrop

18 The percentage cover of each size class is added together to calculate the total surface cover of rock.

19 **Topography (slope and microrelief)**

20 Topography is assessed using slope gradient data generated by LiDAR analysis (see **Landform Assessment – LiDAR analysis** section). Slope gradient is calculated as a percentage and classified into five categories, ranging from < 5% to ≥ 20%. Microrelief is assessed by analysing soil surface data collected in the field (see **Soil and Spoil Monitoring – surface soil characteristics** section). Microrelief is measured as the vertical depth of surface deep ripping created during rehabilitation construction.

21 **Water erosion**

22 Water erosion is assessed by analysing ESP data from surface samples collected in the field (see **Soil and Spoil Monitoring - soil and spoil laboratory analysis** section). The ESP value of surface soils is used as a surrogate for the potential of soil to be eroded by water. Soils are categorised using the following three ranges:

a ESP < 6

b ESP 6 - < 14

c > 14

23 Each of the three soil types is then classified based on slope gradient.

24 Subsoil erosion

25 Subsoil erosion is assessed by analysing ESP data from subsoil samples collected in the field (see **Soil and Spoil Monitoring - soil and spoil laboratory analysis** section). The ESP value of subsoils is used as a surrogate for the vulnerability of subsoils to dispersion and erosion. Subsoil ESP is measured at 0.5m. ESP must be within the suitability class range for samples taken at surface (0 – 10cm), 10 – 30cm and 30 – 60cm depth.

26 Potentially acid forming materials

27 Potentially acid forming materials (PAF) is assessed by analysing data from soil samples collected in the field (see **Soil and Spoil Monitoring - soil and spoil laboratory analysis** section). PAF occur in highly acidic conditions (pH < 4.5). This characteristic is assessed using depth to trigger value of pH 4.5. The suitability classes 4 and 5 can be directly measured, however, the assessment of classes 1, 2 and 3 will require some interpretation of field geology. To classify as suitability class 5 any of the surface (0 – 10cm), 10 – 30cm or 30 – 60cm depth must have a pH of < 4.5. To classify as suitability class 4 the 90 – 100cm sample must have a pH of < 4.5.

Table 4: Land suitability framework for cattle grazing on rehabilitation (Short, in draft)

Limitation	Indicator	Units	Suitability class				
			1	2	3	4	5
Water availability	PAWC in ERD	mm/0.6d	> 75	75 - 60	< 60 - 45	< 45 - 30	< 30
Nutrient supply	P in 0.1m	mg / kg	> 20	20 - 14	< 14 - 8	< 8 - 4	< 4
	pH in 0.1m	pH units	7.3 – 6.6	*< 6.6. – 6.0 or > 7.3 – 8.0*	< 6.0 – 5.5 or > 8.0 – 8.5	< 5.5 – 5.0 or > 8.5 – 9.0	< 5.0 or > 9.0
Soil physical factors	Surface soil structure	variable	Fine (peds < 10mm)	Coarse (peds > 10mm)	Surface crust	Very hard setting	Massive
Salinity	EC in ERD	dS/cm	< 2	2 - < 4	4 - < 10	10 - < 16	≥ 16
Rockiness	Fragments on surface	%	< 5	5 - 10	10 - 30	30 - 60	> 60
Topography (slope and microrelief)	Gradient, surface	%	< 5	5 - < 10	10 - < 15	15 - < 20	≥ 20
	Vertical interval, surface	m	Nil ripping furrows	Regular ripping furrows < 0.2m	Regular ripping furrows > 0.2 – 0.4m	Regular ripping furrows > 0.4 – 0.6m	Regular ripping furrows > 0.6m
Water erosion, surface soil	Slope (ESP in 0.1m <6)	%	< 5	5 - 8	> 8 - 12	> 12 - 18	> 18
	Slope (ESP in 0.1m > 6 - < 14)	%	< 3	3 - 6	> 6 - 10	> 10 - 12	> 12
	Slope (ESP in 0.1m > 14)	%	< 1	1 - 2	> 2 - 4	> 4 - 6	> 6
Sub-soil erosion	ESP at 0.5m	%	< 7	7 - 14	> 14 - 23	> 23 - 34	> 34
Potentially acid forming materials	pH < 4.5	pH units	Not likely to be present within 5m of surface	Not likely to be present within 3m of surface	Not likely to be present within 2m of surface	Present immediately below root zone (0.9 – 0.6m)	Present within root zone (surface 0.6m)

4.1.2. Simpsons Index (woodland habitat final land use only)

28 Species dominance at woodland habitat sites is measured by calculating Simpsons Index. The proportion of each species is calculated using the average percentage cover values calculated from the ground cover intercept data. Simpsons Index is then calculated as the sum of squares of the species proportions. For example, if the proportional live groundcover of a particular site is:

a *Cenchrus ciliaris* (Buffel Grass) – 0.17

b *Urochloa mosambicensis* (Sabi Grass) – 0.42

c *Melinis repens* (Red Natal) – 0.42

29 Then Simpsons Index can be calculated as: $0.17^2 + 0.42^2 + 0.42^2 = 0.38$. Simpsons Index varies from 0.0 to 1.0, with a low score indicating numerous non-dominating species are present and a high score indicating only few species are present.

4.1.3. Rainfall run-off data analysis

30 Event based receiving environment and rainfall run-off water quality monitoring is undertaken following significant rainfall events (generally at least 50mm rainfall).

31 The data from event based monitoring is collated and analysed at each major monitoring event (every 4 years). All available receiving environment water quality data should be analysed to determine the 10^{th}, 20^{th}, 80^{th} and 90^{th} percentiles. These values are then used to assess the compliance of the rehabilitation rainfall run-off with completion criteria (see **Queensland Coal Rehabilitation Completion criteria** section below).

4.2. Traffic light rating system

32 A traffic light rating system has been developed to enable the classification of rehabilitation into one of three performance categories good, fair or poor. The traffic light system has been adopted to summarise rehabilitation monitoring results, which are often detailed and complex, into a visual, clear and easy to interpret performance class presented in a report card format within the rehabilitation report (refer to Reporting Structure and Inclusions). Two separate traffic light rating matrixes have been developed, one for rehabilitation monitoring key performance indicators and one to summarise rehabilitation performance against the Queensland Coal rehabilitation completion criteria.

33 Key performance indicators are designed to provide a detailed assessment of rehabilitation performance as measured by the rehabilitation monitoring methodology. This information can be used to highlight specific issues or aspects of rehabilitation and inform management requirements. The analysis of key performance criteria can assist in determining the long term trajectory of rehabilitation performance.

34 In comparison, assessment of rehabilitation against the Queensland Coal rehabilitation completion criteria provides a high level overview of whether rehabilitation is meeting the core goals for rehabilitation across Queensland.

4.3. Key performance indicators

35 The overall performance of the three key rehabilitation performance indicators (soil / spoil, erosion and vegetation) are summarised in the report card for each monitoring site. Data ranges for each performance category (good, fair, poor) are presented in **Table 5**.

36 The performance categories for each key indicator have been developed based on acceptable ranges for successful rehabilitation. Generally, a classification of good for a particular indicator suggests that the indicator is currently performing well and is not likely to become a limiting factor for

rehabilitation performance in the future. A classification of fair is generally applied to indicators that are currently performing slightly below but within 20 – 25% of the criteria for good. A classification of fair may include indicators that are still developing and may be expected to improve over time but could also highlight a need for corrective action. A classification of poor highlights indicators that are currently significantly underperforming, are unlikely to improve over time and are likely to require corrective action to achieve successful rehabilitation outcomes.

Table 5: Traffic light rating matrix for key performance indicators

Key indicator*	Performance categories		
	Good	Fair	Poor
Soil / spoil	Score of 35 – 45	Score of 25 - 35	Score of 15 - 25
Erosion	1. 70% of slopes ≤ 15% and 2. Minor rill / gully erosion (no immediate remedial work required)	1. 70% of slopes 15% - 20% or 2. Moderate rill / gully erosion (remedial work likely to be required prior to relinquishment)	1. 70% of slopes > 20% or 2. Extensive, severe rill / gully erosion (immediate remedial work required)
Vegetation (cattle grazing final land use)	1. Vegetation groundcover > 80% and 2. Pasture condition rating of ≥ 2	1. Vegetation groundcover 60 – 80% or 2. Pasture condition rating of 3	1. Vegetation groundcover < 60% or 2. Pasture condition rating of 4
Vegetation (woodland habitat final land use)	Score of 20 - 30	Score of 10 - 20	Score of 0 - 10

*See Appendix A for soil / spoil and vegetation (woodland habitat final land use) weighted score calculation method

Note

The criteria have been compared with existing datasets from monitoring undertaken at BMA and BMC mines to date to ensure the categories are reasonable and practical, however, updates to these categories may be required as rehabilitation methods improve or if rehabilitation goals or performance expectations change..

4.4. Queensland Coal Rehabilitation Completion criteria

37 The overall performance of the rehabilitation against the ***Queensland Coal Rehabilitation Completion Criteria*** is summarised in the report card for each monitoring site. Data ranges for each performance category (good, fair, poor) are presented in **Table 6**.

Table 6: Traffic light rating matrix for completion criteria

Completion criteria			Performance categories		
Objective	**Indicator**	**Criteria**	**Good**	**Fair**	**Poor**
All final land uses					
Rainfall run off from rehabilitation achieves relevant water quality objectives for receiving waters*	pH EC Turbidity	Not significantly different to upstream values	Rainfall run-off water quality is within the 20th and 80th percentile of upstream water values	Rainfall run-off water quality is within the 10th and 90th percentile of upstream water values	Rainfall run-off water quality is outside the 10th and 90th percentile of upstream water values
Cattle grazing final land use					
Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover > 50% 2. 70% of slopes ≤ 20%	1. Groundcover > 50% 2. 70% of slopes ≤ 20%	1. Groundcover > 40% 2. 70% of slopes ≤ 25%	1. Groundcover < 40% 2. 70% of slopes > 25%
Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤ 3 or not different from pre-mining class if ≥ 4	Land suitability class ≤ 3 or not different from pre-mining class if ≥ 4	Land suitability class ≤ 4 or not different from pre-mining class if > 4	Land suitability class of 5
	Leucaena stem density	< 250 stems > 2m height per ha (1 per 40m^2), mean total area	< 250 stems > 2m height per ha (1 per 40m^2), mean total area	250 - 300 stems > 2m height per ha, mean total area	> 300 stems > 2m height per ha, mean total area
Woodland habitat final land use					
Rehabilitation is erosionally stable	Groundcover (steep slopes, > 15%)	> 80%	> 80%	> 60%	< 60%
	Groundcover (lesser slopes ≤ 15%)	> 50%	> 50%	> 40%	< 40%
Some native bushland habitat characteristics#	Species richness: Trees Shrubs Grasses	 ≥ 2 ≥ 3 ≥ 4	 ≥ 2 ≥ 3 ≥ 4	 ≥ 2 ≥ 2 ≥ 3	 < 2 < 2 < 3
	Tree canopy cover	≥ 16%	≥ 16%	≥ 12%	< 12%

*performance categories derived from Queensland Water Quality Guidelines 2009 (Department of Environment and Science, 2013)

#All species richness criteria (trees, shrubs, grasses) must be met for a site to achieve a performance category of good or fair. Where scores for species richness criteria differ, the site is allocated to the poorest performance category

4.5. Report structure and inclusions

38 Initial and major monitoring reports will be produced using the structure and formatting of the ***BHP Coal Rehabilitation Monitoring Report Template***. Monitoring reports are to contain the following sections:

- **a** Report cards – summary of current performance for each rehabilitation monitoring site summarising rehabilitation performance across mine site
- **b** Report card map – an aerial map of rehabilitated areas across the mine site, displaying the following key information for each area: the proposed post-mining land use, area (ha), key performance indicator traffic light rating and completion criteria traffic light ratings
- **c** Executive summary – overview of the recent monitoring program
- **d** Introduction – a description of the rehabilitation history of the mine site and the applicable rehabilitation completion criteria
- **e** Methodology – a description of the monitoring sites. This section should reference the BHP Coal Rehabilitation Monitoring Methodology and include a detailed description of any diversions from the methodology
- **f** Results – present current and historical results of monitoring for each rehabilitation and reference site to identify changes, trends and patterns. Data should be presented using graphs and figures. Recent climate data and natural events (fires, drought, floods etc) to be provided
- **g** Discussion – present an analysis of the results in relation to rehabilitation objectives and completion criteria, highlighting trends, emerging issues and overall performance
- **h** Summary & recommendations – this section should provide a summary of the results and present any recommendations relating to the rehabilitation or rehabilitation monitoring process, including any recommended changes to soil sampling and analysis for future assessments. Recommendations should also include any remediation works indicated by the monitoring data to be required to maintain rehabilitation development

39 Actions arising from initial, event based and major monitoring are to be recorded and tracked in the BHP work management system (SAP).

5. Terms and Definitions

Table 7: Terms and Definitions

Term	Definition
CEC	Cation exchange capacity
EA	Environmental Authority
EC	Electrical Conductivity
EP Act	Environmental Protection Act 1994
ERD	Effective rooting depth
ESP	Exchangeable Sodium Percentage
DBH	Diameter at breast height (of a tree)
DEM	Digital elevation model
PAWC	Plant available water capacity

6. References

Table 8: List of reference documents

Controlled Document Number	Title	Hummingbird Number
	Coal Rehabilitation Monitoring Program - Minor Monitoring Field Guide	
	BHP Queensland Coal Rehabilitation Completion Criteria	
	BHP Coal Rehabilitation Monitoring Database	

7. Version Management

Version	Details
1.0	Initial release

8. Appendices

Appendix A – Weighted Scoring Systems

Appendix A – Weighted scoring systems

1 A weighted scoring system has been developed for the allocation of soil / spoil and vegetation (woodland habitat final land use) results into the three traffic light rating system performance categories good, fair and poor. A weighted scoring system is required for these key performance indicators as they are assessed using a number of parameters of differing importance. The key characteristics that have the greatest influence on rehabilitation success have been selected for inclusion in the traffic light rating matrix.

Soil / spoil weighted scoring system

2 The soil / spoil weighted score is calculated using the following methodology.

a Soil / spoil (laboratory results) are assessed using the table below to determine the performance category (good, fair, poor) for each parameter.

Performance category criteria

Soil / spoil parameter	Units	Depth assessed*	Performance category criteria		
			Good	Fair	Poor
Emerson Aggregate Class	n/a	0 - 30cm	≥ 4 (Moderate)	3 / 2 (high - moderate / high)	1 (severe)
pH	pH units	0 - 30cm	5.1 - 8.8	4.5 – 5.1 or 8.8 - 9.5	< 4.5 or > 9.5
EC	µs/cm	0 - 30cm	< 600	600 - 1200	> 1200
Chloride	mg / kg	0 - 30cm	< 600	600 - 1200	> 1200
CEC	meq / 100g	0 - 30cm	> 12	6 - 12	< 6
ESP	%	0 - 30cm	< 6	6 - 14	> 14
Organic carbon	%	0 - 10cm	> 1	0.4 - 1	< 0.4
Nitrogen	mg / kg	0 - 10cm	> 1,000	500 – 1,000	< 500
Phosphorus	mg / kg	0 - 10cm	> 20	5 - 20	< 5
Trace elements#	n/a	0 - 10cm	Meets acceptable criteria		Does not meet acceptable criteria

* where values for surface samples (0 – 10cm) and 10 – 30cm samples vary, assess based on poorest performing value

#if trace elements do not meet acceptable criteria a qualitative assessment of the impact on overall soil / spoil performance is made

3 The weighted score for each parameter is calculated using the multiplier and performance category scores in the table below. The final score is then used to determine the overall performance category for soil / spoil based on the score ranges provided in Table 5.

Multiplier and performance category scores

Soil / spoil parameter	Multiplier	Performance category score			Highest possible score	Lowest possible score
		Good	Fair	Poor		
Emerson Aggregate Class	2	3	2	1	6	2
pH	2				6	2
EC	2				6	2
Chloride	1				3	1
CEC	2				6	2
ESP	3				9	3
Organic carbon	1				3	1
Nitrogen	1				3	1
Phosphorus	1				3	1
				Total:	**45**	**15**

Vegetation (woodland habitat final land use) weighted scoring system

4 The vegetation weighted score is calculated using the following methodology.

a Vegetation field results are assessed using the table below to determine the performance category (good, fair, poor) for each parameter.

Performance category criteria

Vegetation parameter	Units	Performance category criteria		
		Good	Fair	Poor
Species richness: Trees	Number of species	≥ 4	≥ 2	< 2
Species richness: Shrubs		≥ 4	≥ 2	< 2
Species richness: Grasses		≥ 4	≥ 2	< 2
Canopy cover	%	≥ 16	≥ 12	< 12
Vegetation groundcover	%	≥ 50	40 - 50	< 40
Vegetation cover – Simpsons Index	n/a	0.0 – 0.4	> 0.4 - < 0.6	> 0.6 – 1.0
Invasive species	m^2/ha	≤ 5	> 5 - < 20	> 20

5 The weighted score for each parameter is calculated using the multiplier and performance category scores in the table below. The final score is then used to determine the overall performance category for vegetation based on the score ranges provided in **Table 5**.

Multiplier and performance category scores

Vegetation parameter	Multiplier	Performance category score			Highest possible score	Lowest possible score
		Good	Fair	Poor		
Species richness : trees	2	3	2	1	6	2
Species richness : shrubs	1				3	1
Species richness : grasses	1				3	1
Canopy cover	1				3	1
Vegetation groundcover	2				6	2
Vegetation groundcover - Simpsons Index	1				3	1
Invasive species	2				6	2
				Total:	**30**	**10**