Daunia Mine

Transitional PRC Plan Hydrogeology – Revision 3

Whitehaven Coal Pty Ltd

Millennium Poitrel Access Road via Peak Downs Highway, Moranbah, Qld, 4744

Prepared by:

SLR Consulting Australia

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Basis of Report

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Acronyms and Abbreviations

ADWG	Australian Drinking Water Guidelines
AET	Actual Evapotranspiration
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BMA	BM Alliance Coal Operations Pty Ltd
BoM	Bureau of Meteorology
CHD	MODFLOW Constant Head Package
CLL	Cornish Lithium Limited
CMB	Chloride Mass Balance
CSM	Conceptual Site Model
DEM	Digital Elevation Model
DES	Department of Environment and Science
DNM	Daunia Mine
DRN	MODFLOW Drain Package
EA	Environmental Authority
EIS	Environmental Impact Statement
EPBC Act	Environment Protection and Biodiversity Conservation Act
EPML	Environmental Protection Mining Lease
EV	Environmental Value
EVT	MODFLOW Evapotranspiration Package
FEFLOW	Finite Element subsurface FLOW system
GDE	Groundwater Dependent Ecosystem
GHB	MODFLOW General Head Boundary Package
GIS	Geographic Information System
GL/day	Gigalitres per day
GLM-130B	General Language Model 130 Billion
GWBD	Groundwater Bore Database
Kh	Hydraulic Conductivity (Horizontal)
Kv	Hydraulic Conductivity (Vertical)

LGA	Local Government Area
MIA	Mine Infrastructure Area
ML	Mining Lease
ML/day	Megalitres per day
MLE	Most Likely Estimate
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
OOPD	Out of Pit Dump
PET	Potential Evapotranspiration
PMLU	Post Mining Land Use
PRC Plan	Progressive Rehabilitation and Closure Plan
QoI	Quantities of Interest
RCH	MODFLOW Recharge Package
RIV	MODFLOW River Package
RMS	Root Mean Squared error
SI	Site Investigation
SILO	Scientific Information for Land Owners
SLR	SLR Consulting Limited
SMC	Sequential Monte Carlo
SPR	Source-Pathway-Receptor
SRMS	Scaled Root Mean Squared error
Ss	Specific Storage
Sy	Specific Yield
TIB	MODFLOW Transient IBound Package
TVM	MODFLOW Time Variant Material Package
USGS	United States Geological Survey
WMIP	Water Monitoring Information Portal
WQO	Water Quality Objective

1.0 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Whitehaven Coal Pty Ltd (Whitehaven) to undertake a hydrogeological assessment supporting the Daunia Mine (DNM) transitional Progressive Rehabilitation and Closure Plan (PRC Plan). 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 3.01, effective 16 Sept 2024) - "the Guideline". The assessment 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 DNM PRC Plan.

The DNM metallurgical open cut coal mine voids are located primarily on Mining Lease (ML) 1781 and ML 70115 within the Bowen Basin, approximately 20 kilometres (km) east of Moranbah within the Isaac Regional Council Local Government Area (LGA) (**Figure 1-1**). Associated infrastructure for DNM is located on ML 70116 (i.e. the DNM Mine Infrastructure Area(MIA)). Open cut mining operations at DNM currently occurs via five pits: Atlas East, Titan East, Titan Central, Titan North and Titan West. With future mining planned for the Pandora North and Pandora South pits (**Figure 1-2**). Existing operations at DNM are undertaken under the conditions of Environmental Authority (EA) EPML00561913 (in effect as of 30 June 2022), EPBC Act approval 2008/4418 and the Coordinator-General's imposed conditions.

Located in the proximity of DNM are the following mining operations (**Figure 1-1**):

- West - Poitrel Mine and Red Mountain Infrastructure processing plant;
- Northwest - Millennium Mine;
- East - the proposed Isaac River Project;
- Northeast - Moorvale Mine;
- South - the proposed Winchester South Project; and
- Southeast - the Moorvale South Mine, and further southeast the Olive Downs project.

The most recent hydrogeological studies relevant to the DNM transitional PRC Plan are the previous PRCP study undertaken in 2025 (SLR, 2025b) and the Daunia West Infrastructure Project (DWIP) Groundwater Impact Assessment (SLR, 2025c & d). That body of work has been drawn upon as directly relevant to this hydrogeological assessment, including the development of a conceptual groundwater model for DNM.

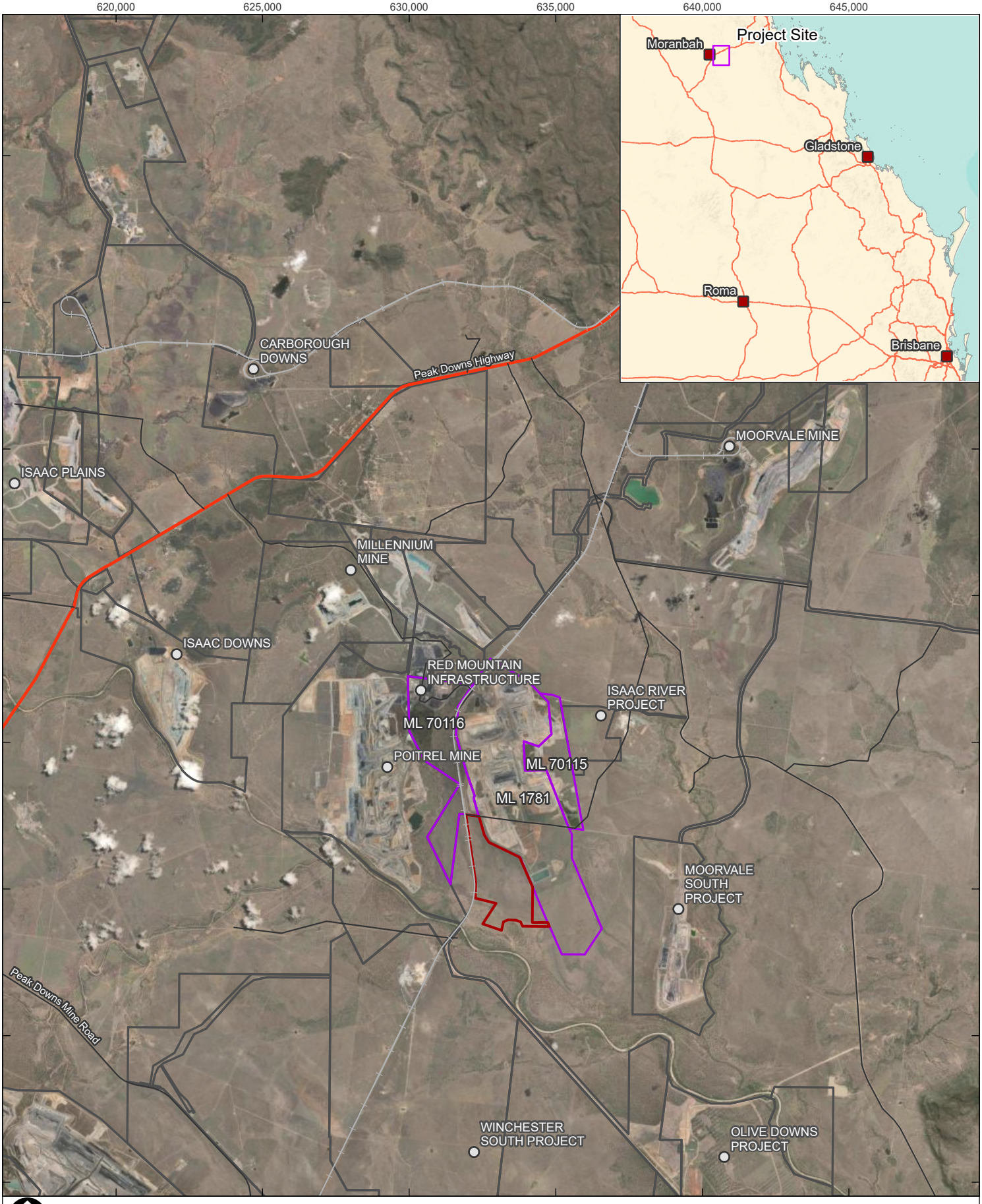
Throughout this report, the terms "the DNM", "Project Area" and "Study Area" are used as defined by:

- The DNM or Project Area are defined as areas covered by Environmental Authority (EA) EPML00561913 within Mining Lease (ML) 1781, ML 70115 and ML 70116 (**Figure 1-3**); and
- The Study Area is the regional area surrounding DNM considered in detail within this assessment, necessary to inform the understanding of the regional scale groundwater system in which DNM lies as documented in SLR (2021a and 2022a).

1.2 Final Landform

The post-mining final DNM landform relevant to this hydrogeological assessment was provided by Whitehaven and is shown as **Figure 1-3.** The final landform contains three

predominant residual final voids: Titan North, Titan East Void, and Pandora Void. A fourth minor void, known as Titan Central, is located at the north of the ML, between Titan North and Titan East. This void is too small to be captured within the groundwater model discretization, and therefore is not included in the groundwater assessment.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:170,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Surrounding Mine/Project
- Rail
- Principal Road
- Road
- Major Watercourse
- DNM Mine Lease
- Mine Lease
- Mining Lease Application Area

DAUNIA MINE TRANSITIONAL PRCP

LOCALITY PLAN

SLR

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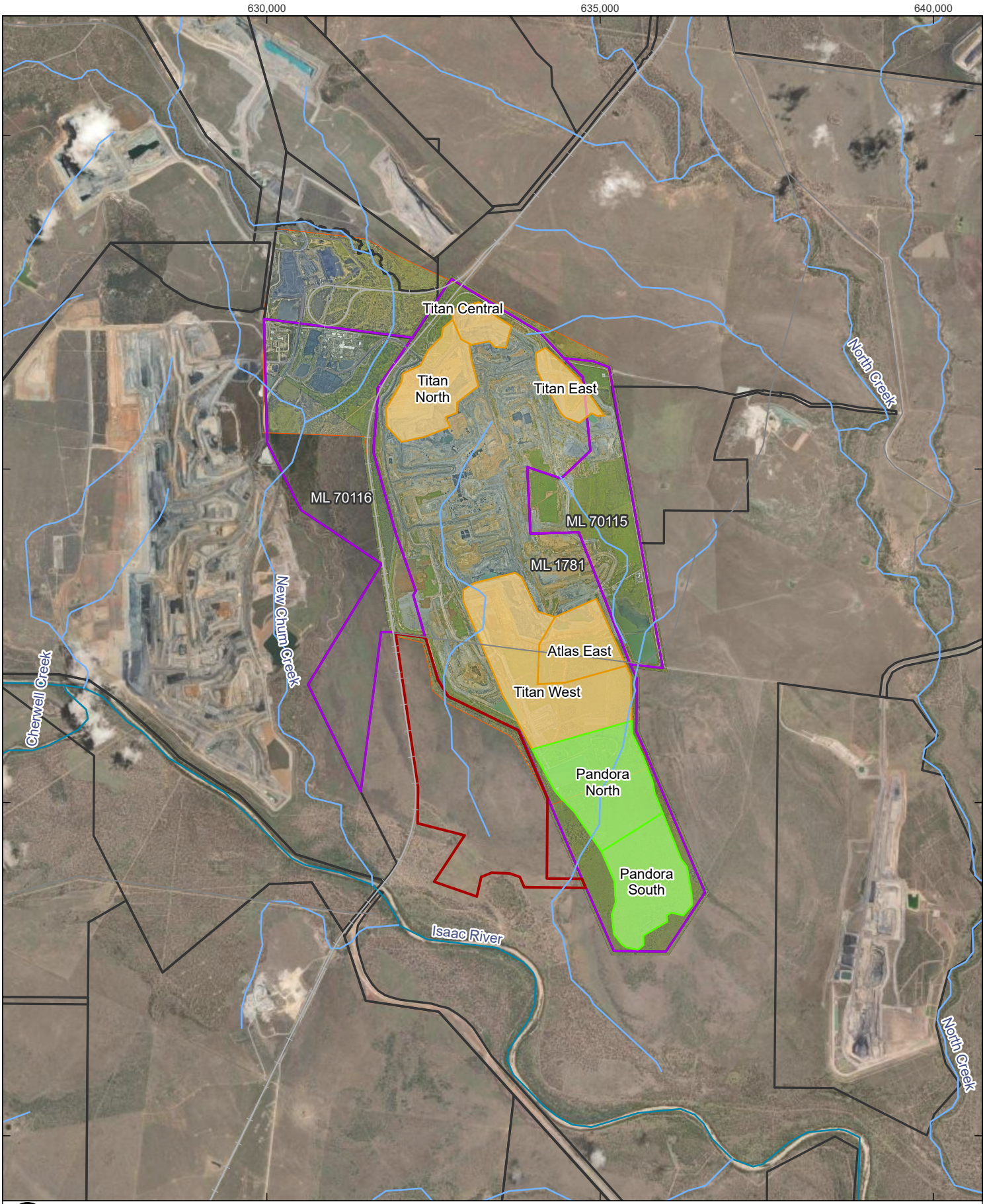
FIGURE 1-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F01-01_Project Location



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Rail
- Road
- Active Pit
- Future Pit
- DNM Mine Lease
- Mine Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

CURRENT MINING AREAS

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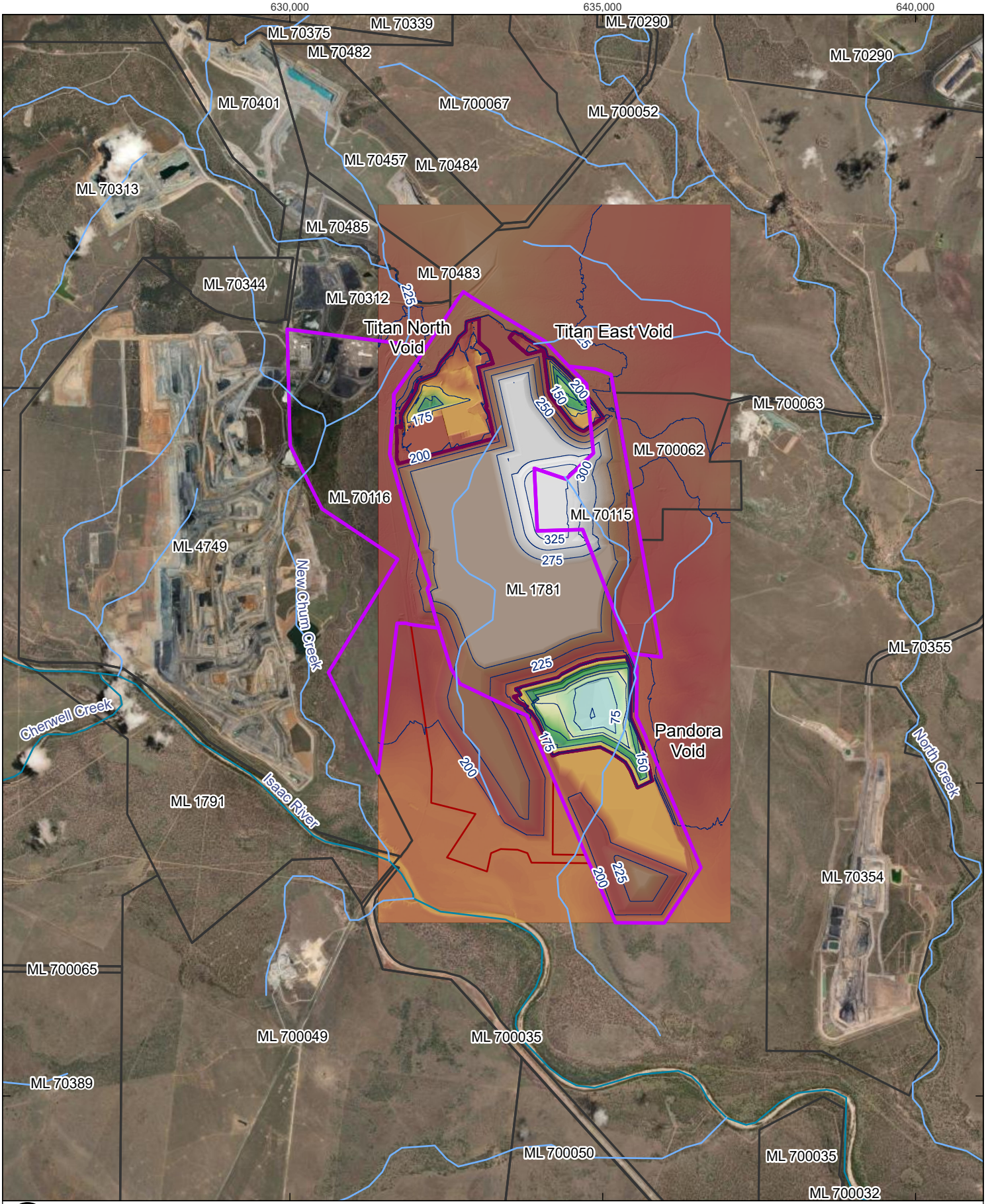
FIGURE 1-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F01-02_Mining Areas



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Final Landform Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- Void Extent
- DNM Mining Lease
- Mining Lease Application Area

Final Landform Elevation (mAHD)

326

48

DAUNIA MINE
TRANSITIONAL PRCP

POST MINING LANDFORM

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FIGURE 1-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F01-03_Post Mining Landform

1.3 Objectives

The primary objective of the hydrogeological assessment is to assess the potential groundwater related impacts at DNM 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 landform for the intended PMLU with respect of the DNM 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 bearing units, i.e. there is sufficient freeboard to negate risk of void water discharge to any shallow groundwater system; and
- That there are minimal additional impacts to groundwater receptors post-closure caused by the final landform that are beyond those resultants from approved mining:
    - Little to no additional groundwater drawdown at potential groundwater dependant ecosystem (GDE) locations; and
    - Little to no additional groundwater drawdown at existing private bore users.

1.4 Guideline Criteria

As discussed in **Section 1.1**, this hydrogeology assessment is undertaken consistent with the Guideline: Progressive Rehabilitation and Closure Plans (ESR/2019/4964). A cross reference between the relevant Guideline requirements with respect of groundwater and specific components of this assessment is provided in **Table 1-1**.

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 3.2** **Section 4.3**
Locating groundwater recharge and discharge locations locally and regionally	**Section 4.3**
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 4.5**
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 7.0**

2.0 Climate, Topography and Drainage

2.1 Climate

The climate at the Study Area is sub-tropical with higher temperatures, higher rainfall and higher evaporation occurring over the summer months (December to February). The closest Bureau of Meteorology (BoM) weather station is located at Iffley (station 34100), 18 km to the southeast of DNM. This weather station has been in operation since 1998 however has several data gaps in the monitoring record. The nearest weather stations with longer data records are Nebo station (33054), located approximately 57 km northeast of DNM, and Carfax station (34016) located approximately 59 km southeast of DNM. Nebo station has been operating since 1870 and has a largely continuous data record since 1897, with sporadic missing data from 1987. Carfax station has been operating since 1962 with just a few months of missing data. Moranbah Airport weather station is relatively close to the site (20 km to the west of DNM), however has a comparatively short monitoring period, being opened in February 2012. **Table 2-1** provides the details of the nearby operational weather stations.

Table 2-1 Operational BoM Weather Stations near to DNM

Name	Site Number	Date Commenced	Easting (GDA94)	Northing (GDA94)	Elevation (mAHD)	Operational Status	Distance from DNM
Iffley	34100	1998	647356	7539801	173	Open	18 km SE
Moranbah Airport	34035	2012	610999	7559653	232	Open	20 km W
Nebo	33054	1870	674643	7600656	195	Open	57 km NE
Carfax	34016	1962	673063	7515595	128	Open	54 km SE

mAHD = metres Australian Height Datum.

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. Monthly averages for the four nearest stations and the SILO data are listed in **Table 2-2**. SILO Grid point data (Latitude: - 22.05, Longitude: 148.30) from January 1900 until December 2024 was used to assess long-term rainfall trends in the vicinity of DNM. This dataset is interpolated from quality checked observational timeseries data collected at nearby stations by the BoM. Based on the SILO data, the average annual site rainfall is 566.6 millimetres (mm). The two highest annual rainfalls were recorded for the years 1910 and 2010, with annual rainfalls of 994.3 mm and 1,081 mm, respectively. The minimum annual rainfall occurred in 1919 with 213.4 mm. Monthly averages for the stations discussed and the SILO grid point are listed in **Table 2-2** for the period 1998 – 2024.

Table 2-2 Average Monthly Rainfall (BoM, 2025)

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Iffley	101.1	88.4	56.0	37.5	15.5	35.5	21.5	36.5	16.0	33.8	63.5	100.8	609.8
Moranbah Airport	105.2	98.7	81.4	32.3	31.3	23.5	34.2	13.7	13.2	25.0	67.1	62.2	582.8
Nebo	145.9	138.2	108.7	42.7	34.5	37.3	24.7	19.8	17.9	30.3	51.7	96.5	742.8
Carfax	110.7	93.6	63.3	31.2	35.9	28.0	22.5	22.4	18.3	36.4	55.2	96.6	616.7

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
SILO Grid Point Data	104.2	91.3	67.0	30.1	26.2	28.1	21.7	17.9	14.1	29.2	54.2	82.1	566.6

Rainfall trends for DNM based on the SILO Grid point data from 1964 are presented by means of the cumulative deviation from mean (CDFM) monthly rainfall shown in **Figure 2-1**. Positive gradients on this curve (rising limbs) confirm wetter conditions than normal, while negative gradients (falling limbs) indicate dry conditions. Average rainfall conditions are inferred during periods of stable residual mass. **Figure 2-1** shows that, over the past 50 years, the wettest periods occurred during 1973-1979, 1987-1991, 1998-2001 and 2010-2012. The driest periods were 1964-1970, 1991-1998 and 2001-2007. As shown by the declining trend in the CDFM between 2017 and 2022 DNM experienced drier than average conditions.

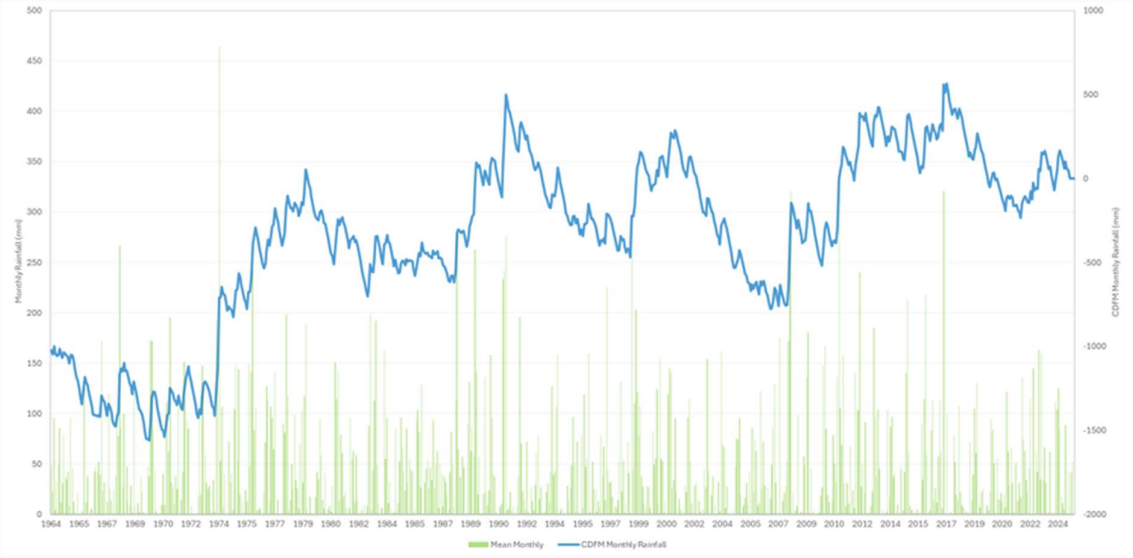


Figure 2-1 Long-term Monthly Rainfall and Rainfall Cumulative Deviation from Mean

The CDFM performs an additional service: if rainfall recharge is a significant source of groundwater, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of this curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, illustrated by the rainfall CDFM. Groundwater hydrographs showing the relationship between rainfall and groundwater levels are assessed in **Section 4.0**.

Actual and potential evapotranspiration (ET) have been taken from BoM's Australia wide interpolation dataset at the weather stations where modern measurement of ET has taken place (BoM, 2024). The potential ET in the district is approximately 2,320 mm/yr according to BoM (2024) (**Table 2-3**). The definition of potential ET by Morton (1983) is: "… the ET that would take place, under the condition of unlimited water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the ET that would occur over a very large wetland or large irrigated area, with a never-ending water inflow. Further to this, where the water table approaches the ground surface, ET can also approach the potential ET value.

Table 2-3 Average Monthly Potential Evapotranspiration (PET)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	247	202	209	175	145	120	134	164	205	250	258	267	2375
Nebo	225	184	189	157	131	111	122	149	186	229	238	246	2167
SILO Grid Point Data	241	198	204	170	142	118	131	160	200	243	252	260	2320

PET = Potential Evapotranspiration.

The actual ET in the district is approximately 1,184 mm/year according to BoM (2024) (**Table 2-4**).The definition of actual ET by Morton (1983) is: "... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the predicted ET that is occurring over a large area of land under the existing (mean) rainfall conditions.

Table 2-4 Average Monthly Actual Evapotranspiration (AET)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	137	123	123	89	58	40	45	66	86	108	121	135	1133
Nebo	160	140	141	107	74	54	61	87	113	140	152	164	1393
SILO Grid Point Data	142	126	126	92	61	43	48	71	92	114	127	141	1184

AE = Actual Evapotranspiration.

Figure 2-2 shows that the average potential monthly ET exceeds the average monthly rainfall over the entire year, often by more than double. Average actual ET is slightly greater than average rainfall for all months.

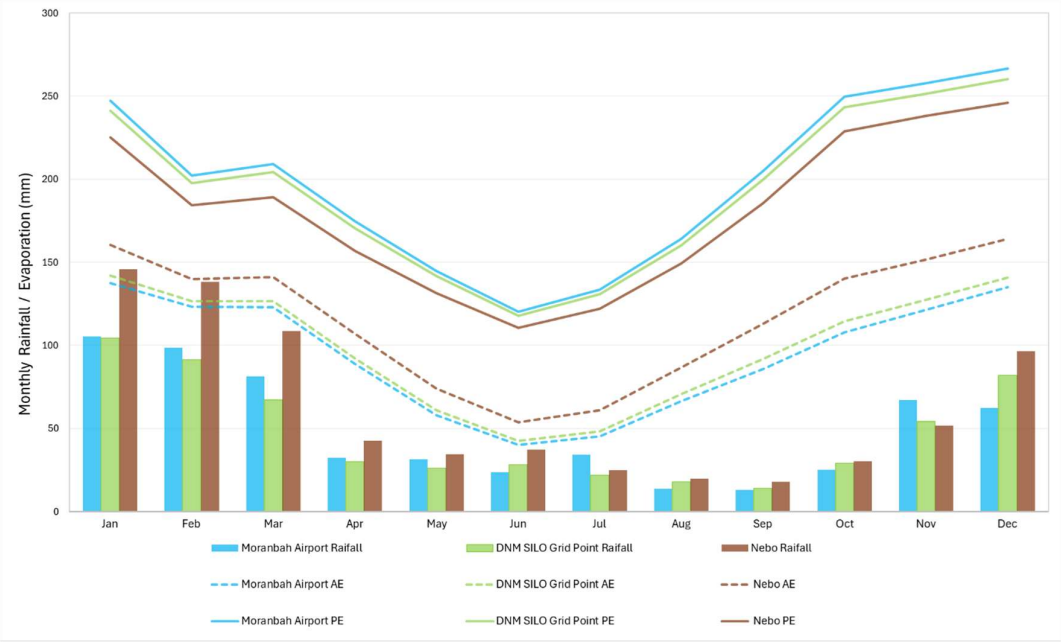


Figure 2-2 Average Monthly Rainfall and Evapotranspiration at Nearby Weather Stations

2.2 Topography and Drainage

DNM is located in the Upper Isaac surface water catchments of the Isaac River Sub-Basin. The topography of the DNM gradually falls from northeast to southwest towards the Isaac River (which is located outside the DNM), with elevations ranging from approximately 210 mAHD to 240 mAHD (**Figure 2-3**).

The Isaac River is the major drainage feature of the region and flows from northwest to southeast in the vicinity of DNM. New Chum Creek, a tributary to the Isaac River, traverses northeast to southwest across the northern section of ML70116, before running south to the west of the ML70116 boundary. New Chum Creek joins the Isaac River approximately 1.5 km directly southwest of DNM. An unnamed secondary drainage feature traverses northeast to southwest across the southern section of ML1781 at DNM. The drainage feature merges with another unnamed drainage line that runs parallel to the western boundary of ML1781, forming a minor tributary to the Isaac River. This unnamed tributary runs southeast, joining the Isaac River approximately 4 km southeast of ML1781 (**Figure 2-3**).

North Creek is located approximately 3.5 km west of DNM, draining from north to south, its confluence with the Isaac River approximately 7.5 km downstream of DNM.

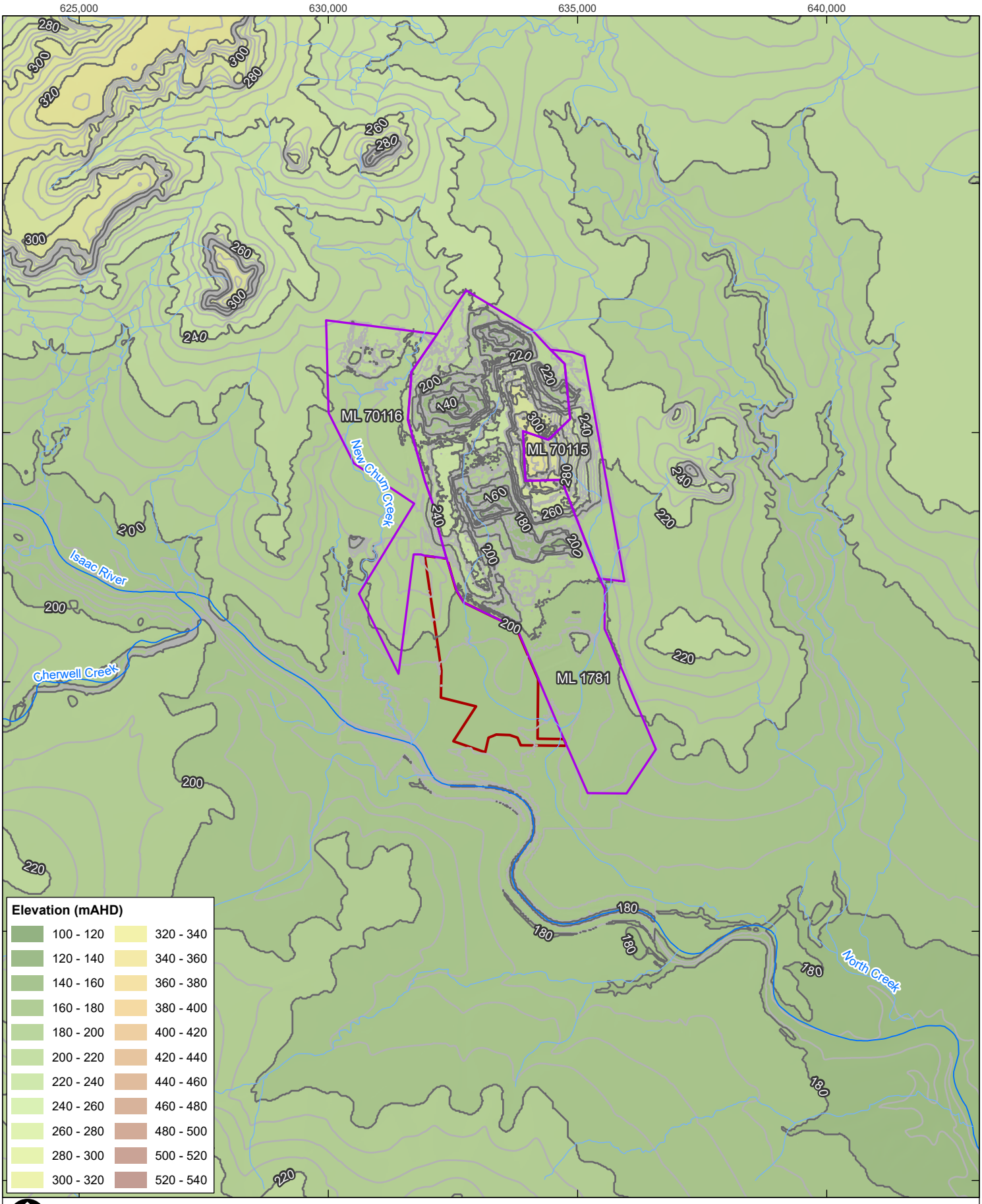
A Queensland Government gauging station is located on the Isaac River approximately 10km south-east (downstream) of DNM (Deverill station - 130410A, see **Table 2-5**). The gauge has a long operational record of good quality data (May 1968 – May 2025). **Figure 2-3** shows the relative location of the stream gauging station. **Figure 2-4** presents daily mean stream discharge at the Isaac River at Deverill station (130410A) from 1968 to present, compared against daily rainfall at Carfax station (34016) 40 km to the southeast, which is the most appropriate rainfall station to compare the long term stream discharge data to since other nearby rainfall stations have a comparatively short historical record. The data show that flows within the Isaac River are typically ephemeral, with short-duration flows generally occurring over the summer months. A flow duration curve has been derived for the 54 years of data from this gauge and is presented in **Figure 2-5**. The data indicates that flows in excess of 1 L/s have only been recorded 25.9% of the time and flows greater than 1 KL/s have only been recorded 11.2% of the time. The maximum recorded discharge was a 24hr average of 2,251 KL/s on the 3rd March 1988, although the observational accuracy of flows of this order is unclear.

Table 2-5 Isaac River Stream Gauging Station near to DNM

Station Location	Number	Distance from DNM	Zero-gauge Elevation (mAHD)	Mean Flow (ML/day)	Max Flow (GL/day)	Max Flow Date
Isaac River at Deverill	130410A	15km downstream*	169.3	439	228	Mar 1988

ML/day = megalitres per day, GL/day = gigalitres per day. *Along river channel, located southeast of DNM

.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Major Topographic Contour (20mAHD)
- Minor Topographic Contour (5mAHD)
- DNM Mine Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

TOPOGRAPHY AND HYDROLOGY

SLR

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FIGURE 2-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F02-04_Topography and Drainage

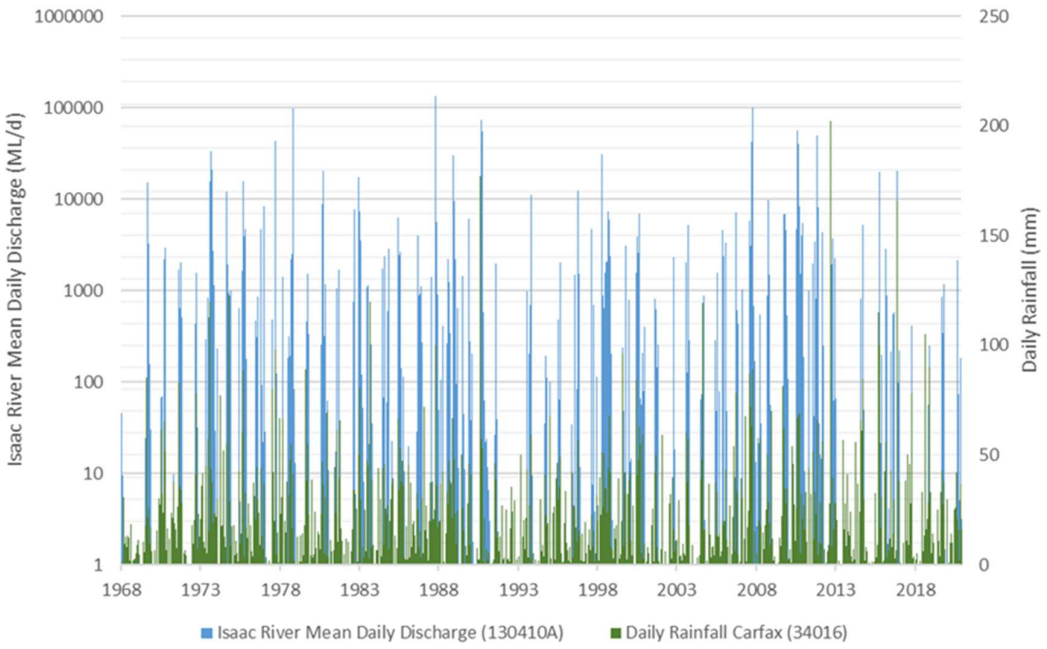


Figure 2-4 Isaac River (Station 130410A) Stream Flow and Rainfall at Carfax (Station 34016)

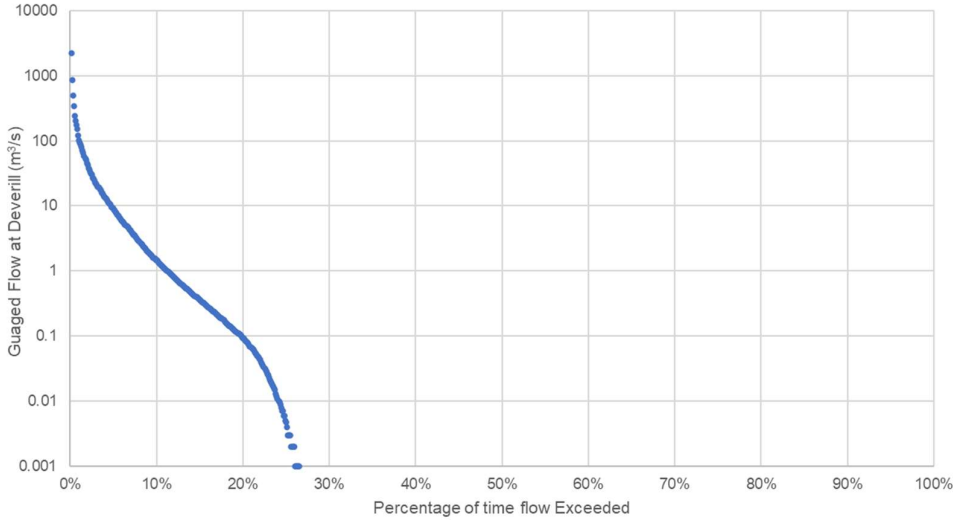


Figure 2-5 Isaac River (Station 130410A) Mean Daily Flow Duration Curve (1968 – 2022 data)

2.3 DNM Mining

This section outlines the historical mine progression and future mine plan at DNM, as relevant to assessing the effect of DNM on the groundwater system post-closure. Given the post-closure groundwater conditions will, in part, be dictated by the condition's resultant from mining activities up to the time of closure, understanding mining activities is important.

2.3.1 Historical Mining Activities

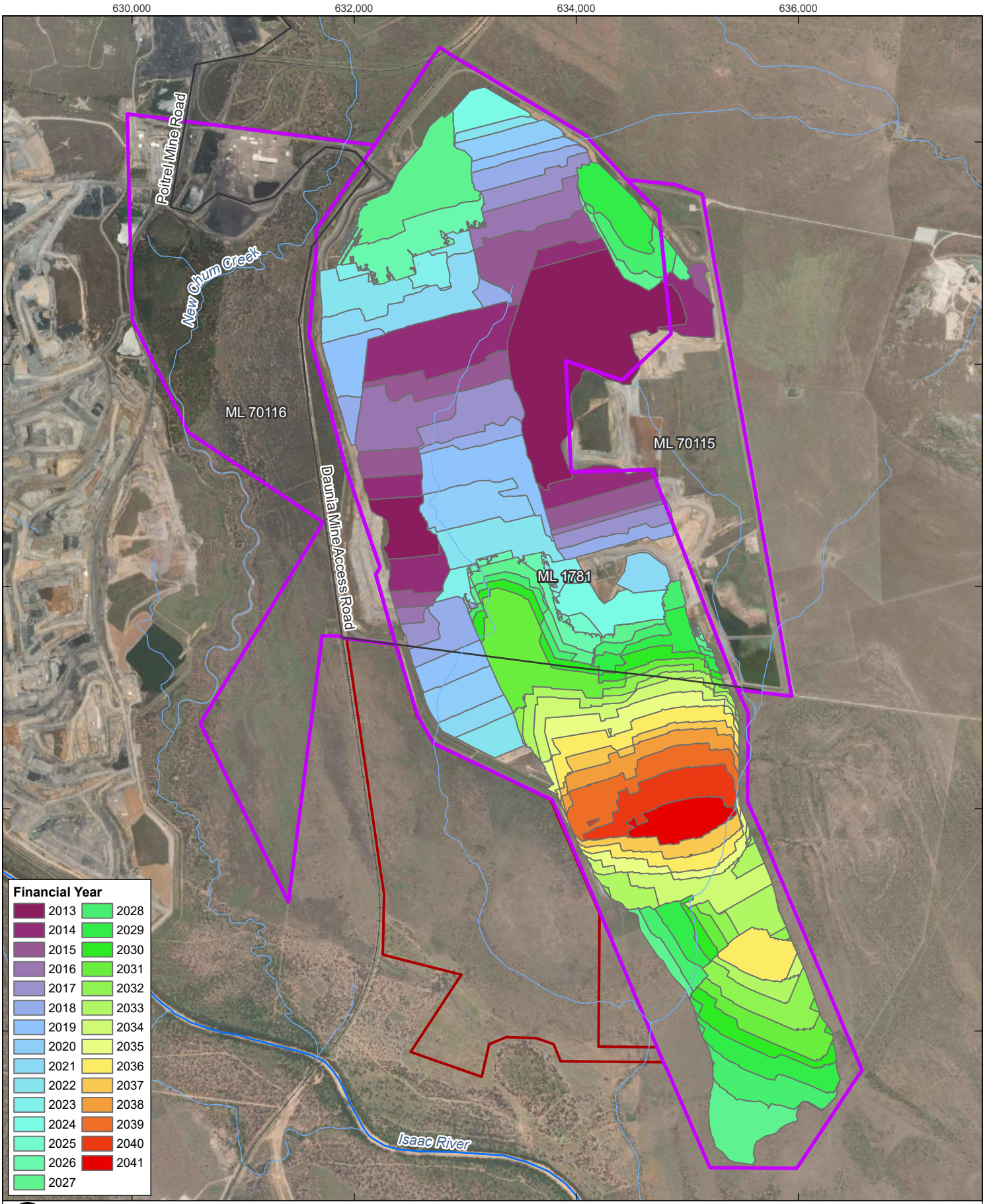
The Daunia coal mine began construction in 2011 and started production in March 2013, with official operations commencing in September 2013. It was developed as part of the Bowen Basin Coal Growth Project and is an open-cut mine focused on producing semi-hard coking coal and pulverised coal injection (PCI) coal for export. The mine was designed with a production capacity of approximately 4.5 million tonnes per annum (Mtpa) of run-of mine (ROM) coal, to a maximum of 5.6 Mtpa ROM.

The mined coal deposits at Daunia are found in the Rangal Coal Measures (RCM), with majority of coal extracted from the Leichhardt seam and Upper Vermont seams.

Mining commenced in the Northern part of the mine, progressing northwest and southeast (**Figure 2-6**).

2.3.2 Current and Future Mining

Current mining pit includes Atlas East, Titan East, Titan Central, Titan North and Titan West. Mining at DNM is expected to continue via the current approved operations until 2041. The current future mine plan, with polygons indicating timing for mine strip extraction is provided on **Figure 2-6.** The northern pits are nearing completion by 2029. Atlas will remain active post 2029 and Pandora is expected to commence operation in 2027 (Refer to **Figure 1-2** for the location of pits).



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:45,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Railway
- Road
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

DAUNIA MINE
MINING PROGRESSION

SLR

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FIGURE 2-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F02-06_Daunia Mine Mining Progression

3.0 Geology

3.1 Regional Geology

DNM is located in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km^2 (Figure 3-1). The Bowen Basin is orientated north-northwest to south-southeast 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 is present to the west (Geoscience Australia, 2017).

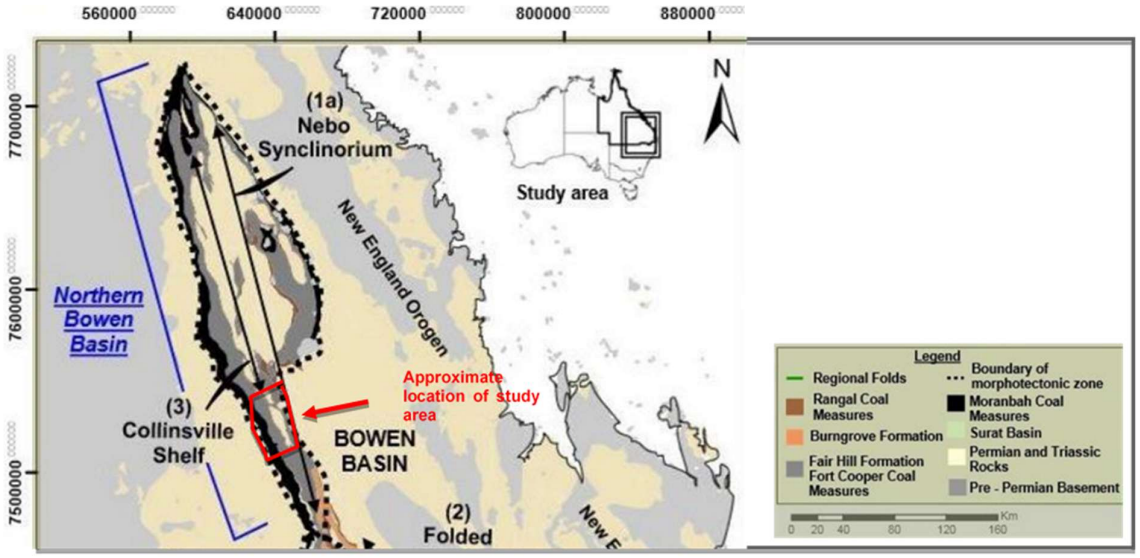


Figure 3-1 Structural Setting of the Bowen Basin (after Dickins and Malone, 1973

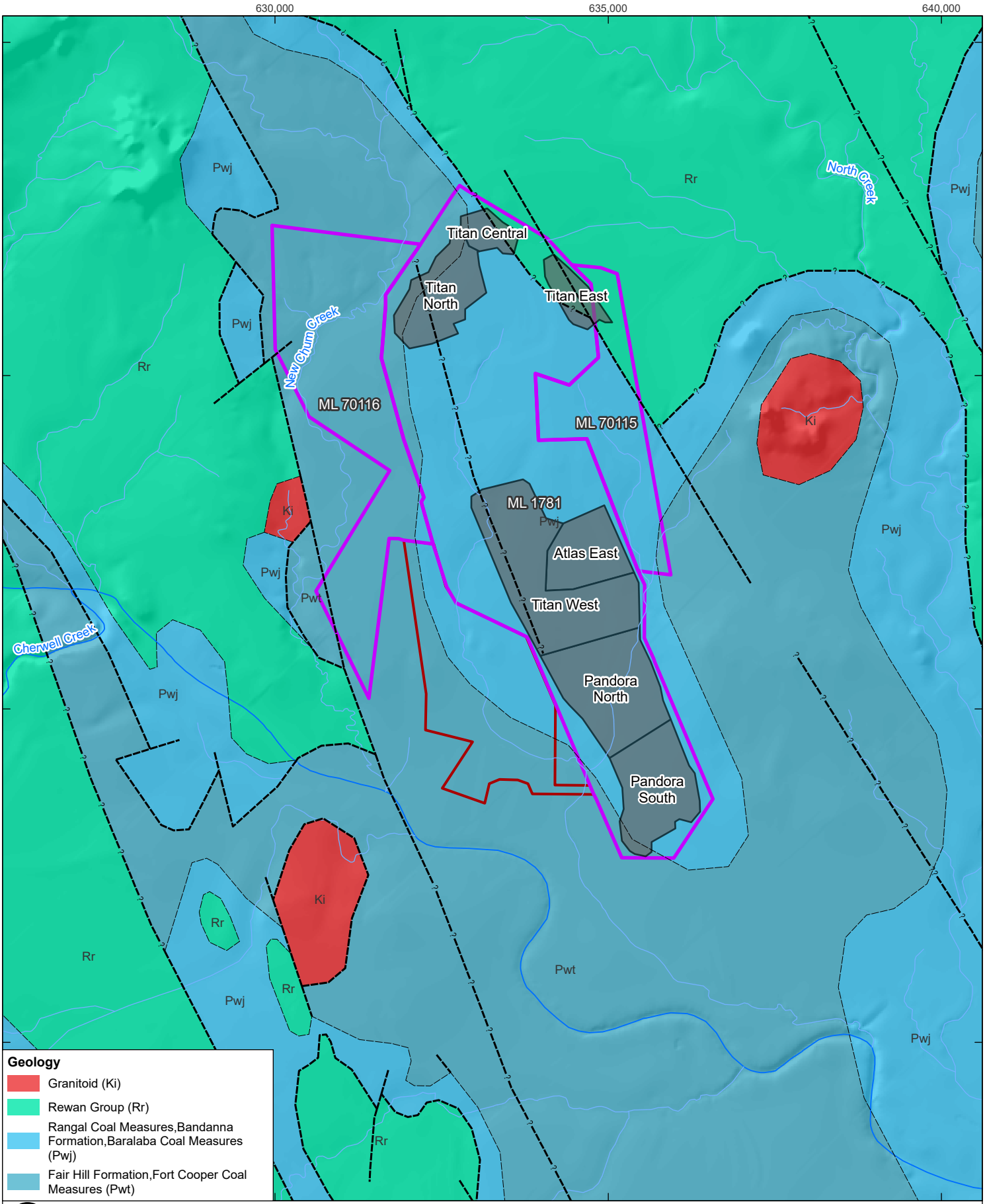
Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which typically comprises fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Moranbah Coal Measures, Fort Cooper Coal Measures (FCCM) and Rangal Coal Measures (RCM). The economic seams at DNM are contained in the Late Permian RCM. The Permian strata outcrop on the eastern and western edges of the Basin and are unconformably overlain by Triassic aged consolidated sedimentary rocks of the Rewan Group.

Where not outcropping, the Permian and Triassic units are covered by a thin veneer of unconsolidated to semi-consolidated Cenozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks. Volcanic intrusions and extrusions are also present within the region.

The generalised regional stratigraphy is summarised in **Table 3-1**. Solid geology based on published geological mapping (1:500k) is presented in **Figure 3-2.** The surface geology is shown in **Figure 3-3**, 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	Max Thickness (m)
Cenozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand, and gravel.	Surficial cover localised along Isaac River and North Creek.	~ 50 m
		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 the Project.	~ 20 m
		Suttor Formation (Tu)		Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, and basalt.	Present to south and east of Study Area.	~100 m
Triassic		Mimosa Group	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	Isolated outcrop to the south-east of the Project.	~100 m
			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 Study Area, and central and northern zones of the Project.	~840
Permian	Late	Blackwater Group	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone, and mudstone.	Within Project Area; isolated Outcrops in the central and northern zones of the Project.	~200
			Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff.	Within Project Area; Outcrops or subcrops in central and northern zones of the Project.	~350
			Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone, and coal.	Within/underlies the Project; Outcrops or subcrops in the west of the Study Area.	~ 400
	Early to Middle	Back Creek Group (Pb)		Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies Project; Outcrops in the west of the Study Area.	~400



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Fault Approximate
- Fault Inferred
- Geological Boundary Approximate
- DNM Mining Lease
- Active/Future Pist
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

SOLID GEOLOGY

SLR

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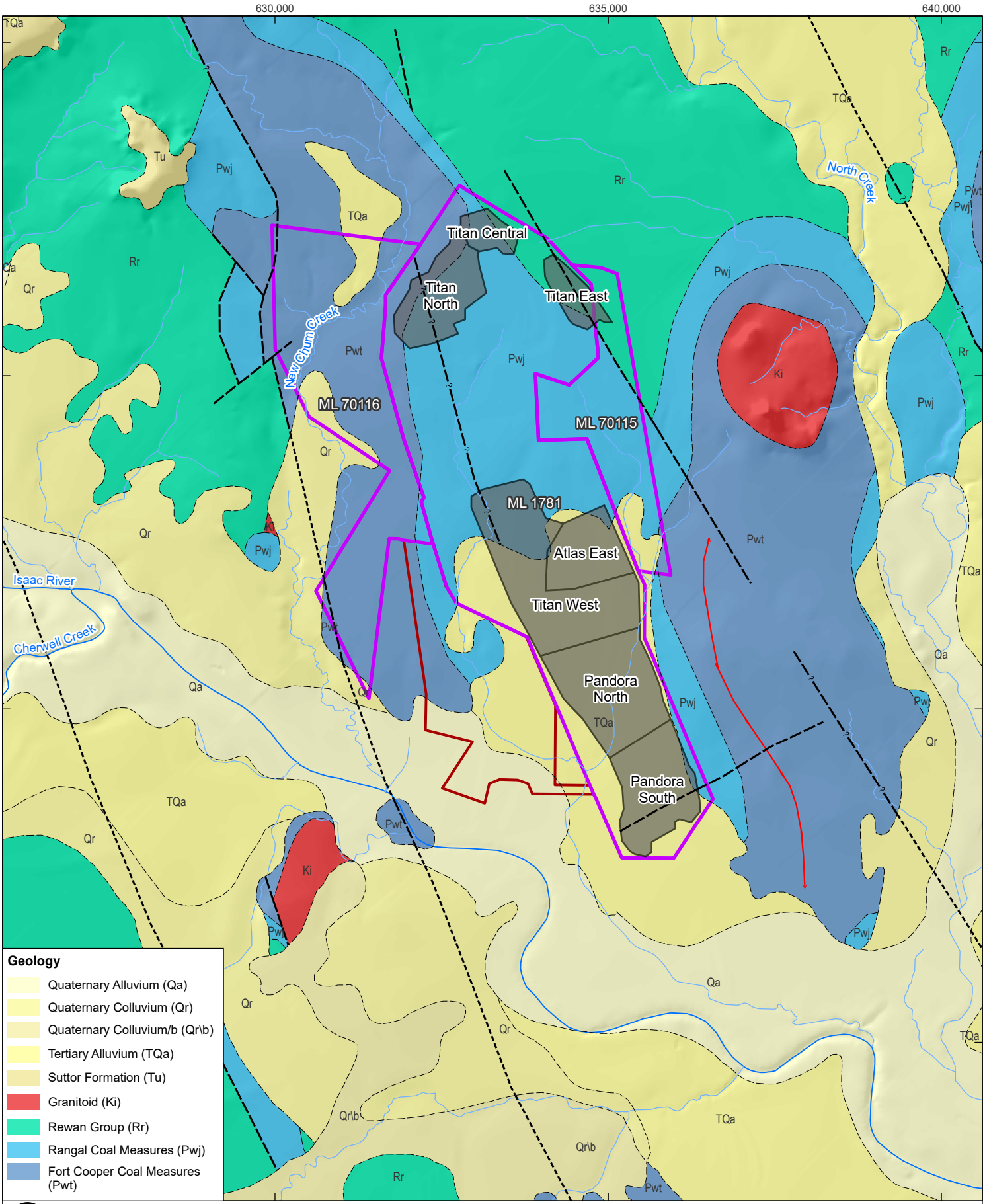
FIGURE 3-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-02_Solid Geology



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Anticline accurate showing double plunge away from culmination
- Fault approximate
- Fault concealed
- Fault inferred
- Geological boundary approximate
- DNM Mining Lease
- Active/Future Pits
- Mining Lease Application Area

DAUNIA MINE TRANSITIONAL PRCP

SURFACE GEOLOGY

SLR

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FIGURE 3-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-03_Surface Geology

3.2 Local Geology

The stratigraphic profile within the DNM comprises three distinct units:

- Cainozoic sediments (alluvium, colluvium) and regolith that includes weathered Permian strata;
- Triassic sedimentary rocks; and
- Permian coal measures.

Each of the main stratigraphic units is discussed in further detail below. The structural geology of the DNM is also discussed in **Section 3.2.4**.

3.2.1 Cainozoic Sediments

3.2.1.1 Isaac River Alluvium

State (Queensland Government) Detailed Surface Geology (SDSG) mapping (**Figure 3-3**) shows that Quaternary alluvium (symbolised as Qa) is localised along the Isaac River, to the west and south of DNM. 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 3-4**.

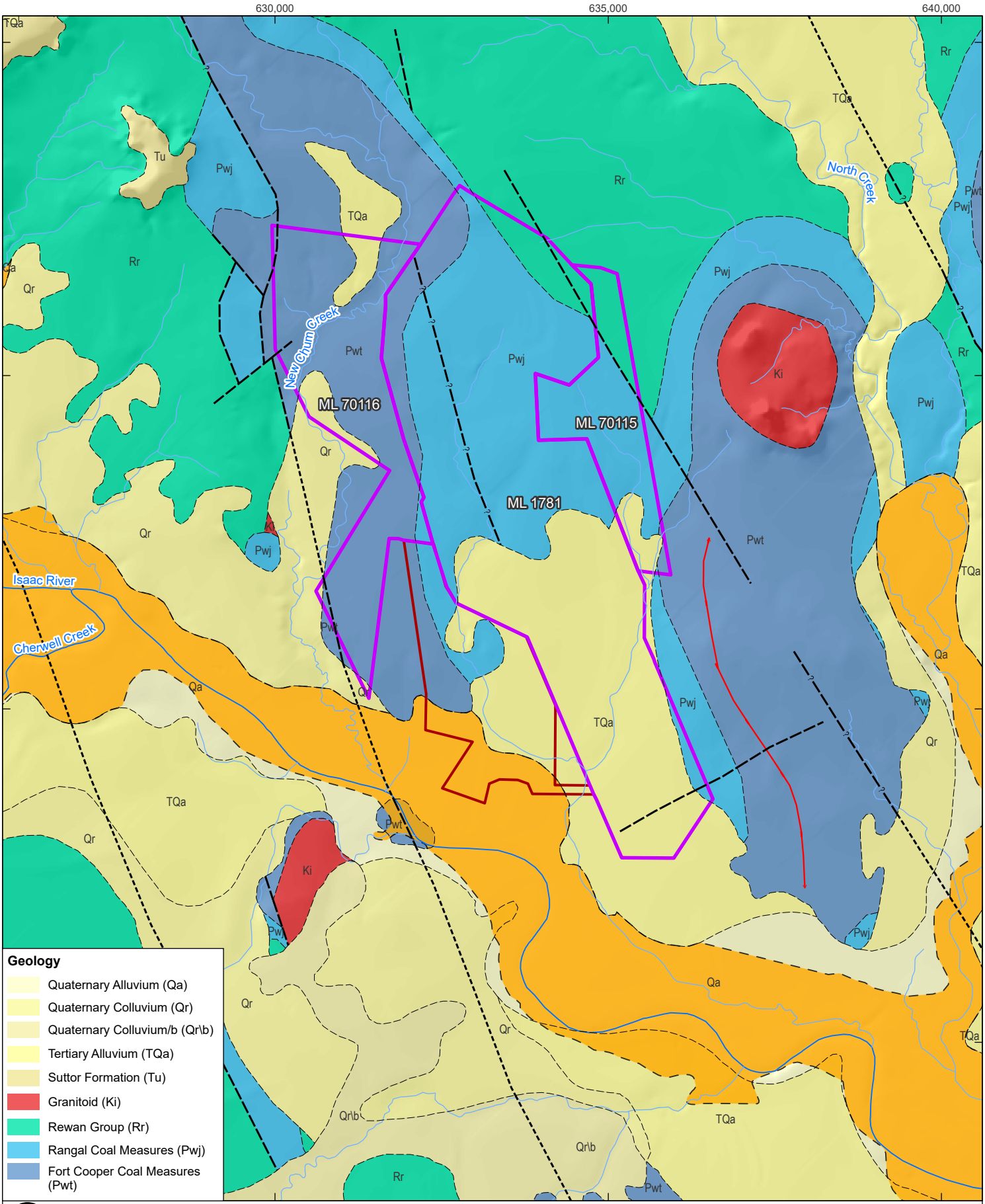
Quaternary alluvium deposits are described as unconsolidated sequences of clay, silt, sand and gravel sediments, which are generally less than 20 m in thickness (AGE, 2013) and are limited to the lower topographic areas outside the southern extent of DNM near to the Isaac River. Advisian (2018) report that the alluvial deposits are thickest in the immediate vicinity of the Isaac River. Analysis of groundwater bore and coal resource exploration drill logs for Poitrel, adjacent and to the west of DNM, indicates that the alluvium thickens on the southern side of the river. The modern river channel is not centred within the alluvial depositional area, but generally towards the southern boundary of mapped alluvium in the immediate vicinity of DNM.

Figure 3-4 indicates that Quaternary alluvium associated with the Isaac River is mapped approximately 500 m to 1 km west of the DNM approved southwestern boundary, and intersect with the south-western boundary of the application ML area. .

The extent and thickness of the alluvial sediments was assessed at the Winchester South Project, located directly to the south of DNM in March 2019. A geophysical survey that entailed AgTEM and DC-ERT transects adjacent to the Isaac River were undertaken to improve understanding of the extent, permeability, and depth of alluvium (SLR, 2020). Detailed subcrop geology information was also identified as part of the survey. The results from the survey are summarised as follows:

- The Permian rock weathering horizon is high in groundwater salinity, resulting in high electrical conductivity signature in the geophysical surveys. This weathering horizon is absent within the alluvium. The absence of the highly conductive weathering horizon allows for clear identification of alluvial extents within the geophysical data;
- A shallow 8 to 10 m embayment of flat layered alluvium covers coal measures to the east of the survey extent (within the DNM mining leases). This alluvium has been mapped in previous reports (Douglas Partners, 2012) as a Cainozoic Sand Plain with somewhat different extents; and
- The Isaac River alluvium is limited in extent away from the modern river channel.

The drillhole log for Winchester South drillhole WSN206, located within the mapped alluvial extents south of the DNM boundary, shows sand present, occurring from the surface down to a depth of 22 m, where it overlies siltstone (SLR, 2020).



Geology

- Quaternary Alluvium (Qa)
- Quaternary Colluvium (Qr)
- Quaternary Colluvium/b (Qr\b)
- Tertiary Alluvium (TQa)
- Suttor Formation (Tu)
- Granitoid (Ki)
- Rewan Group (Rr)
- Rangal Coal Measures (Pwj)
- Fort Cooper Coal Measures (Pwt)

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:75,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Anticline accurate showing double plunge away from culmination
- Fault approximate
- Fault concealed
- Fault inferred
- Geological boundary approximate
- Revised Alluvium Extent (SLR 2020)
- DNM Mining Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

ISAAC RIVER
ALLUVIUM EXTENT

SLR

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FIGURE 3-4

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-04_Isaac River Alluvium Extent

3.2.1.2 Quaternary and Tertiary Sediments (Regolith)

The surficial material covering much of the Study Area comprises unconsolidated to partially consolidated sediments, including Tertiary-Quaternary deposits (TQa), and Quaternary colluvium and residual deposits (Qr and Qr\b) derived from weathering of the underlying Permian strata; i.e. non-alluvial Quaternary sediments. Within DNM, Permian units are, on average, highly weathered to a depth of 25 meters below ground level (mbgl) and the Tertiary to Quaternary aged deposits are on average weathered to 25 mbgl. In many recent previous groundwater studies (e.g. HydroSimulations 2018, SLR 2019, 2020 & 2021b) these residual Quaternary sediments outside of the defined Isaac River Alluvium (Qa) are grouped with the Tertiary units and termed “regolith”, since in a hydrogeological sense they essentially function as a single unit.

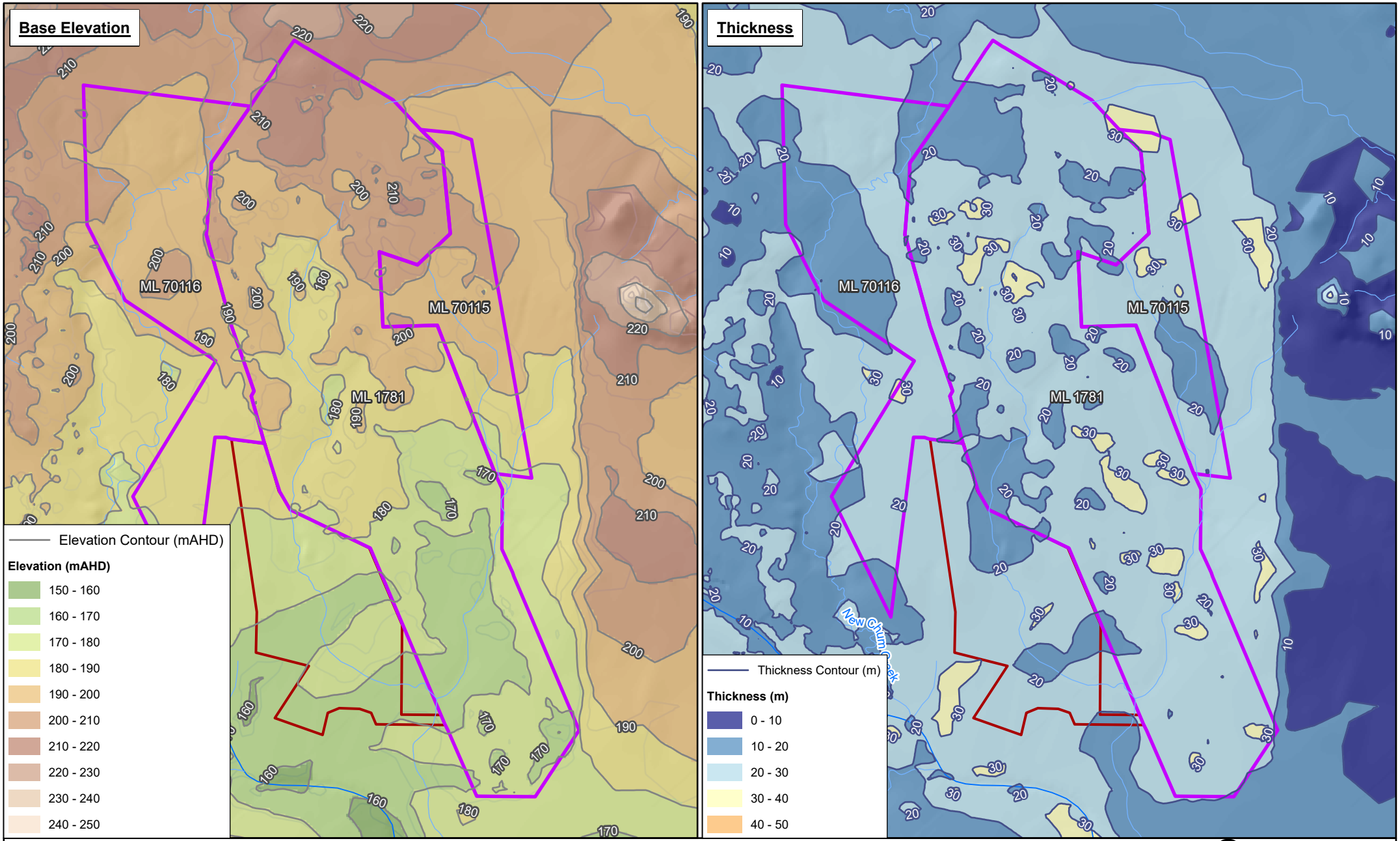
Regional mapping shows Tertiary-Quaternary alluvium (TQa) deposits distributed in the southern areas of DNM only (**Figure 3-4**). TQa is defined in the SDSG mapping metadata as a poorly consolidated or unconsolidated alluvial deposit in an ancestral valley, which has been dissected by more recent channel activity. SDSG mapping shows that the TQa deposits are located along the courses of the unnamed tributaries that drain into the Isaac River to the south of DNM. Mapping shows that the TQa deposits in the vicinity of DNM do not extent beyond the eastern DNM boundary and are therefore absent in the area between DNM and the North Creek alluvium (**Figure 3-3**), i.e. the deposits are not continuous between the DNM and North Creek to the east. The Tertiary material on the western DNM boundary is approximately 8 m thick, directly overlying the weathered top of the Permian strata. The southern portion of DNM is underlain by Tertiary sediments comprising unconsolidated clay, silt, sand and gravel and are generally less than 20 m thick.

The inferred extent and thickness of the regolith material is presented in (**Figure 3-5**), interpolated based on DNM site geological data and the CSIRO Soil and Landscape Grid of Australia (CSIRO, 2015) data.

3.2.2 Triassic Strata

The Triassic aged consolidated sedimentary rocks include the Rewan Group (Rr), 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.

Regionally the Rewan Group unconformably overlies the Permian coal measures. The unit is largely absent where the Permian coal measures occur at outcrop, and where present thickens towards the Isaac River. The Rewan Group is generally absent in the DNM, only subcropping on the northeastern boundary of the DNM mining lease (**Figure 3-3**).



Service Layer Credits:
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS

Major Watercourse
Minor Watercourse
DNM Mining Lease
Mining Lease Application Area

SLR

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BASE OF WEATHERING ELEVATION AND COMBINED THICKNESS OF QUATERNARY-TERTIARY DEPOSITS AND REGOLITH

FIGURE 3-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-05_Base of Weathering Elevation and Combined Thickness

3.2.3 Permian Coal Measures (Blackwater Group)

Permian coal-bearing sedimentary rocks of the Blackwater Group form the primary economic resource of the numerous mines in the Study Area. In decreasing depth order (shallow to deeper), the major coal measures in the Study Area include (in order of increasing age):

- Rangal Coal Measures (Pwj);
- Fort Cooper Coal Measures (Pwt); and
- Moranbah Coal Measures (Pwb).

The following sub-sections provide further discussion of each unit.

3.2.3.1 Rangal Coal Measures

Coal resources at DNM are contained within the ~100 m thick Rangal Coal Measures (Pwj), which is underlain by the Fort Cooper Coal Measures and overlain, in places, by the Rewan Group (SLR, 2019). The Late Permian Rangal Coal Measures comprise light grey, cross-bedded, fine to medium grained labile and well cemented sandstones, grey siltstones, mudstones, shale and coal seams. The non-coal portions of the sequence being predominantly sandstones, siltstones, mudstone and shales are referred to as interburden in the mining context.

The Leichhardt and Upper Vermont Seams occur within the Rangal Coal Measures and are the target seams for mining at DNM. The Leichhardt Seam (DL1) is typically 5 m thick and the Upper Vermont Seam (DV4) typically 3.5 m thick at DNM. The Leichhardt and Upper Vermont Seams are separated by approximately 10 m to 35 m of siltstone and sandstone interburden (BMA, 2008) (**Figure 3-6**). The Leichhardt Seam is highly weathered where it occurs at subcrop near the surface in the DNM. In the north of DNM, the Upper Vermont Seam splits into upper and lower plies (DV2 and DV1 respectively, **Figure 3-6**).

Interpolated structure and thickness contours of the Leichhardt Seam and combined Vermont Seams at DNM are presented in **Figure 3-7** and **Figure 3-8** respectively. These contours have been based on the DNM geological model and drill hole data.

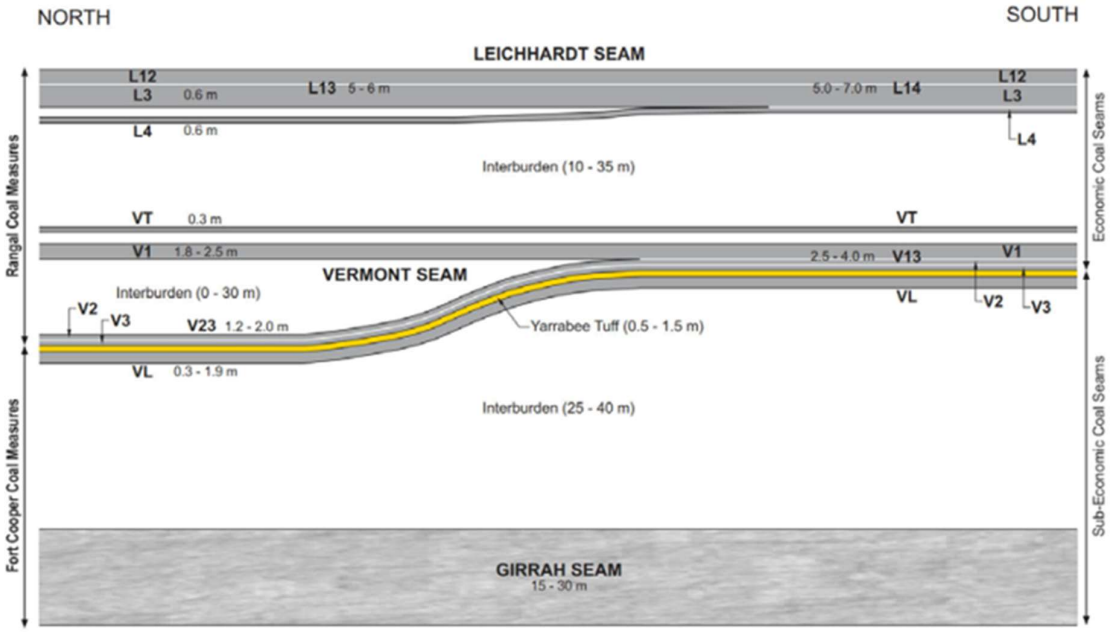


Figure 3-6 Schematic Correlation of Coal Seams at Daunia Mine (BHP, 2019)

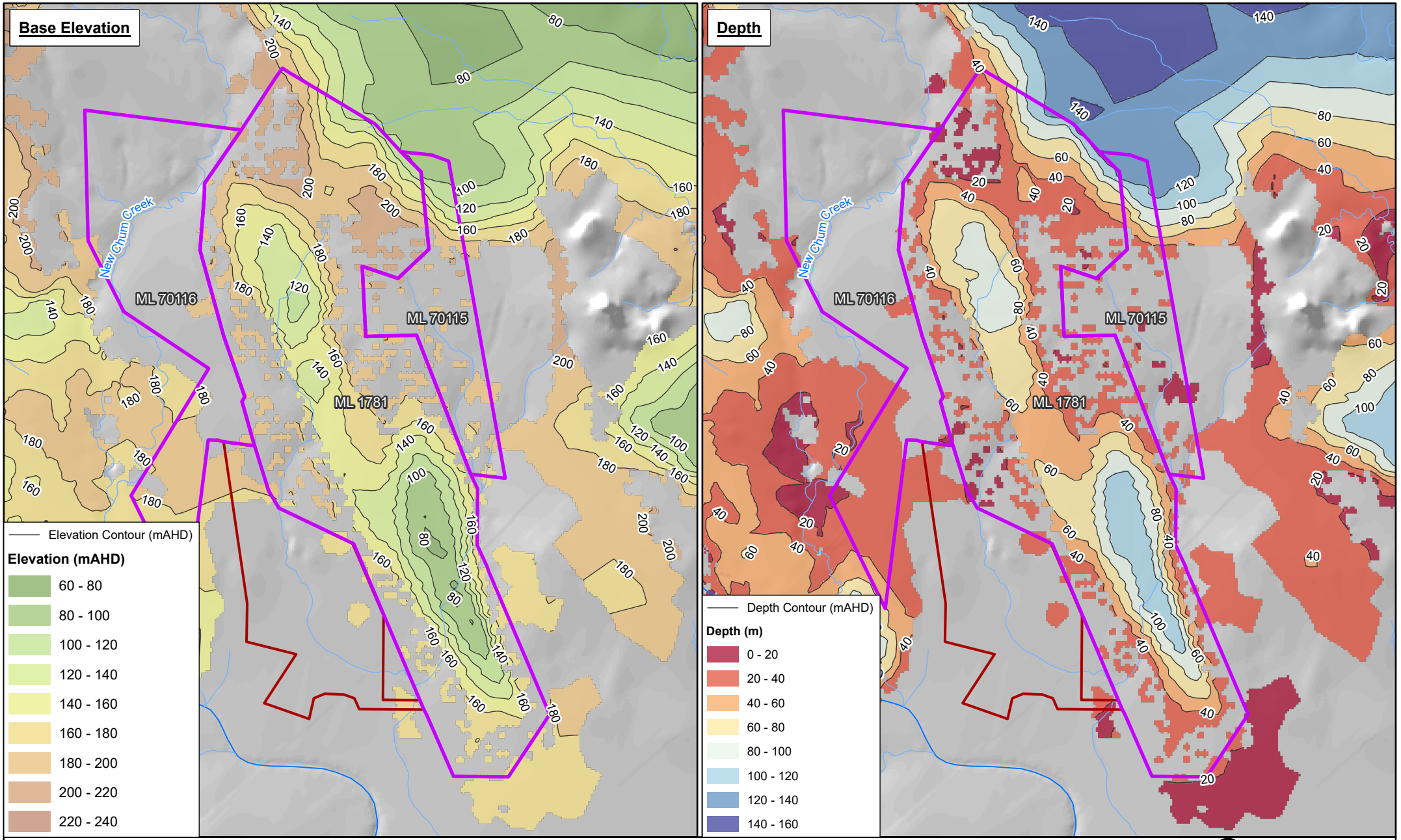
3.2.3.2 Fort Cooper Coal Measures

The Fort Cooper Coal Measures (Pwt) underlie the Rangal Coal Measures at DNM and are only present at subcrop along the northwestern boundary of DNM. The transition between the Rangal Coal Measures and the Fort Cooper Coal Measures is marked by the Yarrabee Tuff, which immediately overlies the Lower Vermont Seam (**Figure 3-6**). The Yarrabee Tuff is a basin-wide marker bed comprised of weak, brown tuffaceous claystone, with an average thickness of 0.7 m (ranging from 0.5 to 1.5 m thick at DNM). Note that in a hydrogeological sense, the Lower Vermont Seam of the Fort Cooper Coal Measures is considered collectively as a single hydrostratigraphic unit with the Upper Vermont Seam of the Rangal Coal Measures given they are only separated by the thin Yarrabee Tuff.

Regionally, the Fort Cooper Coal Measures have a maximum thickness of approximately 350 m (HydroSimulations, 2018) and drill logs indicate the Fort Cooper Coal Measures comprise lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff and tuffaceous (cherty) mudstone. Coal seams above 1 m thickness within the Fort Cooper Coal Measures are the Lower Vermont Seam and the Girrah Seam.

3.2.3.3 Moranbah Coal Measures

The Moranbah Coal Measures (Pwb) are the lowermost coal-bearing sequence of the Blackwater Group. They subcrop on the western limb of the Bowen Basin, and are mined at Caval Ridge mine (CVM), Peak Downs mine (PDM) and Saraji mine (SRM) located to the far west of DNM. The Moranbah Coal Measures comprise volcanic lithic sandstones, with lesser siltstone, mudstone, conglomerate and coal. Their depth of burial in relation to DNM mining activities means the Moranbah Coal Measures are not relevant to this groundwater assessment.



Scale: 1:70,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 19-Feb-2026
Project Number: 640.031614

Service Layer Credits:
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS

Major Watercourse
Minor Watercourse
DNM Mining Lease
Mining Lease Application Area

SLR

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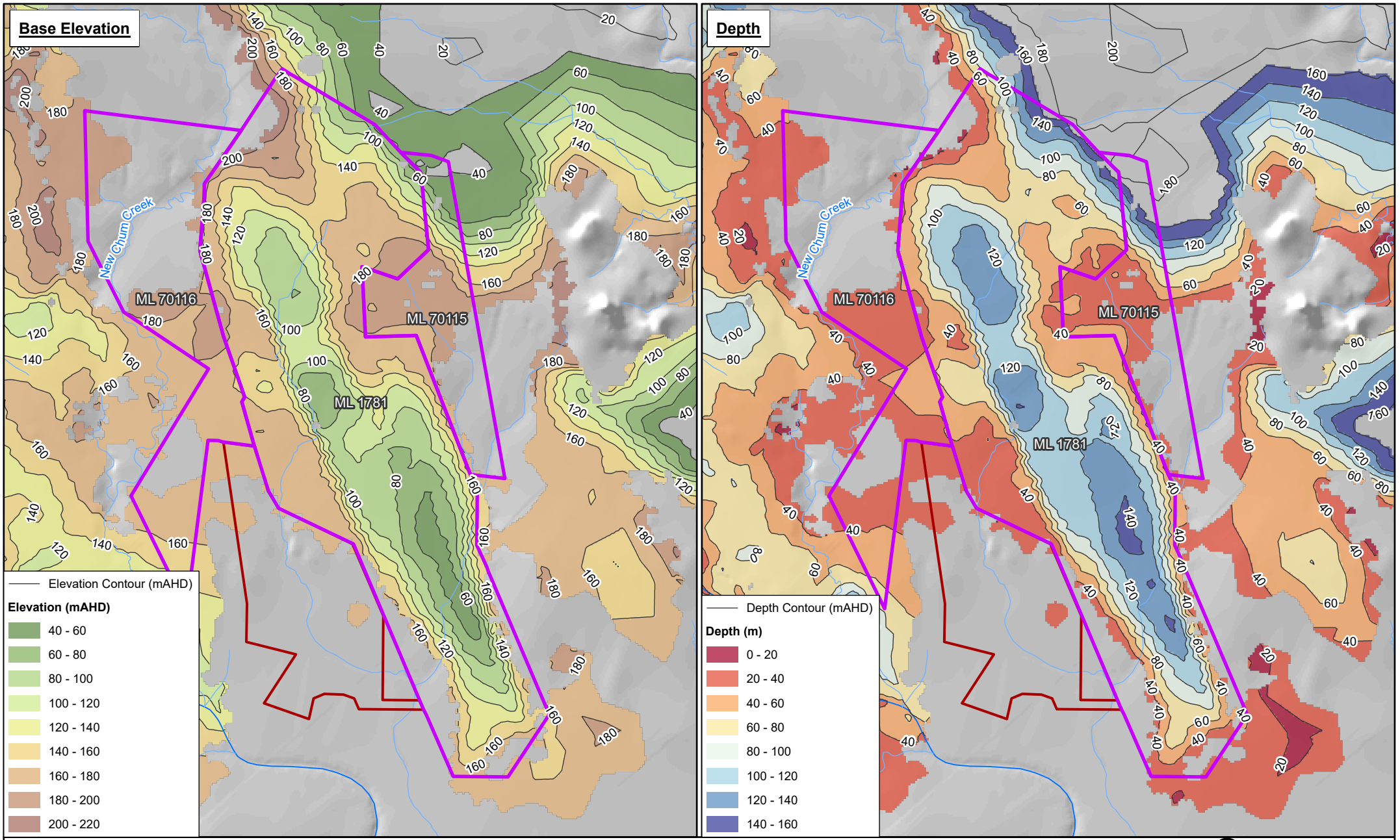
BASE ELEVATION AND DEPTH TO LEICHHARDT SEAM

FIGURE 3-7

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-07_Base Elevations and Depth Leichhardt Seam



Scale: 1:70,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 19-Feb-2026
Project Number: 640.031614

Service Layer Credits:
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS

Major Watercourse
Minor Watercourse
DNM Mining Lease
Mining Lease Application Area

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BASE ELEVATION AND DEPTH TO VERMONT SEAM

FIGURE 3-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F03-08_Base Elevations and Depth Vermont Seam

3.2.4 Structural Geology

The Bowen Basin was subject to significant tectonic compression from the eastern side at the end of coal deposition in the late Triassic. The compression from the eastern side caused major thrust faulting, which resulted in the commercial viability of mining the coal deposits across the region. DNM is located within the regional Western Foreland structural domain of the Bowen Basin, located approximately 20km west of the Jellinbah Fault Zone. Fault throws up to and exceeding 100 m are associated with these regional scale structural features.

The Permian coal measures at DNM have been subject to significant regional deformation, including folding and faulting. DNM is affected by numerous normal and reverse faults (BHP, 2019), with some major northwest-southeast trending faults (i.e. New Chum Fault and Eastern Fault Alignment), and minor southwest-northeast trending faults (SLR, 2017). These major faults repeatedly truncate the lateral east-west extent of the Permian units to both the west and east of DNM, and faulting results in the Fort Cooper / Rangal / Rewan sequence repeating at surface (or subsurface), from west to east. Two main sets of faults at DNM are summarised as (BHP, 2019):

- NNW-striking faults which are traced up to 3.3 km, but majority are in the order of 1-2 km with throws of up to 30 m. These thrusts are part of the broader Jellinbah Thrust System; and
- E-W striking faults with throws in the order 2-5 m and 100-200 m long.

Normal faults at DNM have developed in three orientations (BHP, 2019):

- NNW-striking normal faults that are parallel to thrust systems. These faults are up to 3.6 km long and form overlaps or step zones with each other;
- NE-striking faults with throws up to 30 m and display both strike-slip and dip-slip senses of movement. They may be traced up to 1.35 km in length; and
- E-W minor faults that have throws from 1 to 5 m.

Igneous intrusions have also been mapped within the region, with a large granite intrusion located approximately 1.7 km east of the northern DNM (refer **Figure 3-2**). Drilling in the DNM area has also found that igneous intrusions are present at the southern end of ML 1781 that are not identified in Queensland Government geological mapping.

4.0 Hydrogeology

Based on the understanding of the geological setting presented in **Section 2.3**, the hydrogeological regime relevant to DNM comprises the following key hydrogeological units:

Cainozoic sediments:

- Quaternary alluvium – unconfined aquifer (water-bearing strata of permeable rock, sand, or gravel) localised along Isaac River;
- Quaternary to Tertiary colluvium and weathered units (regolith) – unconfined and largely unsaturated unit bordering alluvium; and
- Triassic Rewan Group – aquitard overlying Permian coal measures in places across DNM and more generally in areas north and west of DNM.

Permian coal measures with:

- Low permeability interburden units with aquitard properties; and
- Coal seams that exhibit water bearing properties primarily associated with secondary porosity via cracks and fissures.

An Early Cretaceous-aged granitoid igneous body occurs approximately 1.7 km east of the northern DNM Area. The rock is solid in nature with a very fine groundmass and unlikely to have significant primary porosity that would facilitate storage and transmission of groundwater, and therefore the body is likely to have aquitard properties.

The coal seams within the RCM can be characterised as confined fractured rock aquifers, with the Leichhardt Seam and combined Vermont Seams being the predominant aquifer units within the Project Area. The overburden above the Leichhardt Seam, including the Triassic-aged Rewan Group where present, generally acts as an aquitard.

Significant structural faulting associated with the Jellinbah Thrust System occurs at DNM and within the surrounding area and has a consequential influence on the regional groundwater system. Field investigations into the hydraulic parameters of the closest major fault southwest of DNM were undertaken in 2019 as part of the Winchester South Project EIS (SLR, 2020). The investigations found that the major structural features are effectively barriers to groundwater flow perpendicular to the faults. The major faults that repeatedly truncate the lateral east-west extent of the Permian units to both the west and east of DNM result in hydrogeological compartmentalisation of the Permian groundwater system.

4.1 DNM Groundwater Monitoring

The current and historic groundwater monitoring network at DNM comprises a total of 35 monitoring bores (13 active, 22 inactive or decommissioned).

The DNM monitoring network was first established in 2009 following the submission of the DNM EIS in 2008 (BMA, 2008). Groundwater level monitoring and water quality sampling is currently undertaken on a quarterly basis at 13 monitoring bores:

- RCM coal seams – 4 bores; 3 in the Vermont seam and 1 in the Leichhardt seam;
- RCM interburden – 5 bores including 1 landholder bore (BMB);
- FCCM coal seams – 1 bore;
- FCCM interburden – 2 bores; and
- Tertiary sediments – 1 bore.

Details of the current and historic monitoring bores at DNM are presented in in **Table 4-1** and bore locations are shown in **Figure 4-1**.

Fifteen monitoring bores (MB01 to MB18) were installed in 2012 as part of hydrogeological studies undertaken to support future mining in the south of the DNM. These bores were monitored for groundwater levels only between September 2012 and August 2013 (AGE, 2013) to support the early development of the mine but were not adopted into the long term monitoring bore network.

4.1.1 Other Projects

Groundwater monitoring data from two bores (OBS2, OBS8) located to the west of DNM on the eastern margin of the Poitrel mine monitoring bore network have been included in the numerical model calibration dataset for DNM which sits within a large regional groundwater model incorporating surrounding mines. Monitoring data from mines across the whole model domain including those neighbouring DNM (Poitrel, Winchester South, Olive Downs, and Moorvale South), are included in the regional model calibration (**Section 7.2**).

Table 4-1 DNM Groundwater Monitoring Network Details

Bore ID	Easting (GDA94)	Northing (GDA94)	Ground Elevation (m AHD)	Screen Elevation (m AHD)	Monitored Unit	Installed	Status	WQ Data	Available WL Data
PZ01	632534	7561905	230.8	164.8 - 158.8	FCCM Overburden	2009	Mined out		May ’09 – Aug ‘13
PZ02	635300	7560237	229.8	154.8 - 148.8	RCM Interburden	2009	EA Compliance	Yes	May ’09 – Feb ‘25
PZ03	632332	7558326	214.9	142.9 - 136.9	RCM Vermont Underburden	2009	Mined out		May ’09 – Aug ‘13
PZ04	635531	7554554	193.2	112.2 - 103.2	RCM Leichhardt Overburden	2009	EA Compliance	Yes	May ’09 – Feb ‘25
PZ05	632576	7561914	231.3	201.1 - 183.1	RCM Vermont Underburden	2016	EA Compliance	Yes	Apr ’16 – Feb ‘25
PZ06	631776	7561217	220.7	186.2 - 165.2	RCM Vermont Coal Seams	2016	EA Compliance	Yes	Apr ’16 – Feb ‘25
PZ07	631627	7559539	219.4	120.4 - 114.4	FCCM combined coal seams	2017	EA Compliance	Yes	Feb ’18 – Feb ‘25
PZ08	635192	7560075	229.7	150.7 - 144.7	RCM Vermont Seams	2017	Active	Yes	May ’19 – Feb ‘25
BMB	639477	7560278	202.9	172.9 - 152.9	RCM Interburden	2013	Interpretation	Yes	Dec ’13 – Feb ‘25
MB19DNM01P	635935	7553725	198.5	138.0 - 132.0	RCM Leichhardt Seams	2019	Active	Yes	Aug ‘23 to Nov ‘24
MB19DNM02P	635924	7553718	198.5	104.0 - 98.0	RCM Vermont Seams	2019	Active	Yes	Aug ‘23 to Nov ‘24
MB20DNM01P_R01	635874	7558005	208.6	151.0 - 145.0	FCCM	2020	Active	Yes	Aug ‘23 to Feb ‘25

Bore ID	Easting (GDA94)	Northing (GDA94)	Ground Elevation (m AHD)	Screen Elevation (m AHD)	Monitored Unit	Installed	Status	WQ Data	Available WL Data
MB01P_HY_R01	634584	7553827	188.9	168.9 - 164.9	FCCM Overburden	2020	Active	Yes	May ‘20 to Nov ‘24
MB02P	635301	7552706	196.0	164.0 - 160.0	RCM Vermont Underburden	2020	Active	Yes	May ‘20 to Nov ‘24
DNMMB08_01	635440	7558348	208.8	190.0 - 184.0	Tertiary	2020	Active	Yes	Aug ‘23 to Feb ‘25
DNMMB02_01	635659	7561135	218.0	179.5 - 173.5	Tertiary Sandstone	2021			No data
DNMMB06_01	633903	7555902	200.3	115.3 - 109.3	Vermont Coal Seams	2020			No data
MB20DNM05A_WB_R01	634589	7553840	189.0	184.0 - 181.0	Alluvium	2020			No data
MB20DNM06P_R_HY	633915	7555904	200.0	146.7 - 140.7	Leichhardt Coal Seams	2020			No data
MB02A	635295	7552703	196.1	191.1 - 188.1	Tertiary Sediments	2020			No data
MB01	633972	7561393	239.5	155.5 - 143.5	Vermont Coal Seams	2012			Sep 2012 to Aug / Mar 2013
MB03	633658	7559559	222.9	145.9 - 126.9	FCCM Coal Seams	2012			
MB04	633383	7558513	212.8	126.8 - 122.8	Vermont Coal Seams	2012			
MB05	633427	7558628	215.1	111.1 - 105.1	Vermont and interburden	2012			
MB06	633550	7558561	214.6	170.6 - 167.6	Vermont Coal Seams	2012			

Bore ID	Easting (GDA94)	Northing (GDA94)	Ground Elevation (m AHD)	Screen Elevation (m AHD)	Monitored Unit	Installed	Status	WQ Data	Available WL Data
MB07	632641	7558617	209.1	114.1 - 105.1	Vermont Coal Seams	2012			
MB08	632681	7558448	209.1	126.1 - 111.1	Vermont Coal Seams	2012			
MB09R	632719	7558551	209.7	125.7 - 122.7	Vermont Coal Seams	2012			
MB10	632362	7558414	210.8	145.8 - 141.8	Vermont Coal Seams	2012			
MB11	635024	7555479	193.6	84.6 - 53.6	Leichhardt and Vermont Coal Seams	2012			
MB12	635146	7555426	193.9	80.9 - 54.9	Leichhardt and Vermont Coal Seams	2012			
MB13	635113	7555295	193.5	104.5 - 68.5	Leichhardt Coal Seams	2012			
MB14	634968	7555335	193.2	83.7 - 53.2	Leichhardt and Vermont Coal Seams	2012			
MB17	634270	7559650	224.4	135.4 - 116.4	FCCM Coal Seams	2012			
MB18	635259	7553028	198.4	91.4 - 85.4	Leichhardt and Vermont Coal Seams	2012			
OBS8 (Poitrel Mine)	631867	7553655	192.4	183.5 - 180.5	Isaac River Alluvium	2015	A&D*		Dry
OBS2 (Poitrel Mine)	631341	7557693	217.7	175.7 - 169.7	FCCM Overburden	2007	Existing		Aug ’18 – Feb ‘20

*A&D – Abandoned and Destroyed
Empty cells indicate no information currently available

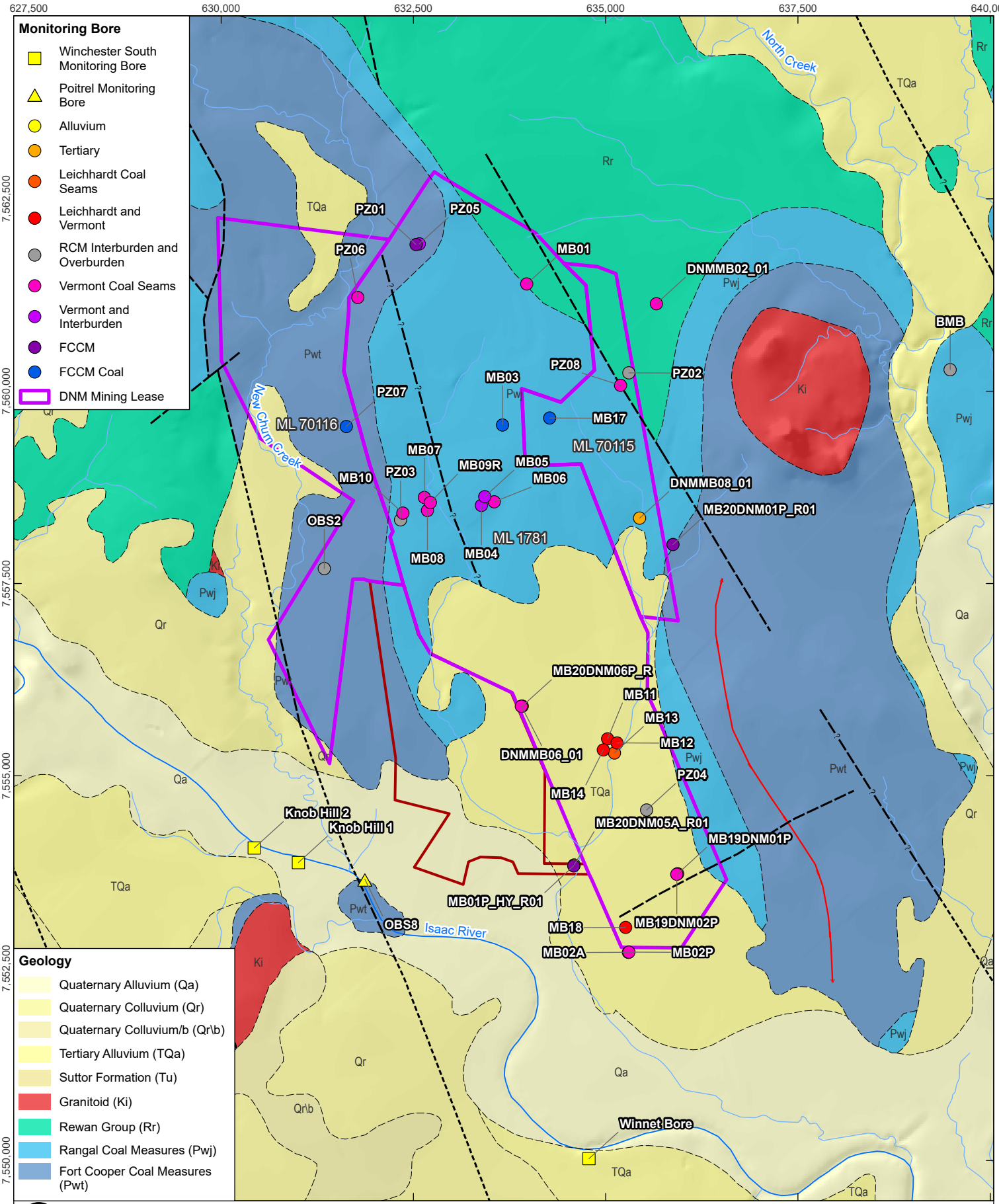
627,500
630,000
632,500
635,000
637,500
640,000
7,562,500
7,560,000
7,557,500
7,555,000
7,552,500
7,550,000
Monitoring Bore
Winchester South Monitoring Bore
Poitrel Monitoring Bore
Alluvium
Tertiary
Leichhardt Coal Seams
Leichhardt and Vermont
RCM Interburden and Overburden
Vermont Coal Seams
Vermont and Interburden
FCCM
FCCM Coal
DNM Mining Lease
PZ01
PZ05
PZ06
MB01
DNMMB02_01
BMB
PZ08
PZ02
MB03
PZ07
MB17
ML 70116
ML 70115
MB07
MB09R
MB05
MB10
PZ03
MB06
DNMMB08_01
MB20DNM01P_R01
OBS2
ML 1781
MB08
MB04
MB20DNM06P_R
MB11
MB13
MB12
DNMMB06_01
PZ04
MB14
Knob Hill 2
Knob Hill 1
MB20DNM05A_R01
MB19DNM01P
MB01P_HY_R01
OBS8
Isaac River
MB18
MB19DNM02P
MB02A
MB02P
Winnet Bore
North Creek
New Chum Creek
Geology
Quaternary Alluvium (Qa)
Quaternary Colluvium (Qr)
Quaternary Colluvium/b (Qr\b)
Tertiary Alluvium (TQa)
Suttor Formation (Tu)
Granitoid (Ki)
Rewan Group (Rr)
Rangal Coal Measures (Pwj)
Fort Cooper Coal Measures (Pwt)
0
1
2
km
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:65,000 at A4
Project Number: 640.031614
Date Drawn: 19-Feb-2026
Drawn by: RB
LEGEND
Anticline accurate showing double plunge away from culmination
Fault approximate
Fault concealed
Fault inferred
Geological boundary approximate
Major Watercourse
Minor Watercourse
DNM Mining Lease
Mining Lease Application Area
DAUNIA MINE
TRANSITIONAL PRCP
GROUNDWATER MONITORING NETWORK
SLR
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FIGURE 4-1
Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F04-01_Groundwater Monitoring Network

4.2 Hydraulic Properties

DNM hydraulic testing of strata includes slug (rising and falling head) tests performed on DNM monitoring network bores completed in 2008 (BMA, 2008), in 2012 (AGE, 2013) and in 2021 (BHP, 2021). In addition, an extensive database of hydraulic testing data for the wider region is also available from neighbouring mine sites through WHC's regional data sharing agreement.

4.2.1 Hydraulic Conductivity Data

The database of available field results for horizontal (Kh) and vertical (Kv) hydraulic conductivity for Bowen Basin strata in the vicinity of DNM is presented graphically in **Figure 4-2**. The data are also displayed according to the type of permeability test due to the effect of test scale on the permeability value derived. Typically, the hydraulic conductivity value derived from a test increases with the scale of the test due to a larger representative volume of the aquifer being tested, including larger scale heterogeneities such as joints, fractures, solution features etc. A laboratory permeability test on a small uniform in-tact core sample will yield a lower hydraulic conductivity value than a pumping test in the same formation which stresses a much larger volume of the same formation.

Figure 4-2 shows that the hydraulic conductivity of the alluvium is variable across the available dataset, ranging from 10^{-2} to almost 10^{1} metres per day (m/day), reflecting the heterogeneous nature of the alluvial sediments. Hydraulic testing of the alluvium within the area of DNM found hydraulic conductivity to be at the lower end of this scale, with values ranging from 0.09 m/day to 1.25 m/day. Pumping tests in the Isaac River alluvium conducted in 2019 as part of the Moorvale South Project assessment (SLR, 2019) reported hydraulic conductivity values in the range of 2.1 – 2.7 m/day for the alluvium.

The Permian coal seams generally record higher hydraulic conductivity than the majority of the tests in interburden/overburden which supports the concept that the coal seams are the dominant horizons for groundwater movement within the coal measures. This is due to the higher dual porosity of the coal seams, with a primary matrix porosity and a second (dominant) porosity provided by fractures (joints and cleats).

Slug tests were performed on DNM monitoring bores in 2013 (AGE, 2013) and 2020 (BHP, 2021) targeting the RCM coal seams. The testing reported the following horizontal hydraulic conductivities (Kh) ranges:

- 1.92 – 2.05 m/day for the Leichhardt Seam (only one bore tested);
- 0.00076 – 0.25 m/day for the combined Vermont Seams;
- 0.0011 – 0.45 m/day where bores are screened across the Leichhardt Seam, Vermont Seams and interburden between seams; and
- 0.002 – 0.035 m/day for non-coal Permian units (interburden).

Interburden/overburden testing shows a hydraulic conductivity of at least an order of magnitude less than that of coal seams at similar depths, typically less than 10^{-4} m/day. **Figure 4-2** also shows that the hydraulic conductivity of the Permian coal measures generally declines with depth, due to increasing overburden pressure reducing the aperture of secondary porosity features.

Within the RCM hydraulic conductivity values for the Leichhardt Seam are generally an order of magnitude greater than those obtained for the Vermont Seams. It should also be noted that the slug tests undertaken at DNM will yield well scale hydraulic conductivity estimates, whereas the regional dataset (**Figure 4-2**) includes estimates derived from pumping tests that are more representative of the coal seams at a larger-scale.

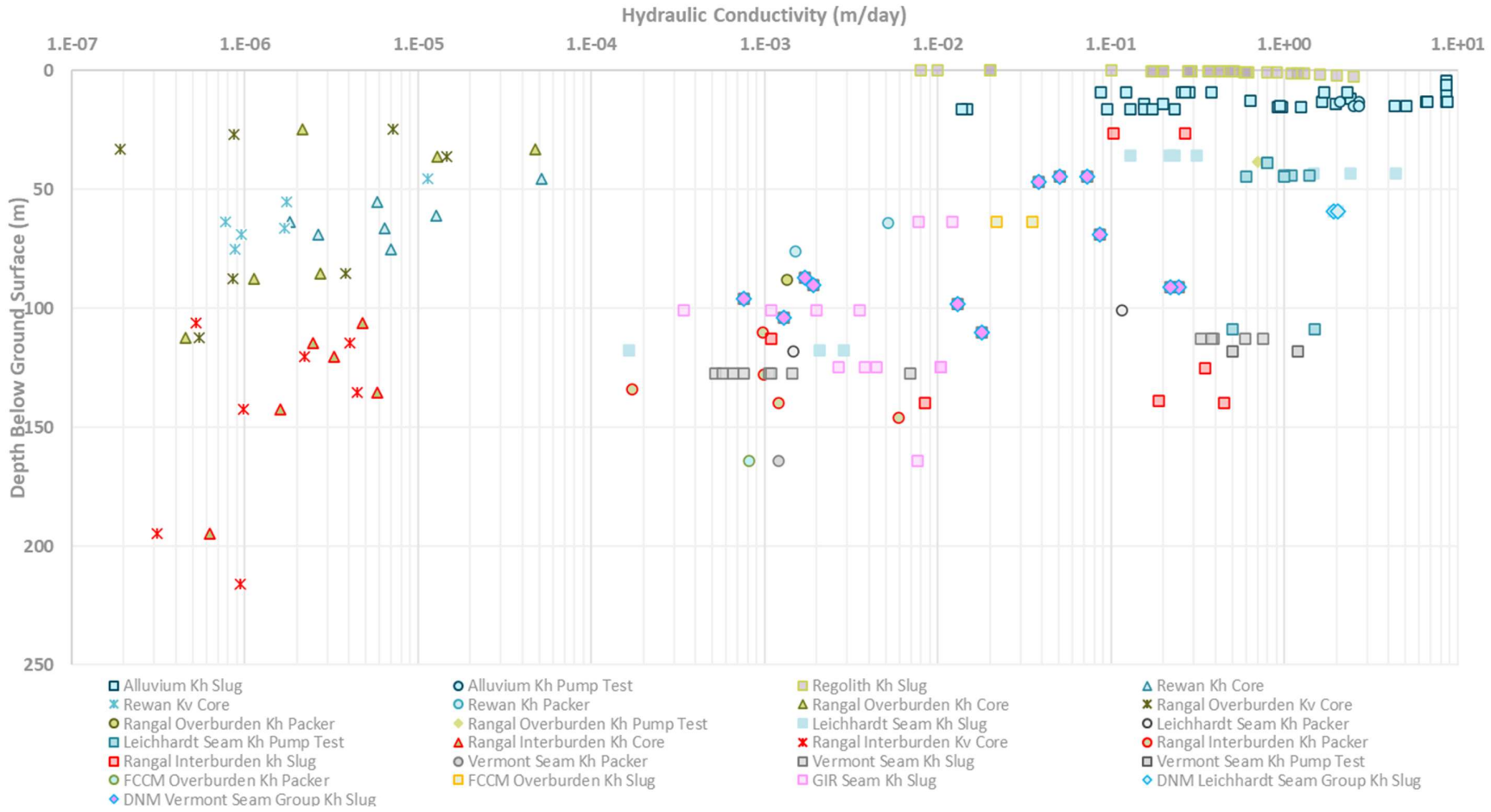


Figure 4-2 Summary of Hydraulic Conductivity Data for Bowen Basin Formations in the Vicinity of DNM

4.2.2 Hydraulic Conductivity Ranges

A histogram of the spread of Kh from the field testing at DNM, as well as at other nearby sites in publicly available literature, is presented in **Figure 4-3**. The results are compared to the range of documented values for each relevant units as presented within a literature review previously completed by HydroSimulations (2018) based on a number of other studies within the Bowen Basin.

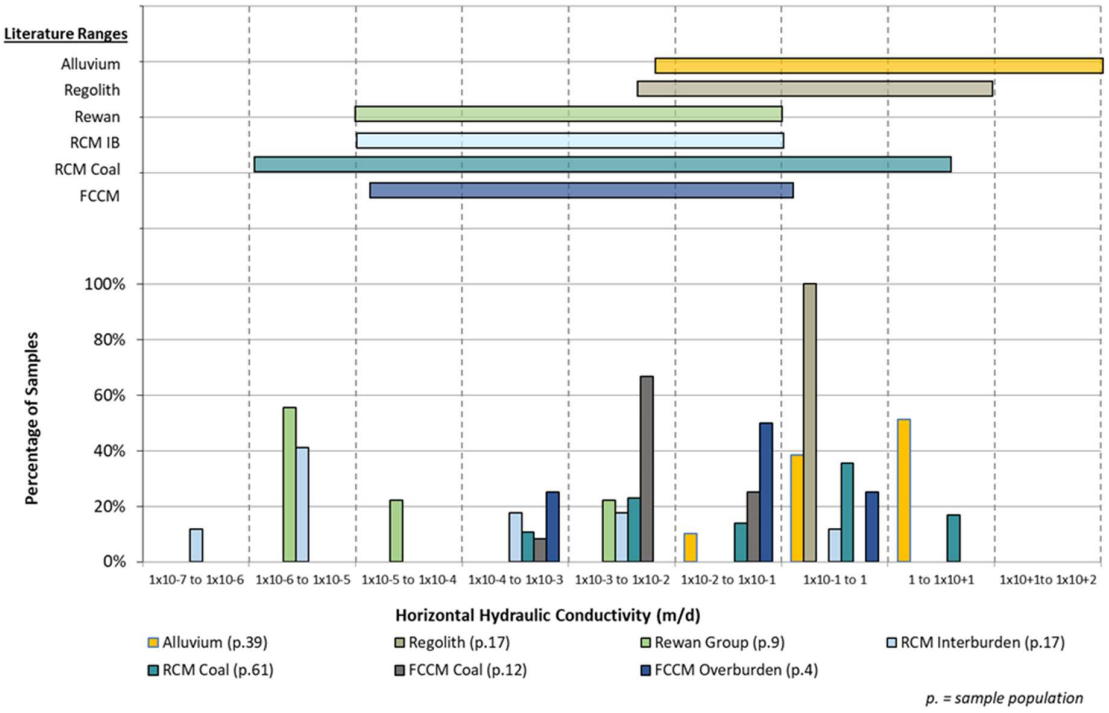


Figure 4-3 Histogram of Horizontal Hydraulic Conductivity Distribution

The comparison shows that field testing values for alluvium, regolith, Rewan Group, RCM, FCCM and Moranbah Coal Measures (MCM) within the DNM and immediate surrounds fall within the range of field data collected through other studies across the Bowen Basin.

4.2.3 Faulting

There are numerous faults trending northwest-southeast within Permian strata across DNM and 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 is due to filling of the fractured pore spaces over time through hydrothermal alteration and mineralisation (Uysal et al., 2000). Drill core logs from within the area show that fractures have typically been logged as “healed” with calcite and siderite. This indicates that many of the existing fractures are cemented, substantially reducing the permeability of the fracture network.

Hydrogeological field studies completed in the south of the DNM found variable groundwater flows indicating groundwater compartmentalisation across the site. AGE (2013) concluded that displacement of Permian strata by faulting has formed hydraulic barriers due to the

vertical offset of the more permeable horizons, rather than enhanced groundwater movement. The barrier effect is most evident in an east-west direction i.e., perpendicular to the dominant fault strike directions.

Downhole hydraulic testing was also conducted in the Permian coal measures for the Winchester South Project south-southwest of DNM (SLR, 2020). Fault zones were intersected in bores as indicated by the presence of fracturing, calcite infills, and slickensides (indicative markers of faulting) in the recovered core. Hydraulic testing yielded relatively low hydraulic conductivity values ranging from $6.93x10^{-5}$ to $2.07x10^{-3}$ m/day, in line with those presented in **Figure 4-4**. These properties indicate that the fault zones intercepted and tested had 'healed' and not pathways for groundwater flow.

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. differences in isotopic compositions of produced water for wells north and south of a major fault line at similar depths, implied little communication across the fault, suggesting the fault acts as a barrier to water and gas flow.

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 4-4**), largely based on Jourde et al. (2002) and Flodin et al. (2001). This conceptualisation provided 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.

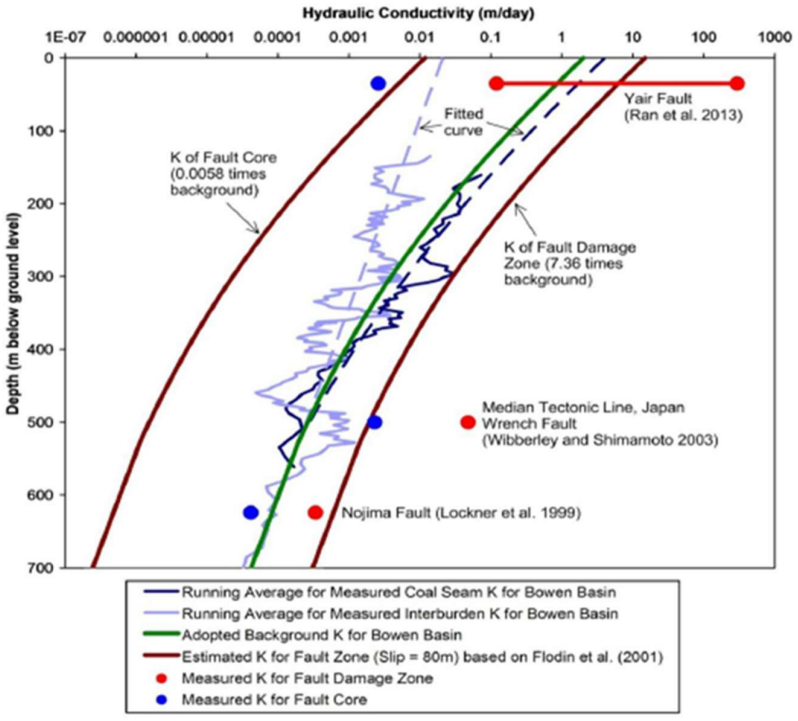


Figure 4-4 Faulting Conceptual Model Developed by Coffey (2014)

4.3 Groundwater Distribution, Flow, Recharge and Discharge

4.3.1 Quaternary and Tertiary Sediments (Cainozoic Sediments)

The Quaternary-aged Isaac River Alluvium comprises unconsolidated clay, silt, sand, and gravel generally less than 20 m in thickness (AGE, 2013) and is present to the southwest of the mine. Older Quaternary and Late Tertiary sediments extend across the footprint of the Pandora Pit.

There are currently no groundwater monitoring bores within the Isaac River Alluvium to the south-west of the mine. However, a Poitrel Mine groundwater monitoring bore (OBS8) screened in the alluvium is located approximately 3 km west-northwest (i.e. up hydraulic gradient) of the mine on the north bank of the Isaac River. This bore proved 8 m of alluvium comprising clay and sandy clay. Groundwater observations at OBS8 were limited, primarily due to the bore often being recorded as dry, and ceased in 2017. Similarly, DNM bores MB20DNM05A_R01 and MB02A, installed within unconsolidated Quaternary-Tertiary sediments, were both recorded as ‘dry’ during the limited period when they were monitored in 2021. This information supports the theory of limited or sporadic saturation of the shallow unconsolidated sediments.

Data is available from three Winchester South shallow monitoring bores (Knob Hill 1 & 2, and Winnet bore - **Figure 4-1**), although these are landholder bores rather than dedicated monitoring bores. These bores are situated on the southern bank of the Isaac River and show groundwater level ranges between 0.5 and 5m below the adjacent Isaac channel invert level. Early data for Knob Hill 2 from 2012 shows levels typically 1 m higher than the rest of the record just in excess of the adjacent channel invert level. This data is from a period of very high rainfall which would have resulted in high flows in the Isaac River and significant recharge to the adjacent alluvial and Late Tertiary deposits. Groundwater levels in these bores range between approximately 14 to 15 mbgl. Given the general interpreted thickness of the unconsolidated sediments not exceeding 20 m in proximity to DNM (**Section 3.2.1**), these results suggest very limited saturation of the alluvium.

All monitoring of the DNM alluvial bores MB20DNM05A and MB02A, located on the south-west side of Pandora Pit (**Figure 4-1**), found the bores to be dry. The Poitrel monitoring bore OBS8 is understood to be monitored irregularly after being found to be dry following installation. This indicates that the Isaac River Alluvium (and potentially also the underlying older Tertiary sediments) is largely dry in the immediate vicinity of DNM. More recent hydrogeological conceptualisations of the Isaac River Alluvium, Quaternary and Tertiary deposits have grouped them into a single hydrogeological unit (SLR, 2024) as the Quaternary and Tertiary sediments are typically difficult to distinguish between in bore logs / drill cuttings.

Alluvial water table surfaces developed for neighbouring mines (Moorvale South, Winchester South, Olive Downs), where alluvial bores show some saturation of the Isaac River Alluvium / underlying Tertiary / Regolith, indicate a south-easterly direction of groundwater flow in the direction of drainage of the Isaac River.

4.3.1.1 Recharge and Discharge

Recharge to the alluvium and underlying / adjacent unconsolidated sediments is considered to occur via leakage of flow into the underlying / adjacent alluvium during river flow events and occasional inundation of the flood plain. Direct infiltration of rainfall to the alluvium will also occur where there are no substantial barriers (clay layers) in the shallow subsurface.

Recharge rates to the Tertiary-Quaternary sediments were estimated using chloride mass balance (CMB) calculations (SLR, 2021). The CMB calculations were based on available

water quality data collected from monitoring bores within the area of DNM. Using the CMB method the following recharge rates were derived:

- Isaac River Channel Alluvium – 3 millimetres/year (mm/yr);
- Isaac River Flood Plain Alluvium – 1.3 mm/yr;
- Other alluvium – 1.3 mm/yr; and
- Tertiary sediments – 0.1 mm/yr.

Groundwater within the Isaac River alluvium discharges as evapotranspiration from riparian vegetation along the Isaac River, as well as potential short term baseflow contributions after major recharge / flood events. There will also be a general downstream (east-southeast) movement of groundwater along the alluvium at times when there are longer reaches of saturated alluvium. Alluvial groundwater will also leak to the underlying strata although this will be limited by the low hydraulic conductivity of these formations (i.e., claystone, siltstone, fine sandstone). Groundwater within the Isaac River Alluvium is also removed via landowner supply bores. Localised perched groundwater within the alluvium is evident where waterbodies continue to hold water throughout dry periods (e.g., floodplain wetlands) where clay layers slow the percolation of surface water.

Non-alluvial regolith material comprises colluvium, Tertiary sediments and weathered coal measures strata (claystone, siltstone, fine sandstone), which will typically be of low hydraulic conductivity restricting rainfall recharge, although it is often regarded as being of higher hydraulic conductivity that the underlying unweathered strata. Groundwater discharge from the regolith occurs primarily via evapotranspiration, with some short term baseflow to streams from the regolith following significant recharge events.

4.3.2 Permian Coal Measures

Groundwater within the Permian coal measures is confined and sub-artesian. Groundwater level trends for DNM monitoring bores screened in the Permian Coal Measures are presented in **Figure 4-5** to **Figure 4-7**. For context, the DNM mining progression is presented in **Figure 2-6**.

4.3.2.1 Leichhardt and Vermont Seams

Hydrographs spanning a limited period for monitoring bores installed as part of a DNM hydrogeological assessment by AGE (2013) are presented in **Figure 4-5**. MB01, MB04 and MB08 are screened within the combined Vermont Seam. MB13 is screened within the Leichhardt Seam and MB18 is screened across both the Vermont and Leichhardt Coal Seams. **Figure 4-5** shows that over the limited monitoring period of these bores (Sep 2012 to Aug 2013) groundwater elevations in the Permian Coal Measures ranged from approximately 191.5 mAHD in the northeast of DNM (MB01) to approximately 170.5 mAHD in the south (MB18). These bores showed a (variable) response to heavy rainfall in January 2013.

Bores MB13 and MB18 located in the south of the site 2 to 3 km from mining activity in the north of DNM at the time this data was recorded show no apparent impact from mining. However, of the bores located in the north of DNM, only MB03 located in the middle of the north of DNM appears to show any response to mining with a steady decline (of only 1m) from late 2014 onwards before being mined out in 2013. MB01 (DNM north, Vermont seam) and MB13 (Pandora Pit, Leichhardt seam), show the largest responses to heavy rainfall in Jan 2013 followed by a slow recession back towards more typical levels although this recession may also be partly related to mining. The limited available data from this early monitoring at DNM appears to indicate very limited (if any), obvious propagation of drawdown from early mining activity in the north of DNM.

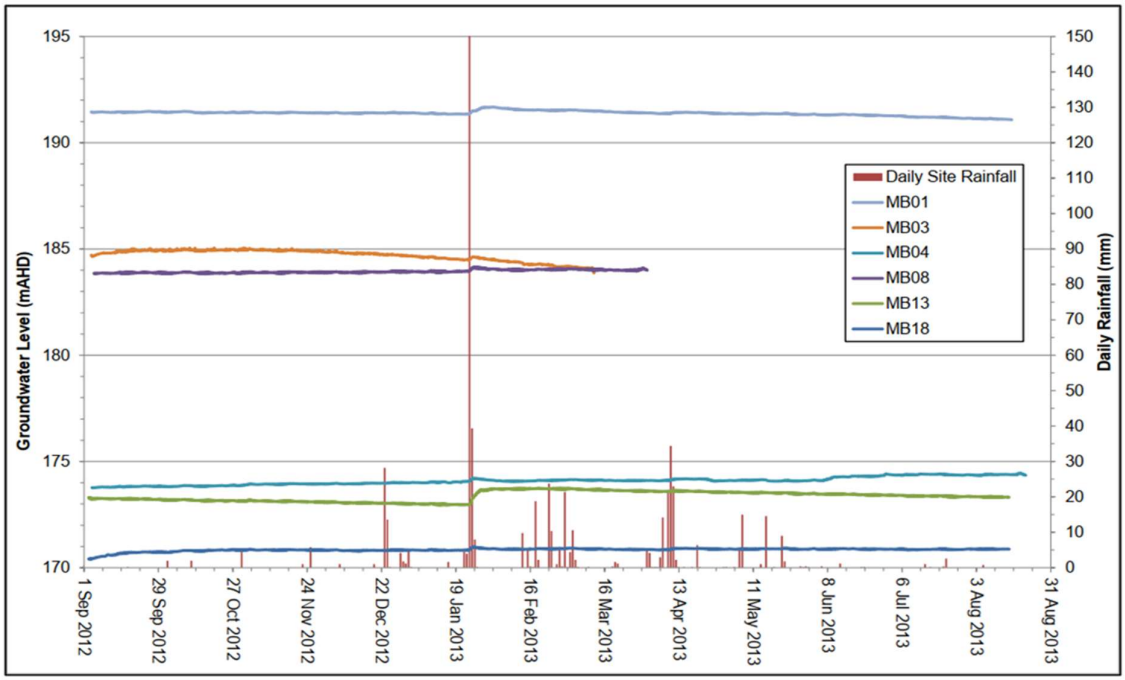


Figure 4-5 Permian Coal measures Monitoring Bore Hydrographs 2012-13 (AGE, 2013)

Groundwater levels from current RCM coal seams monitoring network at DNM are presented in **Figure 4-6**.

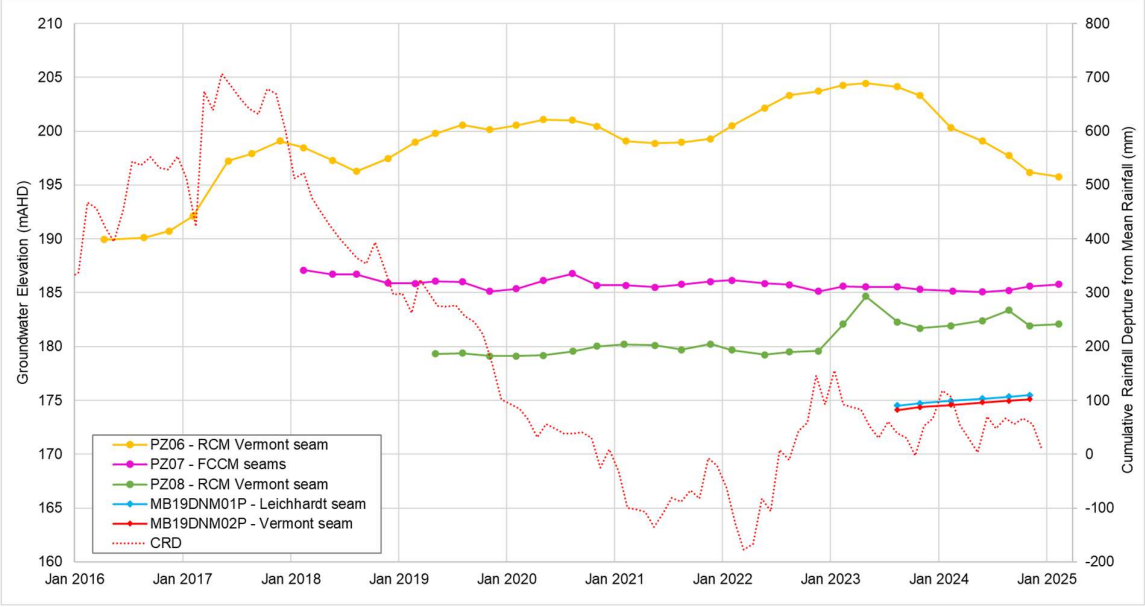


Figure 4-6 Leichhardt and Vermont Seams - Monitoring Bore Hydrographs

Groundwater levels in the Vermont Seam monitored in the north of DNM (PZ06 and PZ08) show responses that do not appear to be obviously linked directly to mining or recharge. PZ06 shows large responses possibly linked to recharge / high rainfall in early 2017 and through 2022 followed by short term recessions, however groundwater level increases are also observed in this bore through the long period of lower than average rainfall from 2018 to 2021.

PZ08 in the north-east of DNM shows steady groundwater level for the first 4 years of monitoring followed by an increase in levels of 5 m in early 2023. This increase could be a slightly delayed response to high rainfall in 2022; however this area of the site is also an area of rehabilitation with a significant landform increase above pre mining topographic levels immediately west of this bore. The increasing groundwater level trend in PZ08 through a period of average rainfall may therefore be due to a combination of pressure loading from the waste rock placement immediately to the west and higher recharge through the waste rock compared to the pre-mining surface. However, it is noted that similar increasing water level trends are seen in other bores screening both coal seams (MB19DNM01P and MB19DNM02P) and Permian interburden strata (discussed below).

MB19DNM01P and MB19DNM02P are paired bores screened in the Leichhardt and Vermont seams respectively, in the south of DNM away from mining activity in the north. The relatively short monitoring record for these bores shows a small and consistent downward vertical gradient from the Leichhardt to the Vermont seams and a matched increasing groundwater level trend in both bores of approximately 1 m over a year, through a period of average rainfall conditions. MB02P (FCCM interburden below RCM) also shows a slight increasing trend (**Figure 4-7**). PZ04 (RCM interburden) located further north shows a more pronounced increase in levels (**Figure 4-7**) of the same trend seen in MB19DNM01P, MB19DNM02P and MB02P.

4.3.2.2 Permian Interburden

Hydrographs for Permian coal measures interburden/overburden are presented in **Figure 4-7**.

PZ01, PZ05 and MB20DNM01P_R01 are located in the north of the DNM, in close or relatively close proximity to the currently active mining voids. PZ05 and MB20DNM01P_R01 show decreasing trends in the order of 2 to 3 m over the monitoring period, which are likely related to a combination of mining activity and possibly also recession from higher levels associated with periods of higher rainfall / recharge. The record for PZ01 mostly spans a period of significantly increased rainfall which may explain the increasing trend in this bore

BMB is a landholder supply bore located 4km east of the DNM mining lease that is monitored as part of DNM's EA. Recorded groundwater levels in this bore are heavily influenced by landholder abstraction and so it is difficult to draw clear conclusions about groundwater level trends in this bore. However, by isolating the maximum recorded levels there appears to be a declining trend in the order of 6 – 7m over the 11-year monitoring record. Given the distance of this bore from the site it is not considered to be impacted by mining activity at DNM.

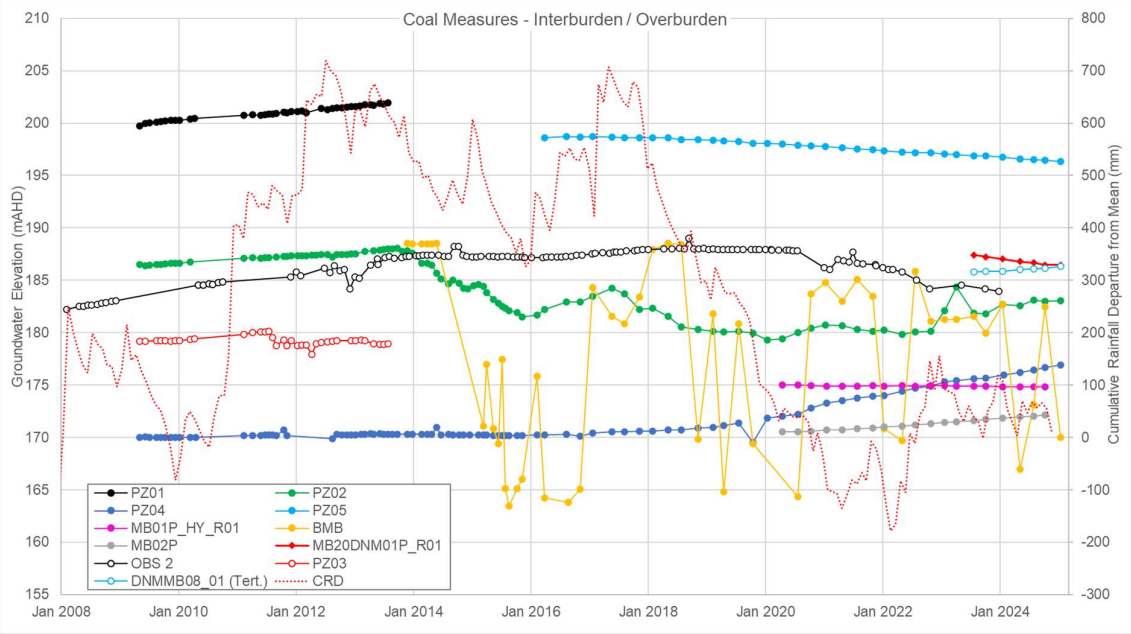


Figure 4-7 Permian Coal Measures (non coal) Monitoring Bore Hydrographs

4.3.2.3 Summary of Permian Coal Measures Groundwater Levels

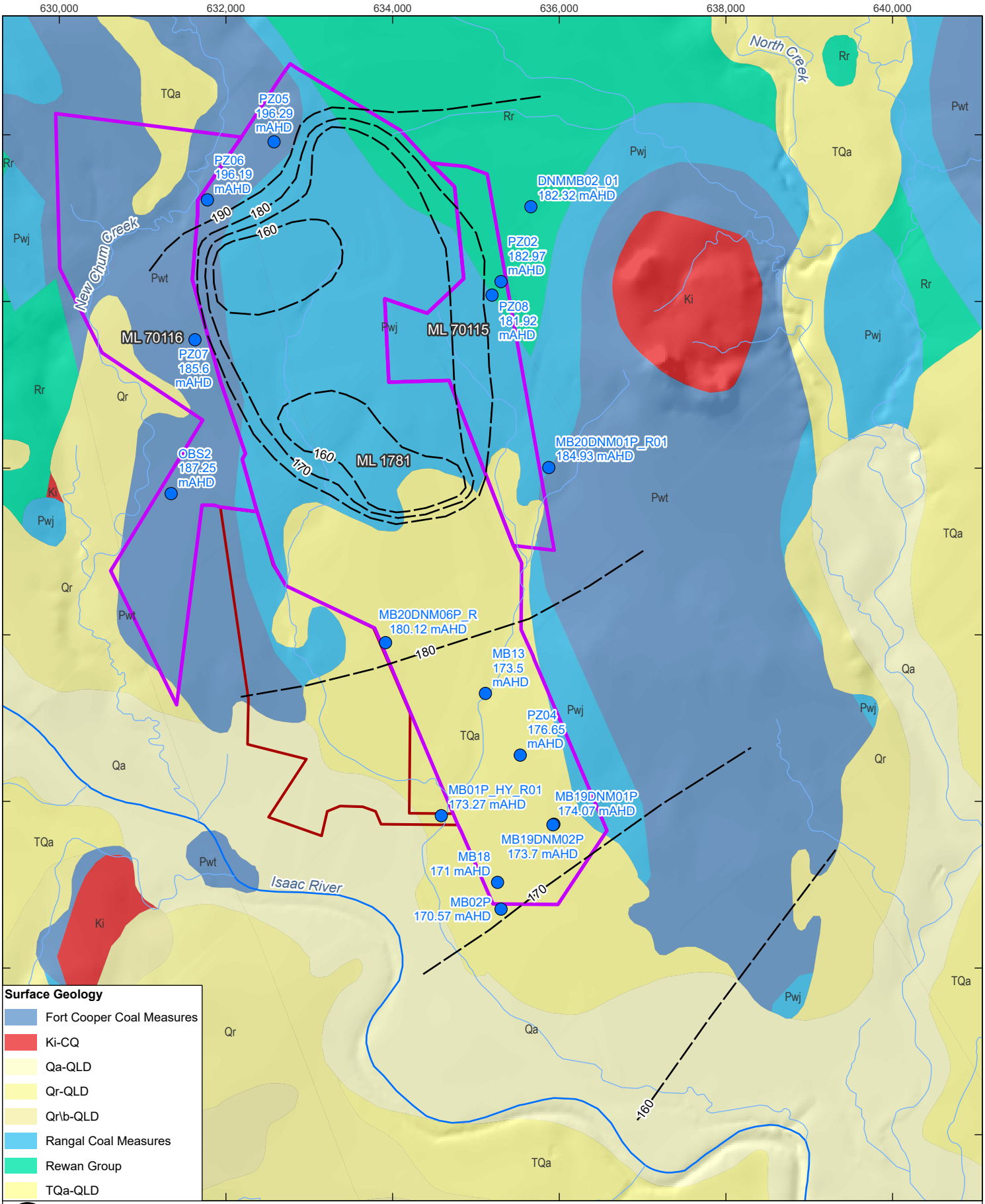
The general lack of obvious / significant groundwater level drawdown response to mining activity within all Permian coal measures monitoring bores at DNM is indicative of very low hydraulic conductivity, and/or compartmentalisation of the groundwater system as a result of structural controls (i.e. faulting), (**Section 4.2.3**). Some indication of groundwater level increases in response to mining surface activity (restoration and waste rock placement) may be evident.

Groundwater levels in the Permian Coal Measures show a general northwest to southeast decline in elevation (**Figure 4-8**), with local drawdown in immediate vicinity of the active mine pit voids as expected. Local groundwater flow is therefore towards the active mine pit voids, whilst regional flow remains towards the southeast.

4.3.2.4 Recharge and Discharge

Recharge to the Permian coal measures occurs where it outcrops / subcrop via direct limited infiltration due to the low hydraulic conductivity of much of the formation with just a small proportion of rainfall reaching the water table. Most rainfall events are unlikely to result in any recharge to groundwater in the Permian with high evaporation rates preventing the soil reaching field capacity and thereby inhibiting deep drainage of rainfall recharge to groundwater. Significant groundwater recharge may only occur after prolonged rainfall events that saturate the soil profile and allow deep drainage. Higher recharge to the Permian is likely to occur via leakage from the alluvium/ Triassic along the zone of the Isaac River Alluvium where higher recharge occurs through river flow losses (when the river is flowing) and occasional flood events.

Groundwater discharge from the Permian coal measures occurs locally via evaporation from mine pit walls, with any discharge to mine voids captured within the mine water management system for reuse. There will also be a slow regional down hydraulic gradient discharge of groundwater from the Permian to the south-east i.e. the direction of regional groundwater flow.



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 4-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F04-09_Rangal Coal Measures Groundwater Levels (Late 2024)

4.4 Groundwater Quality

The following sub-sections provide a summary of the groundwater quality data for monitoring bores at DNM, and comparison to the relevant water quality guidelines.

4.4.1 Water Type

The proportions of the major anions and cations in groundwater at DNM (coal seams and interburden) were used to determine the hydrochemical facies of groundwater. The cation-anion balance from the DNM monitoring bores is shown as a Piper plot (**Figure 4-9**). The plot indicates that Na and Cl are the dominant ions in groundwater across DNM, both within the coal seams and the coal measures interburden. Higher relative proportions of Ca and Mg are seen in some bores but Na is the dominant cation. Chloride is clearly the dominant major anion with very low relative percentages of SO_4 and CO_3.

One of the RCM interburden bores (PZ05 located at the north of DNM), and a Tertiary bore (DNMMB08_01 located on the eastern side of the mine), separately with higher relative proportions of bicarbonate (HCO_3). Both of these bores are relatively shallow and this separation likely reflects shallower groundwater chemistry at these locations, influenced by low rainfall recharge.

Bore BMB is a landholder bore used for water supply located approximately 4 km east of mining activity at DNM. The bore is screened between 30 and 50 m below ground level in RCM interburden. The very linear distribution of water quality samples from this bore on the Piper plot suggests a transition from one water type to another, however there is not a strong correlation between the ion distribution and the sampling time series i.e. a steady shift in the ion balance over time. The sample distribution possibly reflects water chemistry differences relating to the pumping history prior to sampling and the related drawdown zone for the bore. Samples exhibiting more Na-Cl dominant chemistry possibly reflect more prolonged pumping periods or dryer periods with limited recharge, and the fresher (higher proportion of bicarbonate) water chemistry likely reflects sampling after wetter periods with rainfall recharge influenced water.

There are currently no saturated alluvium monitoring bores at DNM, however samples from the Isaac River Alluvium collected from Moorvale South monitoring bores located to the southeast of DNM reflect fresher Na-HCO_3 type groundwaters due to sporadic river flows recharging the alluvium with fresher water.

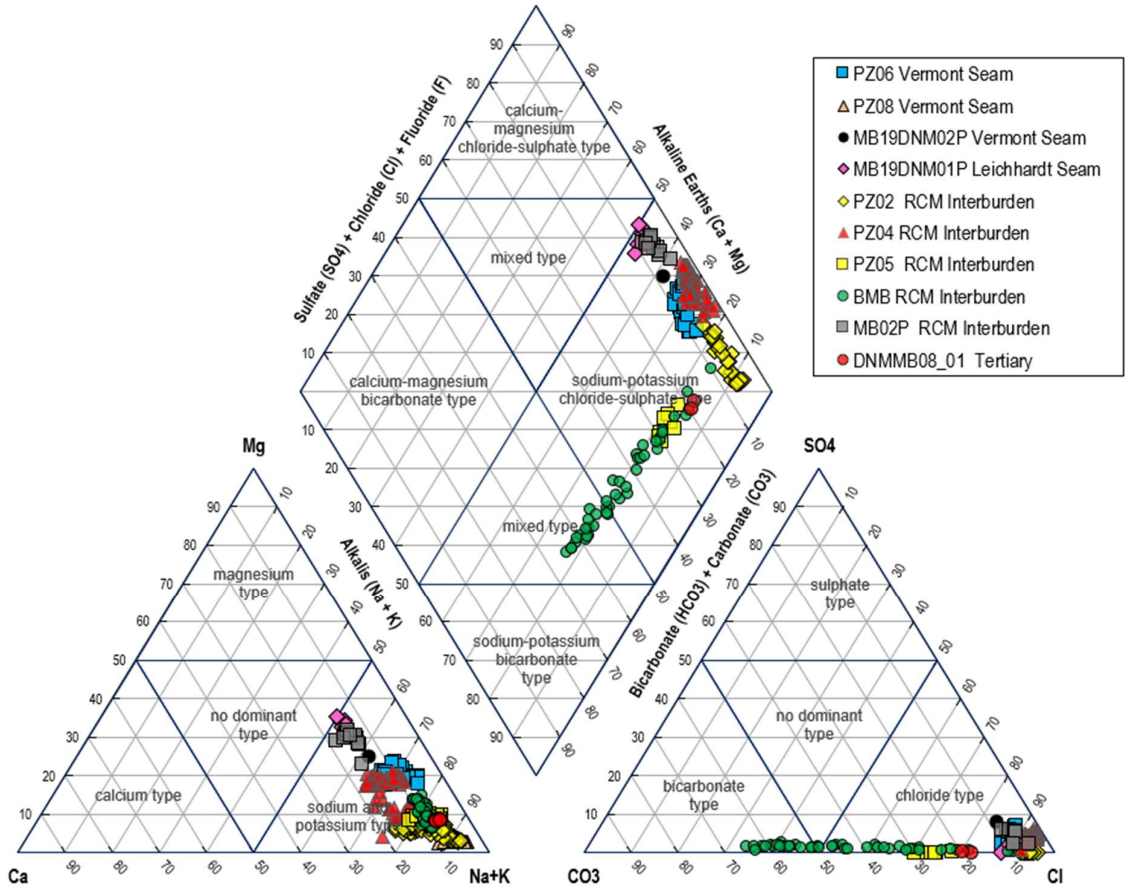


Figure 4-9 Piper Plot of Groundwater Quality at DNM

4.4.2 Groundwater Use (Environmental Values)

Groundwater resources in the DNM are scheduled under the Environmental Protection Policy (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; and
- Human use EVs:
  - Suitability of water supply for irrigation;
  - Farm water supply/use;
  - Stock watering;
  - Primary recreation;
  - Drinking water supply; and
  - 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 20th, 50th and 80th percentile concentrations for a range of metals and non-metal parameters. Where

groundwater quality exceeds a WQO for a particular EV, it is considered indicative that the groundwater may be unsuitable for that EV.

To understand groundwater quality with respect to the scheduled EVs in the vicinity of the Project, available groundwater quality data from DNM has been compared to the following EV guidelines:

- **Groundwater Quality Objectives for Isaac Groundwaters (Zone 34) (DEHP 2011)** – long-term goals for water quality management within the Isaac River Sub-basin of the Fitzroy Basin to support and protect EVs, (20th, 50th and 80th concentration percentiles) for both “shallow” and “deep” groundwater. These WQOs have also been derived with consideration of the guidelines below;
- **Livestock drinking water guidelines (ANZECC, 2000)** – the high salinity of local groundwater in the Permian makes it generally unsuitable for potable supply, it may be suitable for livestock watering, depending on its salinity;
- **Australian Drinking Water Guidelines (NHMRC, NRMMC 2011)** – it is unlikely that the local groundwater in the Permian strata would be regarded as suitable for drinking without treatment (based on salinity alone), but the drinking water guidelines provide a useful benchmark for the evaluation of background groundwater quality in the Project Area; and
- **Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)** – these guidelines, originating from the ANZECC & ARMCANZ (2000) water quality guidelines, provide concentration guidelines for the protection of fresh and marine water habitats. The guideline value selected from this guidance relates to slightly-moderately disturbed freshwater systems and the 95% species protection value. These guideline values may be considered relevant to the protection of the Isaac River.

The WQ1310 WQOs for groundwater at DNM and the guidelines referenced above are presented in **Table 4-2**, together with groundwater quality data for the bores currently monitored at DNM (screened within coal seams or coal measures interburden).

Table 4-2 DNM Coal Measures Groundwater Quality and Interburden Leachability Data Compared to Relevant Guideline Values

Analyte (mg/L unless otherwise stated)	95% Aquatic species protection for freshwater [1]	Livestock (ANZECC)	ADWG [A]	Groundwater Quality Objectives for Isaac Groundwaters (Zone 34)						RCM - coal seams (4 bores at DNM)					RCM – Interburden (5 bores at DNM)					Daunia leachability Data* (1:5 solid : water)				
				Deep (>30m)			Shallow (<30m)			No.	<LOD	20th	50th	80th	No.	<LOD	20th	50th	80th	No.	<LOD	20th	50th	80th
				20th	50th	80th	20th	50th	80th															
pH (units)	-	-	6.5 – 8.5 [C]	7.4	7.8	8.02	7.1	7.75	8.1	67	0	7.36	7.72	8.03	292	0	7.41	7.69	8.01	125	0	8.0	9.0	9.4
TDS	-	**See Table 6-3**	600 [C]							67	0	6072	9690	11760	292	0	3860	6425	12000					
EC (µS/cm)	-	-		3419	6100	16000	498	2150	8910	67	0	10500	14600	17240	292	0	6676	10750	18000	125	0	177	257	417
Aluminium	0.055	5	0.2 [C]							67	56	<0.01	<0.01	0.02	279	219	<0.01	<0.01	<0.01	125	34	<0.01	0.04	0.10
Arsenic	0.013	0.5	0.01							67	30	<0.001	<0.001	0.004	289	123	<0.001	<0.001	0.005	125	31	<0.001	0.016	0.183
Antimony	0.009	-	0.003							67	64	<0.001	<0.001	<0.001	275	271	<0.001	<0.001	<0.001					
Cadmium	0.0002	0.01	0.002																	125	8	<0.0001	<0.0001	<0.0001
Calcium	-	1,000	-	46	145	442	18	84	215	67	0	114	240	373	289	0	101	178	516	125	56	<1	1	6
Chloride	-	-	250 [C]	753	1900	5905	171	1309	3185	67	0	3582	5100	5874	289	0	1756	3700	6390	125	1	8.0	20.5	73.8
Chromium	0.0033 (CrIII)	1	0.05 (as CrVI)												68	21	<0.001	0.002	0.006	125	96	<0.001	<0.001	<0.001
Cobalt	0.0014	1	-																	125	116	<0.001	<0.001	<0.001
Copper	0.0014	0.4 (sheep) 1 (cattle) 5 (pigs & poultry)	2	0.017	0.03	0.03	0	0.01	0.03											125	96	<0.001	<0.001	0.001
Iron	-	not sufficiently toxic	0.3 [C]	0	0.05	0.246	0	0.03	0.14	67	13	0.61	1.09	1.92	279	34	0.28	0.88	2.45	125	111	<0.05	<0.05	<0.05
Lead	0.0034	0.1	0.01																	125	123	<0.001	<0.001	<0.001
Magnesium	-	2,000	-	35	115	491	27	108	389	67	0	37	398	508	289	0	48	81	447	125	70	<1	<1	3.2
Mercury	0.0006	0.002	0.001							67	67	<0.0001	<0.0001	<0.0001	289	288	<0.0001	<0.0001	0.0001	125	125	<0.0001	<0.0001	<0.0001
Manganese	1.9	not sufficiently toxic	0.5	0	0.05	0.291	0	0.01	0.16											125	77	<0.001	<0.001	0.002
Molybdenum	0.034	0.15	0.05							67	32	<0.001	0.002	0.005	279	148	<0.001	<0.001	0.011	125	22	<0.001	0.011	0.056
Nickel	0.011	1	0.02																	125	102	<0.001	<0.001	<0.001
Potassium		-								67	0	10	14	16	289	0	8	11	15	125	40	<1	2	4.0
Selenium	0.005	0.02	0.01							67	67	<0.01	<0.01	<0.01	279	276	<0.01	<0.01	<0.01	125	82	<0.01	<0.01	0.02
Silver	0.00005	-	0.1							67	64	<0.001	<0.001	<0.001	279	275	<0.001	<0.001	<0.001	75	75	<0.001	<0.001	<0.001
Sodium	-	-	180 [3]	480	1100	2565	135	747	1500	67	0	2052	2500	2938	289	0	1256	2020	2912	125	0	33.6	55.0	80.2
SO_4	-	1,000	250 [C]	25	138	398	12	140	318	67	47	<1	193	271	289	90	<1	20	403	125	1	6.0	15.0	30.2
Zinc	0.008	20	3 [3]	0.01	0.025	0.317	0	0.015	0.06											125	93	<0.005	<0.005	0.010
Tot Hardness as CaCO3	-	-	200 [C]	359	919	3208	163	674	2228	67	0	334	653	798	281	0	279	355	831	39	0	8	30	78.4
HCO_3				188	330	650	187	536	878	67	0	408	797	974	281	0	349	433	1014	125	1	40.0	81.5	466

* Percentiles derived from leachability data presented in Table B5 of Terrenus 2025

Metals concentrations presented for groundwater are dissolved, greyed out values for groundwater quality represent method detection limits

1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) - for metals and metalloids, guideline value relates to the dissolved form and slightly-moderately disturbed systems. 95% species protection where data is available.

2 Converted from CaCO3 200mg/l by multiplying by 1.22 (assumes pH <8.4)

3 Natural component of water - guideline value is taste threshold.

A ADWG are recommended guidelines for human consumption of water (i.e. post-treatment), NHMRC (2011);
ID insufficient data;
C Aesthetic guideline / Insufficient data to set a guideline value based on health considerations.
D in absence of default value, ANZECC recommend grading guideline value from NIWA (2013)

4.4.3 Salinity / Total Dissolved Solids

Salinity is a key constraint to water management and groundwater use and can be described by total dissolved solids (TDS) and electrical conductivity (EC).

DNM monitoring bores screened within the Quaternary-Tertiary unconsolidated sediments have been dry since installation and therefore representative alluvium groundwater samples have not been collected at DNM. However, more regional data presented in the DNM PRCP – Revision1 (SLR, 2023) for alluvial groundwater quality for the wider area shows that water within the alluvium is typically fresh to saline with an average TDS of 556 mg/L, but ranging up to 5,620 mg/L. These concentrations of TDS indicate that alluvial groundwater, where it is present, would typically be suitable for watering livestock. Groundwater within the deeper regolith, where present, is generally highly saline but can be brackish to moderately saline with an average TDS of 7,101 mg/L and ranging between 1,110 mg/L and 18,600 mg/L.

Table 4-3 presents the livestock watering guidelines for TDS together with the TDS for coal measures groundwater at DNM. TDS in the coal seams is high with the median value for the coal seam samples significantly exceeding the mid-range guideline for most stock with the exception of sheep. The median coal seam TDS also exceeds or equals the upper range guideline for all but sheep, the most salinity tolerant livestock.

The median TDS for coal measures interburden samples is significantly lower that for the coal seams but exceeds the upper end of the mid-range guideline for stock with the exception of sheep, and sits within the upper guideline range, for all but the most salinity sensitive livestock (poultry). TDS concentrations in the landholder bore to the east of DNM which forms part of the DNM groundwater monitoring network (BMB – RCM interburden), are relatively low with 20th percentile, 50th percentile and 80th percentile concentrations of 1,686, 2,105 and 2,898 mg/L respectively, i.e. TDS concentrations that are generally suitable salinity for stock watering.

Table 4-3 Total dissolved solids (mg/L) guidelines for livestock and groundwater quality

Livestock	Low Range No adverse effects expected	Medium Range Animals may have initial reluctance to drink, but stock should adapt without loss of production	High Range Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef Cattle	0 – 4,000	4,000 – 5,000	5,000 – 10,000
Dairy Cattle	0 – 2,400	2,400 – 4,000	4,000 – 7,000
Sheep	0 – 4,000	4,000 – 10,000	10,000 – 13,000
Horses	0 – 4,000	4,000 – 6,000	6,000 – 7,000
Pigs	0 – 4,000	4,000 – 6,000	6,000 – 8,000
Poultry	0 – 2,000	2000 – 3,000	3,000 – 4,000
Formation	**20th %ile**	**50th %ile**	**80th %ile**
Rangal – coal	6,072	9,690	11,760
Rangal - interburden	3,860	6,425	12,000

4.4.4 Comparison to Guideline Values

4.4.4.1 DNM Groundwater Samples (Permian coal measures)

The groundwater quality data for the Permian groundwater samples and the leachability test samples presented in **Table 4-2** is discussed below in relation to guideline values. It should be noted that the two groups of samples were not tested for the same analytes, and so where exceedances are mentioned for one group of samples but not the other it may in part be due to the different analytical suites (refer to **Table 4-2**).

Livestock drinking water guidelines – excluding salinity (see above), none of the guideline values for stock watering are exceeded by the DNM groundwater samples from the RCM coal or interburden bores.

Australian Drinking Water Guidelines – local groundwater quality in the Permian coal measures at DNM is unsuitable for drinking water supply primarily based on salinity/TDS, but there are several other exceedances of the guideline values:

- Groundwater samples from the Permian coal and interburden exceed the (aesthetic) guideline values for iron at the 20th (coal seam bores), 50th and 80th percentiles, and SO_4 at the 80th percentile.

Water Quality Objectives - Isaac Groundwaters (Zone 34) – with regard to these groundwater quality objectives there are a significant number of exceedances by the Permian groundwater samples, suggesting that broadly that the baseline groundwater quality in the Permian coal measures at DNM does not support the identified EVs for this region:

- EC, calcium, chloride, iron, magnesium, sodium, and HCO_3 at most percentile concentrations, for shallow (<30 m) and/or deep (>30 m) aquifers.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) – 95% species protection. With regard to potential impacts on surface water ecosystems there were no exceedances of the guidelines by the median groundwater quality values. It should be noted that the groundwater analytical suite is limited and does not include many of the parameters for this guideline.

4.4.4.2 Leachability Tests (Terrenus, 2025)

Table 4-2 also presents summary water quality statistics for leachability tests undertaken on coal measures samples from DNM (Terrenus, 2025, Table B5). These data are included as a very approximate guide to understanding water quality that may seep through the OOPD. The test data comprised leachate from 125 samples of predominantly coal measures interburden with 14 samples containing >10% coal. The 1:5 w:v (solid:water) deionised water leach procedure was used to measure soluble metals/metalloids on fine pulps of these samples. It should be noted that the use of fine pulped materials (very high surface area) in water extract tests enables a high level of reaction and dissolution and therefore may not be representative (i.e. over estimate), the potential for dissolution of elements into water seeping through waste rock. However, many analytes were below detection limits for most samples. A comparison of the summary leachate quality to guideline values is presented below.

Livestock drinking water guidelines – the RCM leachate samples were significantly below these guideline values with the exception of selenium which matched the guideline of 0.02 mg/L at the 80th percentile.

Australian Drinking Water Guidelines – the RCM leachability test samples exceed the following guideline values:

- pH at the 50th and 80th percentile

- arsenic at the 50th and 80th percentiles
- molybdenum and selenium at the 80th percentile

Water Quality Objectives for Isaac Groundwaters (Zone 34) - The RCM leachability test samples exceed pH at the 20th, 50th and 80th percentiles, for shallow (<30 m) and/or deep (>30 m) aquifers, and no other parameters.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) – 95% species protection. For the leachability test samples, the following exceedances were identified:

- aluminium, molybdenum, selenium and zinc at the 80th percentile
- arsenic at the 50th and 80th percentiles

With regard to a comparison of the leachability test samples to the Permian groundwater samples, the concentrations of analytes in the leachate samples exceeded those in the Permian groundwater samples as follows, but were otherwise significantly lower:

- pH at 20th, 50th and 80th percentiles;
- aluminium, arsenic and molybdenum at the 50th and 80th percentiles; and
- selenium at the 80th percentile.

In addition to the leachability data presented above, the Terrenus geochemical assessment for the Project (Terrenus, 2025) presents a number of key findings in relation to the geochemical hazard assessment for the proposed OOPD:

- DNM spoil is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage), which is typical for mine spoil in the Bowen Basin.
- DNM spoil has a very low potential to generate acid and metalliferous drainage (AMD).
- The expected proportions of non carbonaceous, carbonaceous and coal materials in the OOPD are 90%, 9% and 1% respectively.
- DNM non-carbonaceous spoil poses a “Low” AMD source hazard, with the small proportions of carbonaceous spoil and coal posing a “Low-Moderate” AMD source hazard.
- Spoil is overwhelmingly non acid forming (NAF) with excess acid neutralising capacity (ANC) and has a negligible risk of developing AMD, including acid drainage (AD), neutral metalliferous drainage (NMD) and/or saline drainage (SD).
- Taking into account the proportion of each material that could generate AMD relative to the total proportion of all materials in the OOPD final landform, the proposed OOPD is expected to pose a “Low” AMD hazard”, with AMD generation rated as “Highly Unlikely”.

4.4.4.3 Tertiary – Quaternary Groundwater

Due to the DNM alluvial monitoring bores being consistently dry since installation, no data is available for alluvium groundwater quality at DNM. Results from the Winchester South Project groundwater assessment (SLR, 2020) showed that groundwater within the alluvium sporadically exceeds the Isaac Groundwaters (Zone 34) EV criteria for iron and manganese, boron and uranium, and zinc. Alluvial groundwaters were also found to exceed the Zone 34 WQO for aquatic ecosystem protection in groundwater for pH, manganese, iron, alkalinity and bicarbonate. Overall, the comparison indicates that alluvial groundwaters generally exceed some of the WQO criteria for all scheduled EVs.

Groundwater quality in the Tertiary strata across DNM is limited to five samples collected between 2022 and 2025 from one bore located on the eastern side of DNM (DNMBMB08_01), due to the limited presence of groundwater in the Tertiary sediments across DNM. This dataset is considered insufficient to provide representative groundwater quality statistics for the Tertiary, however the averaged data for this bore yields a TDS of 4,567 mg/L with exceedances of the drinking water guidelines for iron, and the Zone 34 50th percentile WQOs for shallow groundwater for calcium and iron.

The Moorvale South Project (SLR, 2019) and Olive Downs Project (HydroSimulations, 2018) groundwater assessments identify that water within the Tertiary sediments (where present), is of poorer quality than the alluvium with exceedances of guideline criteria for livestock, irrigation, drinking water and aquatic ecosystems.

4.5 Groundwater Receptors

4.5.1 Local Groundwater Supply Bores

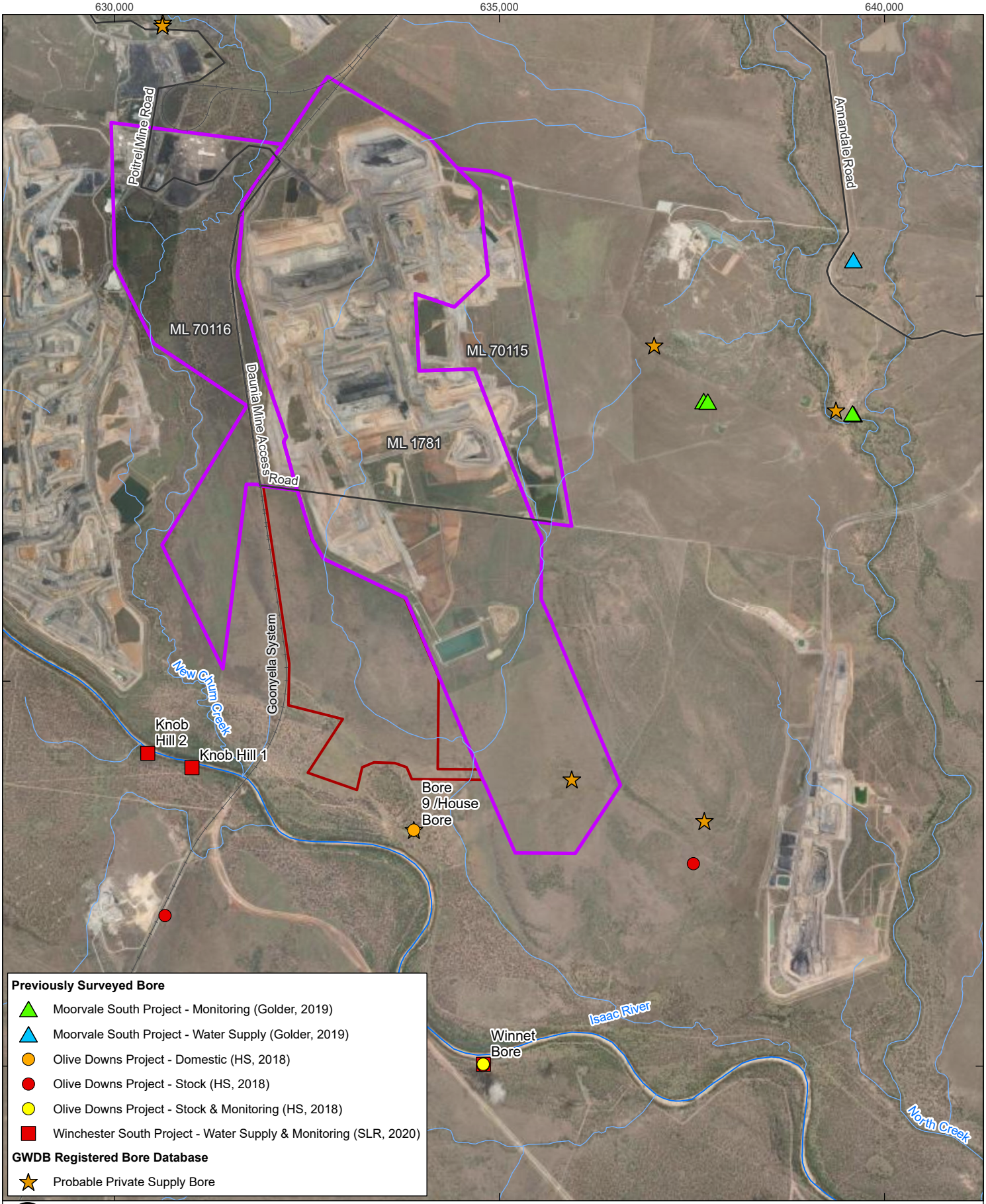
A search of the Queensland Government's Groundwater Bore Database (GWBD) was carried out for registered bores within 5km of DNM. The search indicated that there are 70 registered bores within 5 km of the DNM Area, of which 57 are recorded as being for groundwater monitoring and investigations, and only 4 are recorded as being used for water supply. The remaining 9 do not have an identified use recorded in the GWBD.

Bore BMB, a landholder bore located 4km east of DNM (blue triangle on **Figure 4-10**), is included within the DNM groundwater monitoring network. This bore is actively used for water supply and extracts from the RCM interburden. Given its location and the very limited (if any) visible impact from mining on groundwater levels observed in the onsite DNM monitoring bores, this landholder bore is not considered to be at risk from drawdown impacts related to mining at DNM.

The 2023 PRCP groundwater assessment for DNM (SLR, 2023) included a review of landholder bore surveys for surrounding mining projects (Olive Downs, Moorvale South, and Winchester South). **Figure 4-10** presents a summary of the identified groundwater supply bores from these surveys and the GWBD. Four alluvium / Tertiary bores were identified directly south of the DNM, the nearest being an apparently "active" domestic supply bore (Bore 9 / House Bore) adjacent to the Isaac River approximately 1 km directly south of the southern end of the DNM. Available details for the four landholder bores identified to the south of the DNM are summarised in **Table 4-4**.

Table 4-4 Groundwater Bores Directly South of the DNM

RN	Bore Name	Easting (GDA94Z55)	Northing (GDA94Z55)	Purpose	Geology	In use?	Survey
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 (2020), Olive Downs (2018)
Unregistered	Bore 9 / House Bore	633886	7553064	Domestic	Alluvium	Yes	Olive Downs Bore Census 2017



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:65,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Road
- Railway
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area

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LOCAL GROUNDWATER SUPPLY BORES

SLR

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FIGURE 4-10

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F04-11_Local Groundwater Supply Bores

4.5.2 Groundwater Dependent Ecosystems

A groundwater dependent ecosystem (GDE) is one in which the plant and/or animal community is dependent on the availability of groundwater, either permanently or periodically, to maintain its structure and function.

National Atlas of Groundwater Dependent Ecosystems

The BoM National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) is a high level national scale mapping tool that classifies ecosystems based on the potential for dependence on groundwater through various lines of evidence using regional datasets. It is regarded as a high level "first pass" guide to the potential presence of GDEs within a given area rather than confirmation of their presence. The GDE Atlas delineates several areas or ecosystems within the vicinity of the Project with potential dependence on groundwater as follows:

- High potential for groundwater dependence (strong possibility the ecosystem is interacting with groundwater);
- Moderate potential for groundwater dependence; or
- Low potential for groundwater dependence (relatively unlikely the ecosystem will be interacting with groundwater and will include ecosystems that are not interacting with groundwater).

The GDE Atlas indicates that areas with possible high, moderate and low potential for groundwater interaction occur in the vicinity of DNM (BoM, 2017; **Figure 4-11**), with moderate to high potential GDE's identified predominantly to the southwest of DNM in alignment with the Isaac River:

- Terrestrial vegetation associated with the riparian zones of the Isaac River and tributaries is mapped as having a high potential to be dependent on groundwater;
- Broader areas of the Isaac River floodplain are mapped as hosting terrestrial ecosystems with a moderate to low potential to be dependent on groundwater; and
- The channel of the ephemeral Isaac River channel and an adjacent unnamed minor drainage line is designated as having a high potential to be dependent on the surface expression of groundwater.

The Isaac River is ephemeral flowing only 26% of the time, i.e. there is no perennial baseflow (groundwater) supported flow. The surface expression of groundwater in the creeks and the associated aquatic habitat be limited to isolated occasions following significant rainfall where partial saturation of the alluvium may result in some short term baseflow to the Isaac and other watercourses. Alluvial groundwater may also support aquatic GDEs in the form of water holes within the Isaac River channel hosting aquatic species through no-flow periods, depending on their permanence.

4.5.3 Local GDE Studies

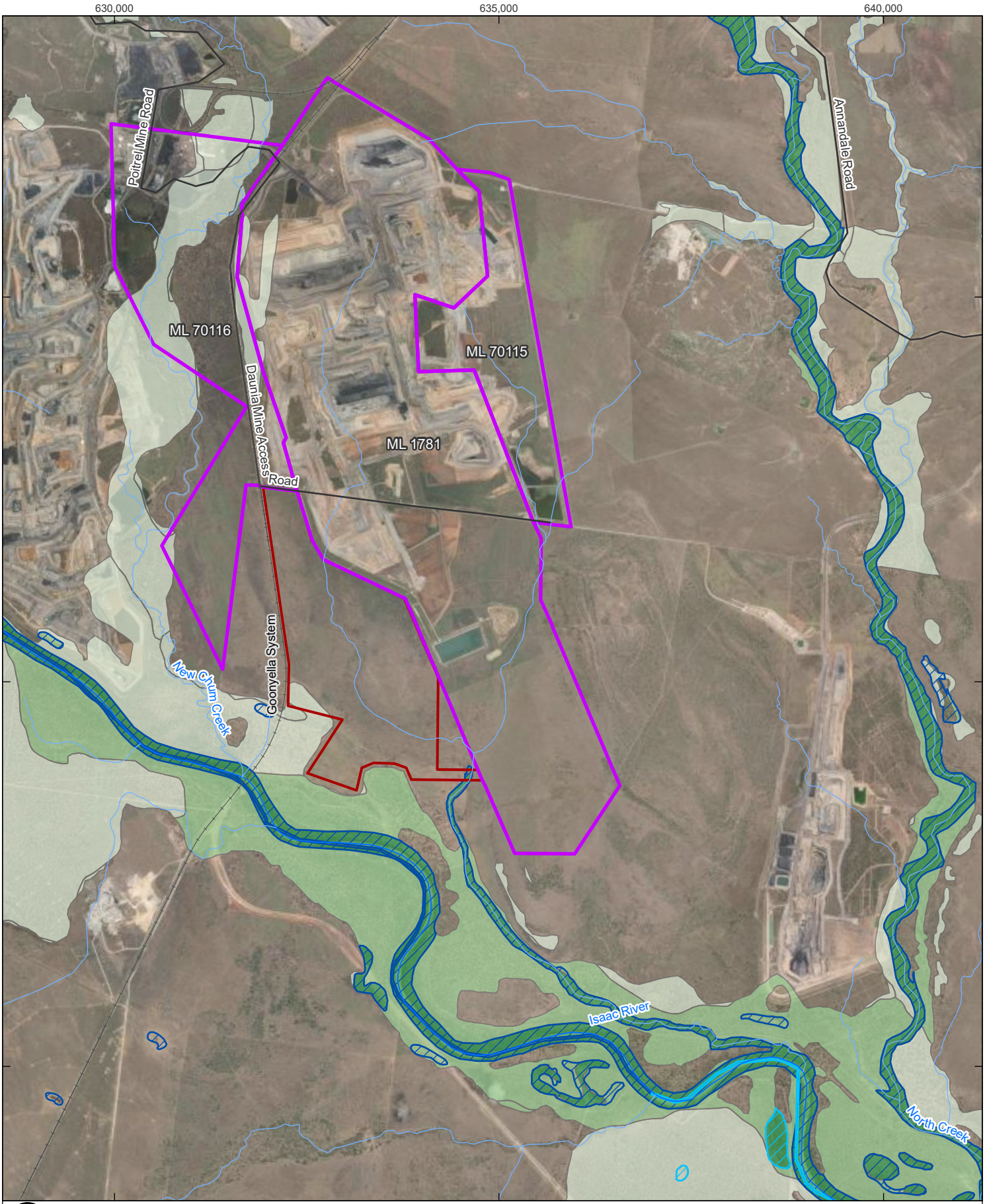
Ground truthing GDE studies have been completed for the Isaac Downs Project 9 km to the west of DNM (3D Environmental, 2019) and for Poitrel Mine immediately adjacent to the west of DNM (3D Environmental, 2024). These studies focussed on the Isaac River and associated floodplain environment and the results are considered directly relevant to DNM given the same hydrogeological setting. The results from both studies indicated:

- There is no evidence that terrestrial vegetation is utilising groundwater from deeper confined aquifers associated with Permian coal seams;
- Areas were identified where terrestrial vegetation is likely interacting with shallow alluvial groundwater, both associated with riparian ecosystem analogous to

RE11.3.25 (Eucalyptus tereticornis or E. camaldulensis [red gum] woodland fringing drainage lines).

- Vegetation on the riparian fringe was found to be variably interacting with groundwater depending on riverbank position, 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 that have no, or limited dependence on groundwater;
- The dependence of vegetation on groundwater decreases significantly moving up the bank onto higher river terraces to the point that there is no interaction between trees and groundwater on the higher, older alluvial terraces; and
- Providing volumetric changes to the alluvial aquifer are not rapid and otherwise normal hydrological function of the River system is maintained, the studies found that mining related impacts to the identified GDEs are likely to be minor.

Overall, the GDE ground truthing studies at nearby Isaac Downs and Poitrel mines indicate that GDEs associated with the Isaac River are limited to mature deeper rooted red gum tree species immediately fringing the modern river channel.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:65,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Road
- Railway
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area

Aquatic GDE

- High Potential GDE
- Moderate Potential GDE

Terrestrial GDE

- High Potential GDE
- Moderate Potential GDE
- Low Potential GDE

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GDES IN THE VICINITY OF DNM

SLR

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FIGURE 4-11

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F04-12_DWIP_GDEs in the Vicinity of DNM

4.6 Mine Pit Groundwater Management

Groundwater inflows from the Permian coal measures to DNM's active pit voids are generally small and do not typically need to be actively managed via advance dewatering or other groundwater management methods, with evaporation from the pit void walls and floors removing most of the groundwater inflow. When small volumes of groundwater inflow do require management, they are generally managed via the use of in-pit sumps to capture the water. The water is then used for dust suppression purposes or circulated via the mine water management system for use in coal washing.

Inflow estimates for DNM are available through the latest numerical modelling and provided in **Section 7.4**

5.0 Conceptual Site Model – End of Mining

A conceptual site model (CSM) of the groundwater regime has been developed based on the review of the hydrogeological information for DNM presented in the preceding report sections. The CSM is based on the hydrogeological data review presented above and the DNM CSM presented in SLR (2025a), and as well as the results of previous DNM groundwater modelling reported in SLR (2025b).

5.1 General

5.1.1 Site Setting and Hydrogeology

DNM is located within the northern part of the Bowen Basin, which comprises Permian aged coal measures that have been subject to regional deformation, including folding and faulting. DNM is affected by numerous normal and reverse faults, with some major northwest-southeast trending faults associated with the Jellinbah Fault Zone (i.e. New Chum Fault and Eastern Fault Alignment), and minor southwest-northeast trending faults. Faulting across the DNM area results in the Fort Cooper / Rangal / Rewan sequence repeating at surface (or subsurface), from west to east. Mining at DNM targets the coal seams of the Rangal Coal Measures, that occur at subcrop on the eastern and western boundary of the mining lease. Surficial cover consists of regolith material comprising Quaternary to Tertiary sediments and weathered Permian strata. Surficial cover in the southern area of DNM includes alluvium associated with New Chum Creek, a minor tributary of the Isaac River located directly to the west. Quaternary alluvium associated with the Isaac River is mapped to within 500 m of the western DNM approved ML, and intersects the ML application area at the south-western corner.

- Cainozoic sediments:
  - Quaternary alluvium – unconfined aquifer (sporadically water-bearing strata of permeable unconsolidated sand or gravel) localised in close proximity to the DNM and regionally along the Isaac River, and to the east along North Creek; and
  - Quaternary to Tertiary older alluvium, colluvium and weathered bedrock (regolith) – unconfined and largely unsaturated unit at DNM and in the Study area.
- Permian coal measures with:
  - Low permeability interburden units comprising mudstone, siltstone and fine sandstone; and
  - Coal seams which are more permeable units within the coal measures due to secondary porosity (cleats and fissures).

The unconsolidated alluvial sediments of the Isaac River, other Cainozoic sediments (e.g. Tertiary sediments), and weathered Permian coal measures, generally function as one interconnected hydrogeologic unit (collectively termed the ‘regolith’ in this study), though with significant heterogeneity given the lithological and stratigraphic distinctions within.

Based on the currently limited available data in the vicinity of the Project the Isaac River alluvium appears to be largely dry although it will occasionally partially saturate from occasional river flow and flood events. The alluvium is underlain by older Tertiary sediments as well as weathered Permian mudstone, siltstone and sandstone, which act as a partial barrier to vertical groundwater seepage. Local DNM alluvial bores have always been dry and a nearby Poitrel alluvial monitoring bore was abandoned after it was found to be dry after installation.

Unconsolidated Tertiary-Quaternary sediments are also mapped at surface within the southern portion of the DNM mine lease (where not overlain by alluvium) and comprise

unsaturated sands and clays. Tertiary-Quaternary aged sediments present across the Project area form the base of the unconfined shallow groundwater system and have been found to be consistently unsaturated.

5.2 Groundwater Flow, Recharge and Discharge

5.2.1 Shallow Groundwater System

Shallow groundwater is variably present in Quaternary alluvium and/or older unconsolidated Tertiary sediments and weathered Permian bedrock. Hydrogeologically, where saturated, these unconsolidated units are considered to function as a single aquifer (SLR,2024).

Alluvium associated with the minor creek lines in the vicinity of DNM is poorly developed and only sporadically saturated. Along the ephemeral Isaac River which drains south-east approximately 1.5 km to the south-west of the DNM, the Isaac River Alluvium extends over a 1.5 to 2 km wide tract along its course. Where it occurs, groundwater within the alluvium is recorded at depths of between 10 mbgl to 17 mbgl, typically significantly below the riverbed elevation. Groundwater flow within the alluvium and underlying hydraulically connected Tertiary sediments / weathered bedrock is to the south-east consistent with the flow direction of the Isaac River. There are currently no DNM alluvium monitoring bores but the limited available information indicates that the alluvium is generally dry in the vicinity of DNM.

Recharge to the alluvium is considered to be primarily from river flow leakage or flooding, with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub surface. Discharge is via evapotranspiration from vegetation growing along creek beds and possibly limited duration baseflow to the Isaac River following significant alluvial recharge from flow events and flooding. In addition, in areas where the Isaac River Alluvium is saturated there will be discharge in the form groundwater flow along the alluvial channel in the downstream (east-southeast) direction, as well as leakage from the alluvium to underlying strata.

The flow events in the Isaac River and associated tributaries, and occasional inundation of the flood plain result in enhanced recharge to the Isaac River Alluvium. This generates a low hydraulic gradient away from the river to adjacent areas where the topography is still relatively low lying and recharge is limited to rainfall infiltration through lower permeability surface geology. The regional groundwater flow direction however is towards the south-east.

Groundwater recharge across the broader region is very low with just a small proportion of rainfall reaching the water table. Most rainfall events are unlikely to result in any recharge to groundwater with high evaporation rates preventing the soil reaching field capacity and thereby inhibiting deep drainage of rainfall recharge to groundwater. Significant groundwater recharge may only occur after prolonged rainfall events that saturate the soil profile and allow deep drainage. Recharge estimates for the Tertiary-Quaternary sediments vary between approximately 3mm/yr for the Isaac River alluvium and 0.1mm/yr for Tertiary sediments.

5.2.2 Deep Groundwater System

Groundwater within the Permian coal measures is typically confined although at shallower depths and in the regolith, where many of the monitoring bores are screened, groundwater may be relatively unconfined depending on the surface geology. The coal seams are typically the most permeable horizons within the coal measures with permeabilities an order of magnitude or so higher than the bulk hydraulic conductivity of the interburden (mudstone, siltstone, fine sandstone).

Infiltration to the Permian is limited by the predominantly low hydraulic conductivity of the units although sub-cropping coal seams may receive recharge via leakage from the alluvium when it becomes partially saturated. Regionally, discharge from the Permian coal measures

will be via mine dewatering and regional flow with some limited exploitation of groundwater where salinity is sufficiently low for uses such as stock watering.

A review of fault behaviour within the wider Bowen Basin has identified that faults in the Permian strata can increase vertical hydraulic conductivity parallel to the fault trace and reduce it perpendicular to the fault trace. However, any increase in vertical hydraulic conductivity is limited and variable between faults depending on mineralisation and in-filling along the fault plane. Hydraulic testing of faults within the area indicate that faulting zones are not pathways for preferential flow, but instead act as hydraulic barriers and lead to compartmentalisation of the groundwater system with the more permeable coal seams juxtaposed against low permeability interburden which prevents the coal seams from acting as continuous pathways for groundwater migration.

Hydrographs for the Permian coal measures monitoring bores at DNM currently show limited to no groundwater level drawdown impact from mining, even in close proximity to active mining, reflecting the very low permeability of the coal measures interburden and/or structural compartmentalisation of groundwater withing the Permian strata. The RCM coal seams will be entirely worked out across Pandora Pit (and DNM immediately to the north). As the RCM target coal seams do not locally extend beyond the ML, this will limit the extent of groundwater level impacts which propagate more extensively along coal seams which have higher hydraulic conductivity that than interburden.

In the vicinity of DNM groundwater flow within the Permian coal measures is to the south-east. Regionally, groundwater within the Permian coal measures flows in a southeasterly direction, but the flow system is significantly modified by mining, with active mine voids now functioning as major sinks for groundwater flow. This has resulted in substantial local drawdown within the Rangal Coal Measures, driven by evaporative discharge from associated water take from open-cut mines and residual void lakes. Consequently, inward hydraulic gradients have developed towards these voids, effectively preventing any outflow. Due to the close proximity of both the proposed Isaac River Coal Project and Poitrel Mine, there is high potential for Permian coal measures cumulative impacts to the with the Project.

5.3 Groundwater Quality

There are currently no alluvial groundwater monitoring bores at DNM as limited historical monitoring indicates it is unsaturated, however groundwater quality data for the alluvium within the broader study area indicates it is fresh to saline and highly spatially and temporally variable. Where groundwater is present within the alluvium beyond the DNM study area it is of a quality mostly suitable for stock water supply and irrigation but exceeds guidelines for drinking water and protection of freshwater aquatic ecosystems.

Groundwater quality data for the older Tertiary sediments at DNM is limited to one bore, again largely due to this unit being largely dry at DNM. However, the available data (one bore) shows it is brackish and exceeds the drinking water guidelines for iron, and the WQ1310 shallow WQOs for calcium and iron.

Groundwater in the Permian coal measures at DNM is brackish to moderately saline with median TDS values at the very upper end of the acceptable range for beef cattle and sheep. Permian groundwater quality also exceeds some drinking water guidelines and the Isaac River Groundwater Management Area objectives for EC, calcium, iron, magnesium, and HCO at most percentile concentrations, for shallow and/or deep aquifers.

Leachability tests on samples of interburden at DNM i.e. waste rock material that might be considered similar in nature to that in the proposed OOPD, identified a number of exceedances of guideline values for drinking water (pH, As, Mo and Se); WQ1310 WQOs (pH only); and the ANZ guidelines for protecting freshwater ecosystems (Al, Mo, Se, Zn, and As). It should be noted that the testing suite for the leachate samples was more extensive than that for the Permian coal measures samples which partly explains the greater number

of exceedances by leachate samples. In addition, the leachate test method of pulverising the sample before mixing with water (1 part spoil to 5 parts water) is not representative of waste rock / water interactions within the proposed OOPD due to the very high rock surface area generated by the test method. The leachability data is a poor proxy for a source term for the OOPD but does provide a conservative assessment of the potential for the waste rock to affect the quality of infiltrating water.

In comparison to the Permian groundwater samples the leachability test samples contained higher concentrations of Al, As, Mo at the 50th and 80th percentiles; Se at the 80th percentile; and pH at all percentiles. The leachate samples showed much lower in EC/TDS than Permian groundwater.

The waste rock material tested is expected to generate pH-alkaline to highly alkaline contact water with very low potential to generate acid and metalliferous drainage (AMD).

5.4 Groundwater Receptors

The Isaac River Alluvium is considered a significant regional aquifer from a natural environmental receptor perspective, where there is evidence that it supports both landholder extractive use and deep-rooted facultative GDEs immediately fringing the River channel. Where it occurs, groundwater within the alluvium is recorded at depths of between 10 mbgl to 17 mbgl, typically significantly below the riverbed elevation.

Review of the Queensland GWDB and a landholder census indicates alluvial groundwater associated with the Isaac River is used by local landholders, predominantly for stock water supply. A number of alluvium bores were identified to the south and south-west of DNM, the nearest being an “active” domestic supply bore adjacent to the Isaac River approximately 1 km south of DNM.

5.5 End of Mining

The potential impacts to the groundwater system post-closure, as relevant to the hydrogeology assessment for the PRC Plan, are relative to how the groundwater system recovers from active mining. Therefore, it is important to understand the nature of the groundwater system at the conclusion of mining immediately prior to the closure period.

A visual representation of the end mining CSM is provided as **Figure 5-1**, noting the features discussed above.

When mining below the water table commences there will be a local reversal of the hydraulic gradients and resulting in groundwater flowing back towards the mine voids. The active pits will all form local groundwater sinks during mining operations. At the conclusion of mining, the pits will all be dry and acting as groundwater sinks, with recovery in the post-mining environment resulting in the formation of pit lakes, as discussed in Section 8.0.

The OOPD associated with the Pandora Pit will conclude receival of waste rock at the end of mining, and will achieve its final landform, to remain stable in the post-closure environment. There will be a higher rate of rainfall recharge over the area of the OOPD due to the more permeable and unstructured nature of waste rock. The rainfall infiltrating the OOPD will exit the OOPD in the following ways:

- Evaporation and transpiration from the OOPD as it is profiled to its final form and vegetated;
- Possible localised seepage from the toe of the OOPD where the underlying soil permeability does not permit infiltration at the rate water is percolating through the OOPD. This seepage may be captured in a toe drain around the OOPD; and,

- Seepage through the base of the OOPD to the underlying Tertiary/Quaternary sediments and weathered Permian coal measures.

It is anticipated that the higher rate of recharge to the OOPD will result in seepage / recharge to the underlying strata at a rate higher rate than would occur in the absence of the OOPD, due to a greater volume of water infiltrating and being retained by the spoil. The higher rate of recharge to the underlying strata will result in a local mounding of groundwater. Groundwater mounding beneath the OOPD will migrate outwards towards the Pandora Pit void which will act as a strong local sink for groundwater, and potentially off site to the west and south. The position of the groundwater divide beneath the OOPD will depend on the infiltration rate to the spoil. The higher the infiltration rate to the OOPD the higher the hydraulic gradient west of the divide and the greater the potential for off-site migration of groundwater from below the OOPD.

Rainfall infiltration through the OOPD may leach substances from the waste rock, although leachability data indicates that the waste rock which will comprise the OOPD is overwhelmingly non acid forming with excess acid neutralising capacity, and has a negligible risk of developing acid metalliferous drainage, including acid drainage, neutral metalliferous drainage and/or saline drainage. The waste rock leachability test data is a poor proxy for a “source term” in that is likely to overestimate the concentrations of substances that may leach from the OOPD. Leachate quality from DNM spoil leachability tests does not exceed any of the local Water Quality Objectives for Isaac Groundwaters (Zone 34). Consequently, the potential risk posed by off-site migration of seepage from the OOPD is considered low

Based on previous DNM groundwater modelling presented in SLR (2025d), key hydrogeological features present at the end of mining that are relevant to the discussion of potential groundwater impacts post-mining are likely to be:

- Groundwater drawdown within the Rangal Coal Measures, associated with passive dewatering into the DNM mine pit voids, results in inwards hydraulic flow gradients in the coal measures in all pits;
- Fault displacement of Permian sequences has potentially formed hydraulic barriers, resulting in compartmentalisation within hydrostratigraphic units;
- Mine pit voids capture seepage from in-pit spoil emplacements;
- Potential for minor seepage from the OOPD, and groundwater mounding in the local underlying strata;;
- Little to no impact on environmental receptors; and
- No likely impact on anthropogenic receptors.

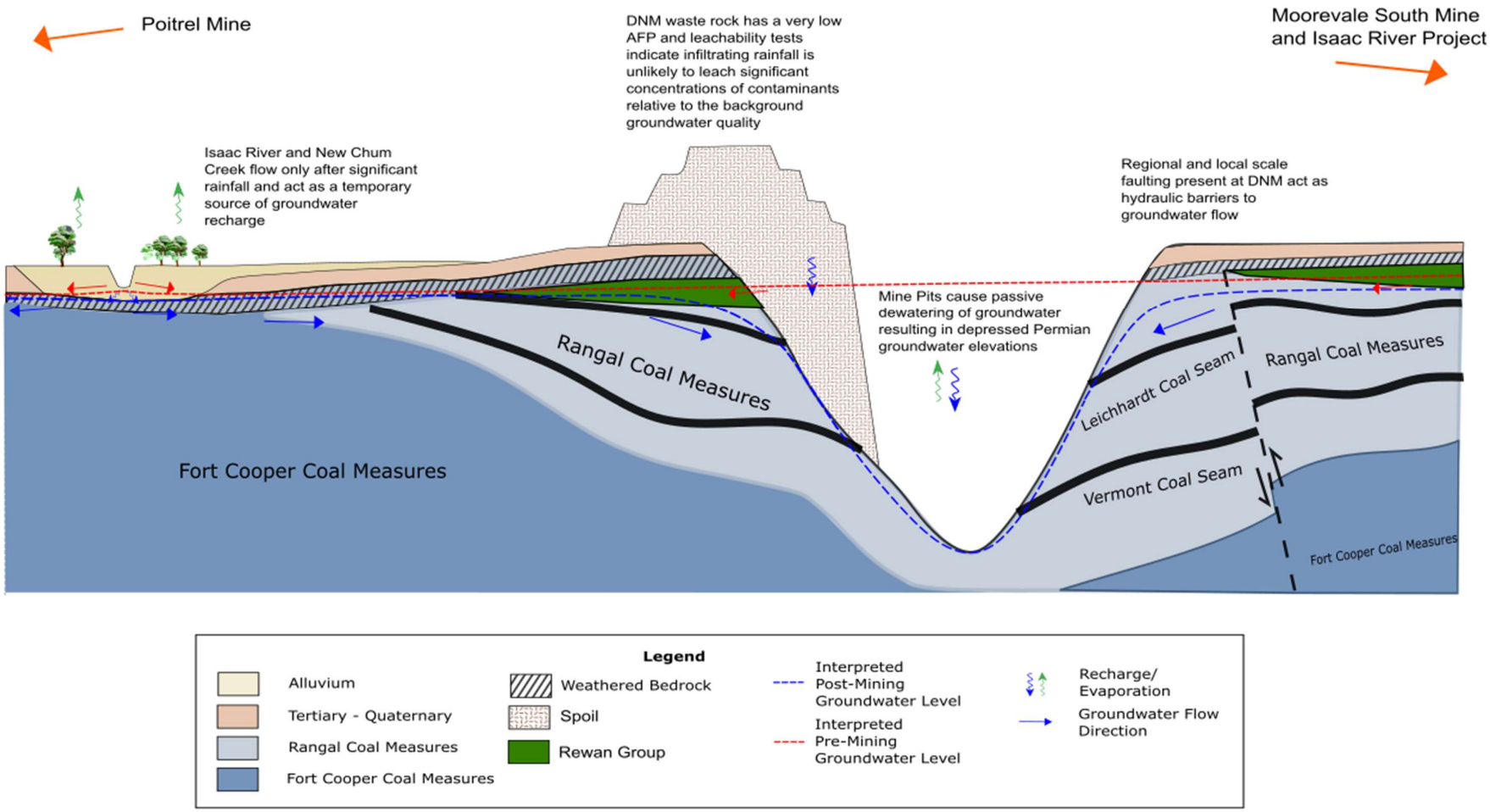


Figure 5-1 Conceptual Model of the Regional Groundwater System – End of Mining

6.0 Potential Impacts

Potential Impacts associated with shallow sources of potential groundwater contamination at DNM are being assessed for the PRC Plan by a separate Contaminated Land Assessment. This hydrogeology assessment focuses on the larger scale impacts to the site groundwater system.

6.1 Groundwater System at End of Mining

The potential impacts to the groundwater system post-closure, as relevant to the hydrogeology assessment for the PRC Plan, are relative to how the groundwater system recovers from active mining. Therefore, it is important to understand the nature of the groundwater system at the conclusion of mining immediately prior to the closure period. The SLR (2025b) and SLR (2025c and 2025d) work has been interrogated to provide an indication of the predicted nature of the DNM groundwater system at the end of mining, and potential groundwater system impacts that may have arisen at the end of mining. These can be summarised as:

- Groundwater level drawdown of the Permian coal measures, associated with passive dewatering into the active DNM mine pit voids. The magnitude of this drawdown will be most significant in the immediate vicinity of the pit voids, but extend northwards, eastwards and southwards of DNM by several kilometres and interact with drawdown from nearby mines such as Poitrel, Millennium, Winchester South and Olive Downs;
- No groundwater level drawdown of the alluvium;
- No significant groundwater-related effect on surface water flows of the Isaac River;
- Limited potential for groundwater level drawdown impacts to potential GDE's along the Isaac River and New Chum Creek to the west of the DNM, where the water table in the regolith material may be accessed by deeper rooted riparian species and may be subject to relatively small drawdowns;
- The more permeable and unstructured nature of waste rock the anticipated higher infiltration rate (compared to the natural ground) over the out of pit dump (OOPD) located on the south-west side of Pandora Pit, will result in greater recharge to the underlying strata; and
- Low potential for water infiltrating through the OOPD to leach substances from the waste rock, which could result in significant changes in groundwater quality beneath and down hydraulic gradient of the OOPD.

6.2 Groundwater System Post-Mining

Potential impacts to the groundwater system in the post-closure period as relevant to this hydrogeology assessment are summarised as:

- Void water level recovery (i.e. lake formation) significantly below the pre-mining groundwater levels in all the northern pits, and significantly below the base of weathering or any shallow Cainozoic aquifers;
- The higher recharge applied to the OOPD is predicted to result in slightly higher predicted groundwater inflows to the Pandora Pit void. However, predicted void lake levels remain far below the crest level of the void, and the elevation of Quaternary and Tertiary sediments.
- Partial groundwater system recovery outside the voids, particularly in the Permian coal measures;

- Recent modelling (SLR, 2026b) assumes that rainfall infiltration passes through the OOPD and reaches the groundwater table. There is the potential for water infiltrating through the OOPD to leach substances from the waste rock, which may result in changes in groundwater quality beneath the OOPD
- Potential for salinisation of residual void lakes through evapo-concentrtation.

7.0 Groundwater Modelling

7.1 Model Details

The Central Bowen Basin regional numerical groundwater model was adopted for the PRC Plan's hydrogeological assessment. This section provides a summary of the design and development of the numerical groundwater model (the model). Full details of the numerical groundwater model adopted in this hydrogeological assessment are included within SLR (2025b).

The Central Bowen Basin regional numerical groundwater model was deemed appropriate for the purposes of the PRC Plan for the following reasons:

- Adoption of the MODFLOW-USG code in the existing model allows for sufficient refinement of the model grid around the DNM operations such that the limitations of a regional model in terms of the grid design are mitigated;
- The model incorporates the DNM geologic model with model layer representation consistent with the geologic model;
- The stochastic model is calibrated using an extensive regional dataset, including data collected at neighbouring mines. Calibration of the ensemble incorporates optimisations to the regional dataset and localised subsets at individual mine sites. The model realisation with the best fit to the DNM dataset was selected for the project assessment;
- The model incorporates regional influences that may interact with the groundwater system (and model predictions) post-closure at DNM, including operations at the neighbouring mines Poitrel and Moorvale South that are considered likely to interact with the DNM voids given their proximity;
- The model has previously been used at DNM to support Water License compliance reporting to the State; and
- The version of the model adopted for the DNM PRC Plan is the latest update to the existing Central Bowen Basin 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 previous 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).

7.1.1 Model Objectives

Numerical modelling was undertaken in support of this hydrogeology assessment for the PRC Plan 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 voids;
- Assess long-term impacts of proposed spoil emplacement.
- Simulate the level and rate of recovery of the void lakes, and the level and rate of mining-related groundwater drawdown recovery in the groundwater system surrounding the voids; and
- Identify areas of potential risk, such as private supply bores or GDEs where groundwater impact mitigation/control measures may be necessary post-closure.

7.1.2 Model Design

The most recently updated (2025) version of the Central Bowen Basin regional groundwater model, adopted for the updated DNM PRC Plan, is designed primarily to predict regional scale mining impacts in a cumulative impact framework. That is, mines such as DNM are represented within the regional cumulative hydrogeological impact framework in which they sit.

The current Central Bowen Basin regional numerical groundwater model builds on the Olive Downs Project EIS model (the foundational regional Bowen Basin model) (HydroSimulations, 2018). The foundational model was subsequently updated for the Moorvale South Project in 2019 (SLR, 2019), for the Winchester South Project EIS in 2020 (SLR, 2020), for the Lake Vermont North Project and CVM HPE Project in 2021 (SLR, 2021b), for Daunia Mine Water License reporting in 2021 (SLR, 2021a), for the Saraji East Mining Lease Project in 2022 (SLR, 2022b), and most recently for the Peak Downs Mine Continuation Project (PDMCP) in 2025 (SLR, 2025a).

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.

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 7-1**. Those layers identified in the table as not present at DNM are 'pinched out' at DNM within the MODFLOW-USG code.

Table 7-1 Model Layering

Model Layer	Geologic Formation	Hydrogeologic Unit	Present in the DNM
1	Quaternary alluvium (Qa), Quaternary colluvium, Tertiary basalt (at outcrop)	Quaternary alluvium, surface cover	Yes
2	Tertiary-Quaternary alluvium (TQa), Tertiary sediments, Tertiary basalt	Tertiary-Quaternary alluvium, Tertiary sediments, weathered Permian (collectively 'regolith') Tertiary basalt	Yes
3	Rewan Group	Triassic	Yes (in part)
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

Model Layer	Geologic Formation	Hydrogeologic Unit	Present in the DNM
13		Interburden	Yes
14		P Seam	Yes
15		Interburden	Yes
16		H Seam	Yes
17		Interburden	Yes
18		D Seam	Yes
19		Interburden	Yes

7.2 Model Calibration

Model calibration was performed using a Sequential Monte Carlo (SMC) approach, which incrementally refines parameter distributions through a series of resampling and adjustment steps. This method begins with an ensemble of parameter realisations sampled from the prior distribution for each parameter, which is established on the basis of conceptual hydrogeological bounds. At each stage of calibration, the ensemble is updated by weighting realisations according to their likelihood that they result in acceptable calibration statistics with respect to the groundwater level observation dataset, followed by resampling and slight modification of parameter values to maintain diversity. To enhance the accuracy of the posterior parameter estimates, Laplace approximations to the likelihood function were employed, allowing for more precise characterisation of parameter uncertainty around high-likelihood regions. This approach enables a more flexible and robust assimilation of groundwater level data, particularly in the presence of nonlinearity and multimodality in the parameter space.

A detailed description of the calibration procedure for the most recent version of the Central Bowen Basin regional groundwater model is provided in SLR (2025d).

7.2.1 Calibration Targets

Transient calibration was for the period 2008 to 2024 and includes representation of historical mining at DNM, CVM, Peak Downs, Saraji, Lake Vermont, Poitrel, Millennium, Isaac Plains, Olive Downs, Eagle Downs, Winchester South, Isaac Downs, Moorvale South, and Meadowbrook mines.

For DNM specifically, calibration targets were selected from the regional dataset on the basis of monitoring locations that are within or proximal to the DNM. The resulting calibration target locations included all monitoring locations in the DNM monitoring network. In all, calibration used 580 targets heads for 13 monitoring locations across DNM with available groundwater level data.

The selected datasets were separated into two separate target datasets: (i) initial water level elevations (13 targets), and (ii) change in water level elevations (567 targets). The initial water level elevations are the first (i.e. earliest) groundwater level readings at each selected calibration location. The change in water level elevations are all subsequent water levels readings minus the initial water level elevation, this providing a dataset on the variability of the water levels with time. By calibrating to both datasets, the objective of calibration is to provide a balanced approach to calibration whereby the model is calibrated to both water level elevations, and the magnitude and timing of changes in water levels.

7.2.2 Calibration Performance

7.2.2.1 Evaluation Process

Calibration performance is assessed throughout the calibration process by tracking the following statistics for each of the calibration datasets:

- Mean (average) residual
- Median residual
- Standard deviation residual
- Lower Quartile Range (LQR)

A likelihood value is calculated for each of the realisation using each of the above-mentioned statistics for each of the calibration target datasets, resulting in 8 different likelihood values for each realisation. These eight likelihood values for each realisation are then combined (i.e. multiplied by each other) to establish an overall likelihood for the realisation based upon the combined calibration performance.

The Most Likely Estimate (MLE) model realisation (i.e. the parameter set that results in the highest likelihood, also otherwise known as the best calibrated model realisation) has been adopted for model predictions. **Sections 7.2.2.2** and **7.2.2.3** provide a summary of calibration performance for the MLE realisation.

7.2.2.2 Initial Water Level Elevations

Calibration statistics for the MLE using the initial water level elevation dataset are provided in **Table 7-2**. The four statistics used for the selection of the MLE are provided in **BOLD**, with other commonly reported calibration statistics provided for transparency.

Table 7-2 Initial Water Level Elevation Calibration Statistics

Statistics	Value
Mean Residual (m)	**0.04**
Median Residual (m)	**1.4**
Standard Deviation (m)	**6.1**
Lower Quartile Range (m)	**-4.2**
Mean Absolute Residual (m)	5.1
Sum of Squares (m2)	451.8
Root Mean Square Error (RMS) (m)	5.9
Minimum Residual (m)	-11.3
Maximum Residual (m)	8.6
Number of Observations	13
Range in Observations (m)	30.8
Scaled Standard Deviation (%)	19.9
Scaled Absolute Mean (%)	16.5
Scaled RMS (SRMS) (%)	19.1

Figure 7-1 presents the observed and simulated groundwater levels graphically as a scattergram for the initial water level elevations dataset for the DNM bores included in the calibration. **Figure 7-1** shows that the majority of data points fall close to the line of equality, with most lying within the expected confidence interval, indicating that the model generally performs well in reproducing observed groundwater levels.

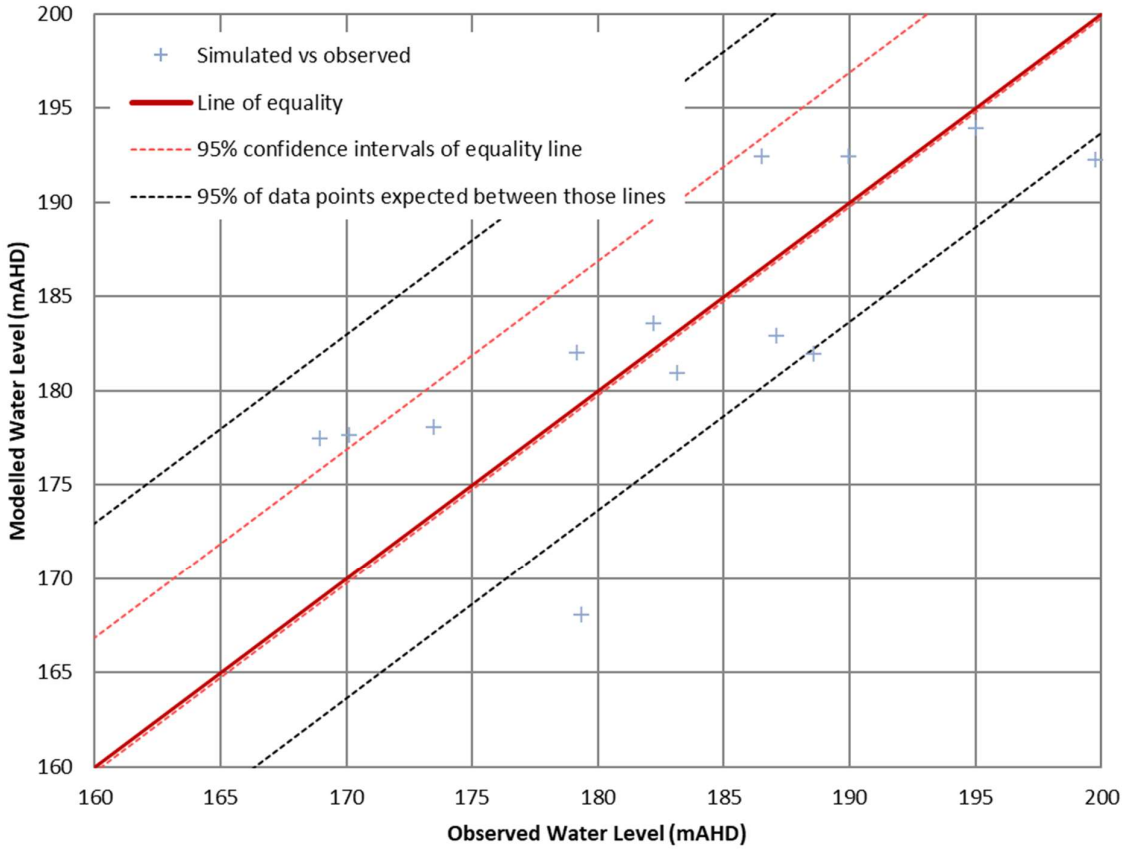


Figure 7-1 Calibration Scattergram – Modelled vs Observed Groundwater Levels (Initial Water Levels)

Figure 7-2 shows the distribution of calibration residuals for the initial groundwater level elevation dataset at the DNM bores included in the calibration. The histogram shows that the residuals are generally well centred around zero, indicating a balanced model performance with no strong bias toward either overprediction or underprediction of groundwater levels. Most residuals fall within the ±5 m range, suggesting a good overall fit to the measured data.

Figure 7-3 is a map depicting the spatial distribution of residuals for the initial water level elevations target dataset.

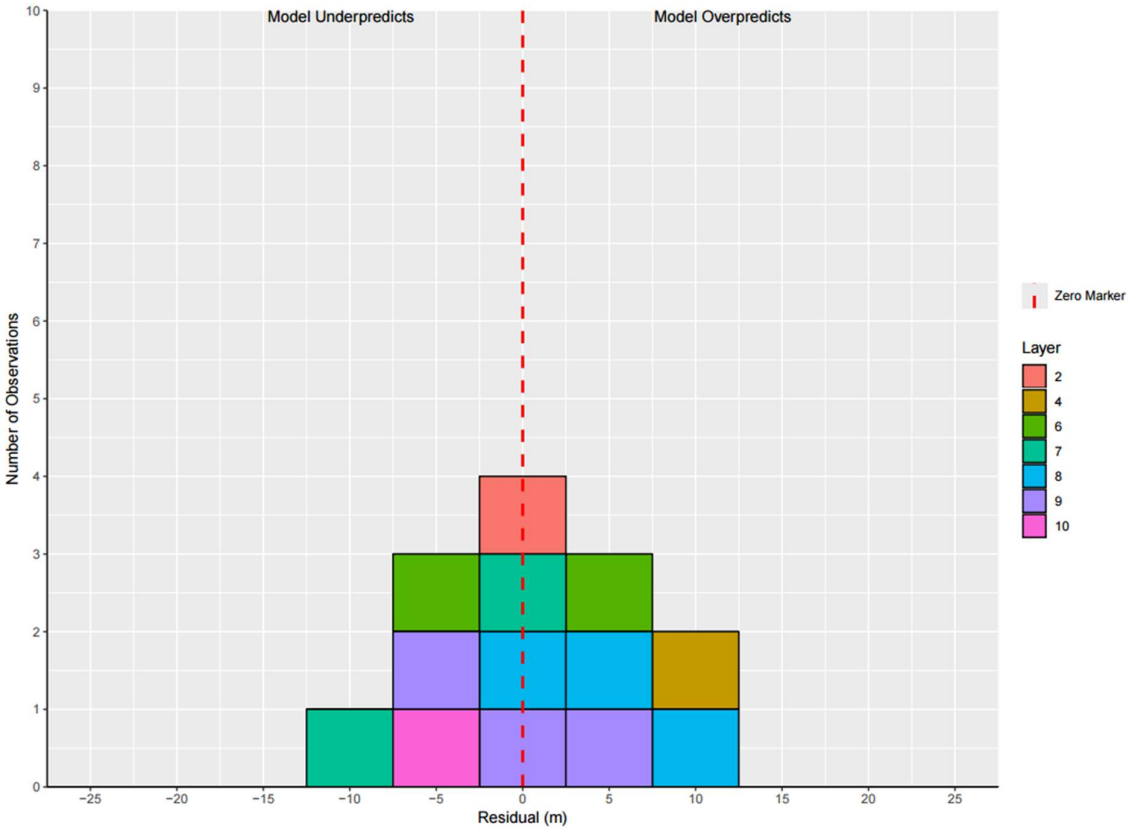
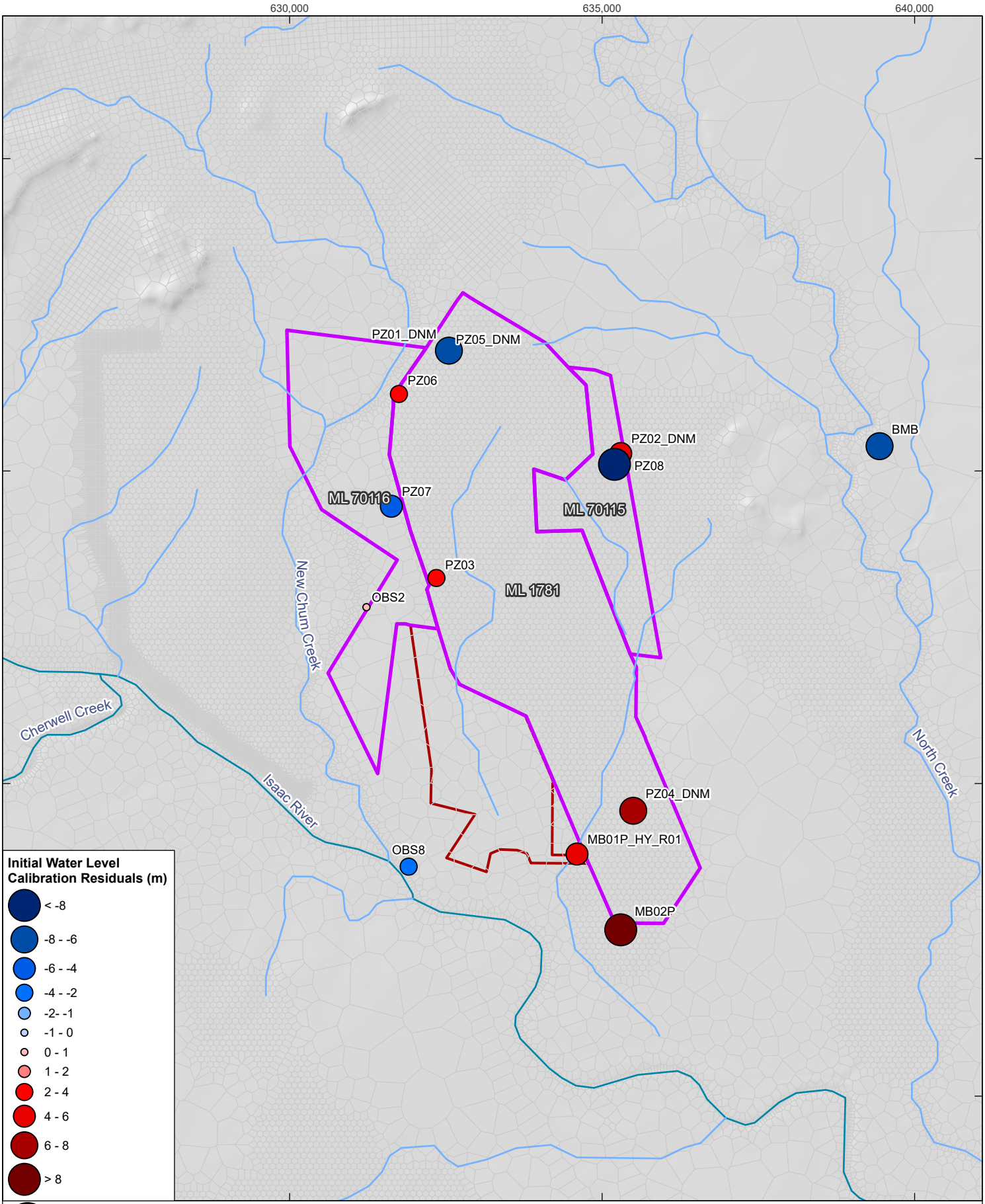


Figure 7-2 Calibration Residual Histogram (Initial Water Levels)



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Model Grid
- Model Boundary
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

INITIAL WATER LEVEL CALIBRATION RESIDUALS (M)

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 7-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-03_Initial Water Level Calibration Residuals (m)

7.2.2.3 Change in Water Level Elevations

Calibration statistics for the change in water level elevation dataset used in selecting the MLE are provided in **Table 7-3**. The statistics used to select the MLE are calculated on the average residual at each bore.

Additional commonly reported calibration statistics are shown on **Table 7-3**. The statistics provided on **Table 7-3** are calculated based on all measurements (i.e. using all datapoints rather than the average at each bore).

Table 7-3 Change in Water Level Elevation Calibration Statistics - MLE Selection

Statistics	Value
Mean Residual (m)	-1.1
Median Residual (m)	0.4
Standard Deviation (m)	-13.9
Lower Quartile Range (m)	-1.8

Table 7-4 Change in Water Level Elevation Calibration Statistics - Unweighted

Statistics	Value
Mean Residual (m)	-2.0
Mean Absolute Residual (m)	2.9
Standard Deviation (m)	4.5
Sum of Squares (m2)	13626.2
Root Mean Square Error (RMS) (m)	4.9
Minimum Residual (m)	-25.1
Maximum Residual (m)	8.8
Number of Observations	565
Range in Observations (m)	23.1
Scaled Standard Deviation (%)	19.4
Scaled Absolute Mean (%)	12.4
Scaled RMS (SRMS) (%)	21.3

Figure 7-4 presents the observed and simulated change in water level elevations graphically as a scattergram for the DNM bores included in the calibration. **Figure 7-4** shows that the majority of data points fall close to the line of equality, with most lying within the expected confidence interval, indicating that the model generally performs well in reproducing observed changes in groundwater levels. Bore PZ06 stands out as the model performed poorly in reproducing change in water levels at this bore, with a bias toward overestimating declines in water level.

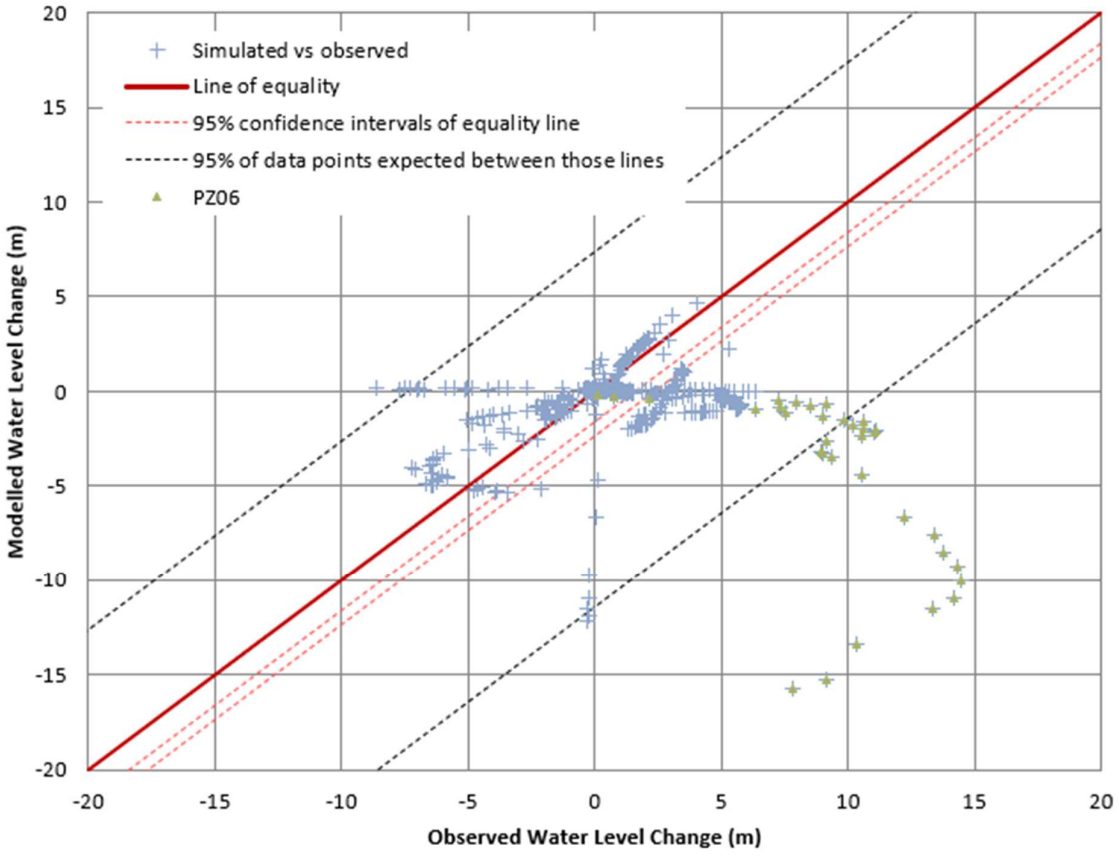


Figure 7-4 Calibration Scattergram – Modelled vs Observed Groundwater Levels (Change in Water Levels)

Figure 7-5 shows the distribution of calibration residuals for the change in groundwater level elevation dataset at the DNM bores included in the calibration. The histogram shows that the residuals are generally well centred around zero, indicating a balanced model performance. There is a small bias toward underprediction of change in groundwater levels. However, most residuals fall within the ±5 m range (except for PZ06), suggesting a good overall fit to the measured data.

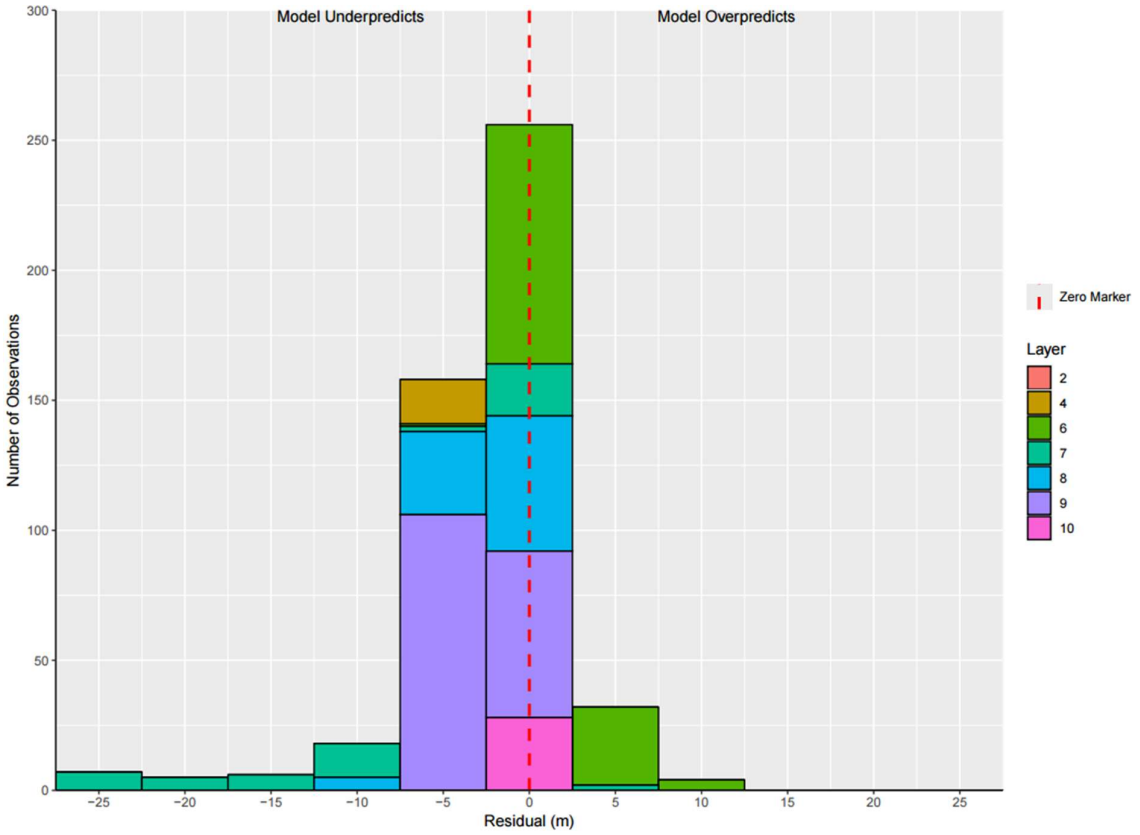
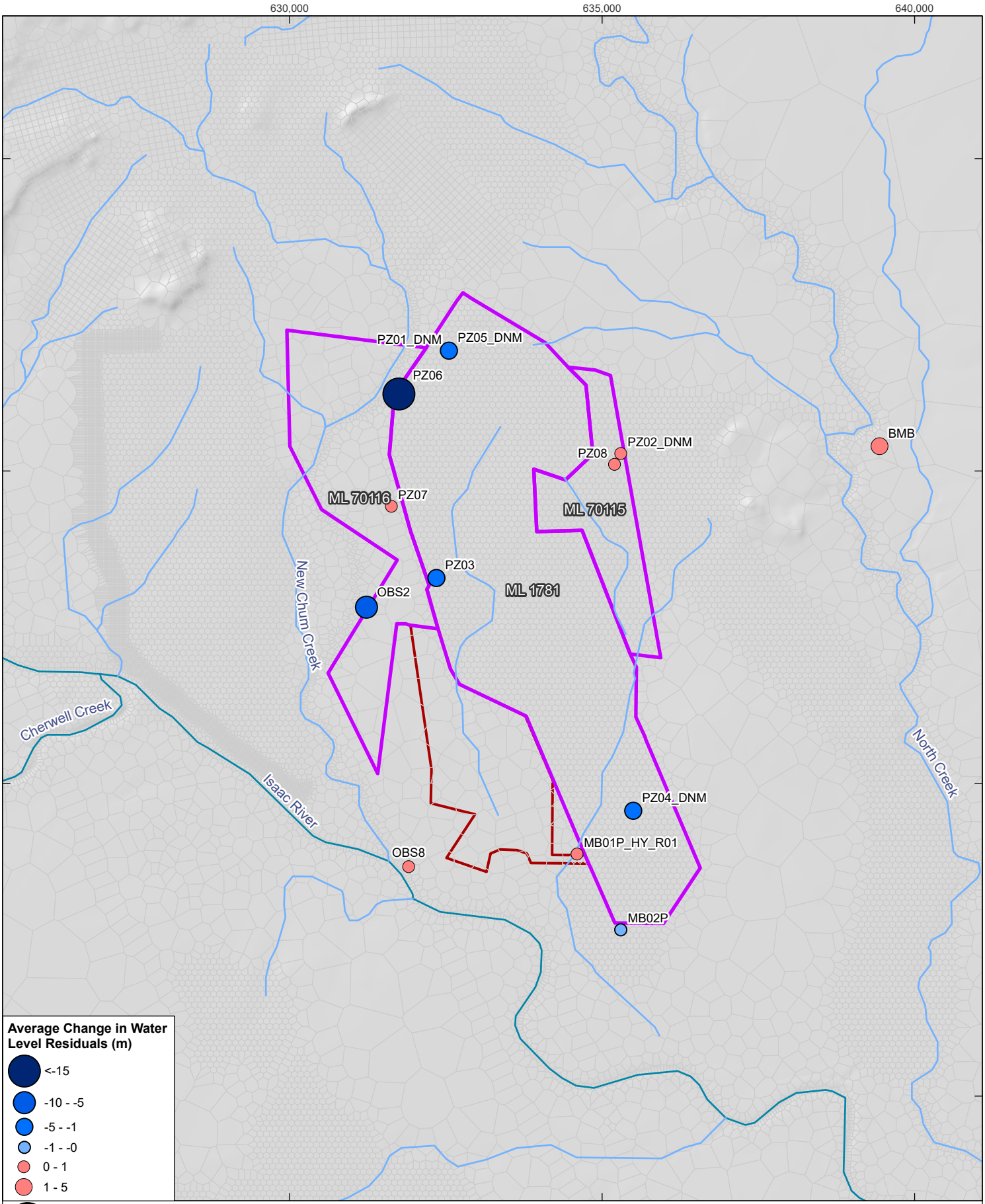


Figure 7-5 Calibration Residual Histogram (Change in Water Levels)

Figure 7-6 is a map depicting the spatial distribution of average residuals at each location for the change in water level elevations target dataset.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Model Grid
- Model Boundary
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

AVERAGE CHANGE IN WATER LEVEL CALIBRATION RESIDUALS (M)

SLR

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FIGURE 7-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-06_Average Change in Water Level Calibration Residuals (m)

7.2.3 Calibration Hydrographs

This section discusses the model to measurement fit at the DNM observation sites, for the MLE realisation. Example calibration hydrographs for a selection of monitoring bores at DNM are provided in **Figure 7-7** to **Figure 7-9**. The hydrographs for the full calibration data set (13 locations), comparing the observed data with simulated outputs from the MLE realisation at DNM, are included as **Appendix B**. Overall, the model demonstrates reasonable performance across the range of hydrographs, with areas of both relatively strong and relatively weak agreement as is typical in modelling.

7.2.3.1 Layer 2 (Tertiary-Quaternary alluvium, Tertiary sediments, weathered Permian, and Tertiary basalt)

Figure 7-7 shows the calibration hydrographs for DNM bore OBS8. As seen in the hydrographs for OBS8, there is generally a good match between the observed and simulated groundwater levels, with simulated level 2 m lower than observed on average.

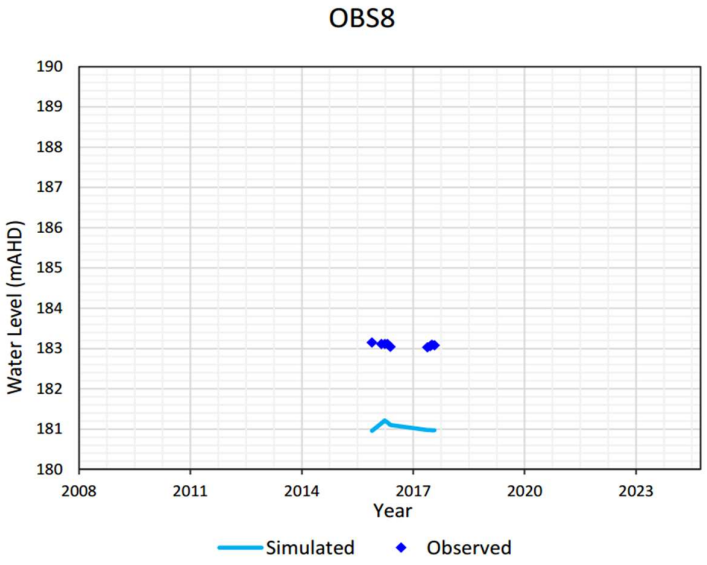


Figure 7-7 Calibration Fit – Layer 2 – Bore OBS8 (MLE Realisation)

7.2.3.2 Layers 4, 6, 8 and 9 (Rangal Coal Measures and Fort Cooper Coal Measures Interburden)

Example hydrographs for selected Interburden bores (PZ05-DNM and PZ02-DNM) are shown in **Figure 7-8**. Generally, trends are well reproduced in the interburden, as illustrated with bores PZ05-DNM and PZ02-DNM. Average absolute water levels difference between modelled and measured water levels are approximately 4 m for bore PZ05-DNM and 5 m for bore PZ02-DNM.

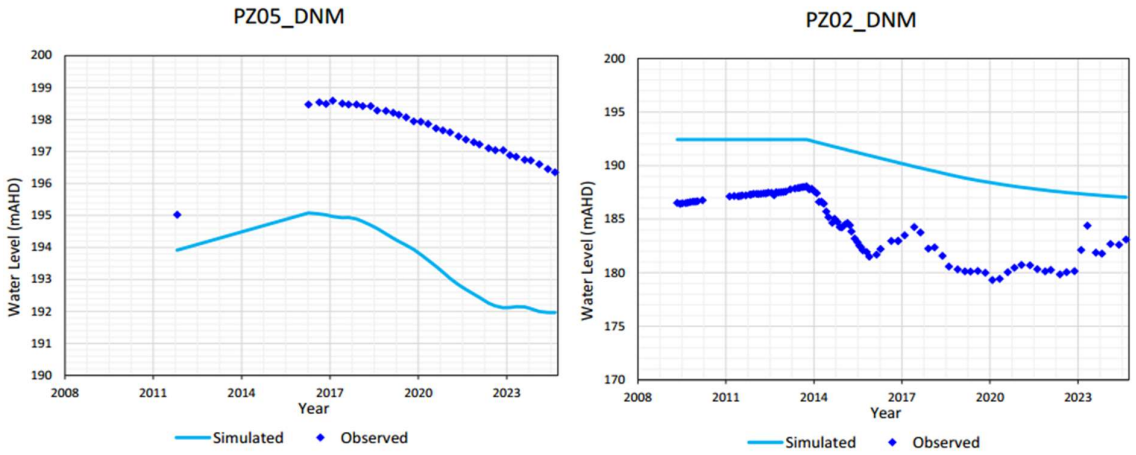


Figure 7-8 Example Calibration Fit – Interburden Bores (MLE Realisation)

7.2.3.3 Layers 7 and 10 (Rangal Coal Measures and Fort Cooper Coal Measures Coal Seams)

Example hydrographs for observation sites PZ06 (Vermont seam), PZ07 (Fort Cooper seams) and PZ08 (Vermont seam) within the coal seam layers are presented in **Figure 7-9**. The model effectively captures the overall trends in water level changes at these sites, except for PZ06, where an initial increase in water level is not simulated. Generally, the model tends to underestimate water levels in the coal seams, with average discrepancies of approximately 15 meters at PZ06, 10 meters at PZ08 and 4 meters at PZ07 when compared to measured data.

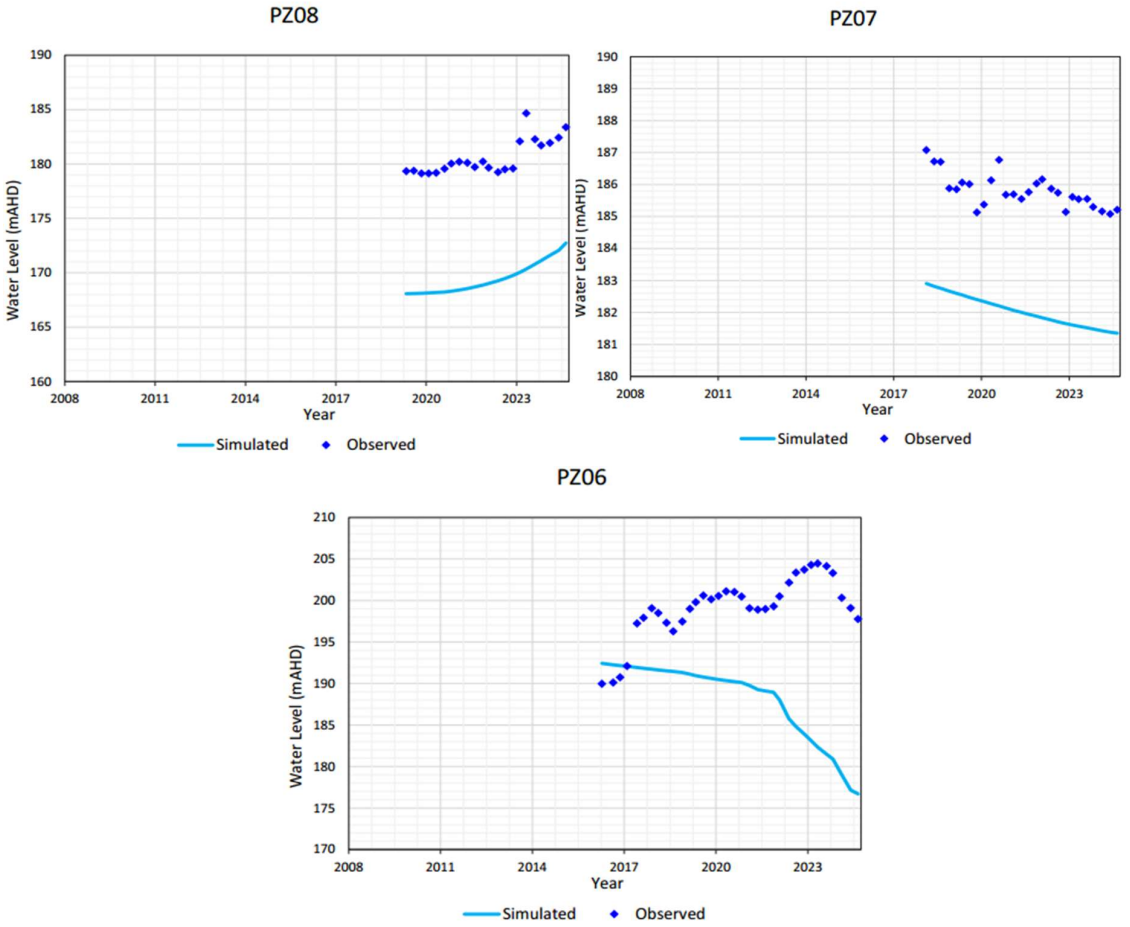


Figure 7-9 Calibration Fit – MCM Coal Seam Bores (MLE Realisation)

7.2.4 Model Water Balance

7.2.4.1 Steady State

The steady state water balance for the MLE realisation of the model is shown in **Table 7-5**. The water balance for the steady-state model indicates that regional groundwater inflow was the largest net inflow contributor to the steady state model (13.8 ML/d), followed by recharge (11.9 ML/d). Groundwater outflow is dominated by regional groundwater outflow (15.1 ML/d) and evapotranspiration (10.1 ML/d outflow) where the water table is within a few metres of the land surface. The mass balance error for the steady state calibration is less than 0.1%, within the error threshold recommended by the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 7-5 Steady-State Water Balance

Component	Inflow (ML/d)	Percent of Total Inflow (%)	Outflow (ML/d)	Percent of Total Outflow (%)
Recharge (RCH)	11.9	46%	-	-
ET (from GW) (EVT)	-	-	10.1	39%

Component	Inflow (ML/d)	Percent of Total Inflow (%)	Outflow (ML/d)	Percent of Total Outflow (%)
Rivers (RIV)	-	-	0.5	2%
Regional GW Flow (GHB)	13.8	54%	15.1	59%
Total	**25.7**	100%	**25.7**	100%

7.2.4.2 Transient Calibration Period

The model water balance for the MLE realisation in the transient calibration, averaged over the duration of the calibration period, is presented in **Table 7-6**.

The water balance for the MLE realisation in the transient calibration period indicates that recharge to the groundwater system within the model averages 14.2 ML/day. Approximately 10.2 ML/day is lost to evapotranspiration in areas where the water table is within a few metres of the land surface.

The net flux from the general head boundary (GHB) component is -1.2 ML/day, indicating that groundwater leaves the model domain through this boundary. 6.2 ML/day is removed from the model by the Drain boundary condition that represents cumulative mining in the model (Many mines are included in the model, including Daunia. See SLR (2025d) for a detailed review of active mines during prediction). River inflow and outflow are 0.9 and 0.5 ML/d, respectively, indicating a net inflow of approximately 0.4 ML/d. The mass balance error for the transient calibration is less than 0.1%, within the error threshold recommended by the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 7-6 Transient Calibration Period Water Balance

Component	Inflow (ML/d)	Percent of Total Inflow (%)	Outflow (ML/d)	Percent of Total Outflow (%)
Recharge (RCH)	14.2	40%	-	-
ET (from GW) (EVT)	-	-	10.2	28%
River (RIV)	0.9	3%	0.5	1%
Regional GW Flow (GHB)	13.8	38%	15.0	42%
Drains (DRN)	-	-	6.2	17%
Storage	7	19%	4.0	11%
Total	**35.9**	100%	**35.9**	100%

The transient water balance is presented on **Figure 7-10**. Recharge (Recharge In) stands out as the largest components of inflow. Water going into storage (Storage Out) shows peaks associated with large recharge events. Evapotranspiration (ET Out) also respond to sustained recharge events.

Water coming out of storage (Storage In) shows peaks associated with mine dewatering (Drains Out).

Contributions from regional boundary flow (head dep bounds In and Out) are relatively constant, highlighting that near steady state conditions exist at the model boundaries.

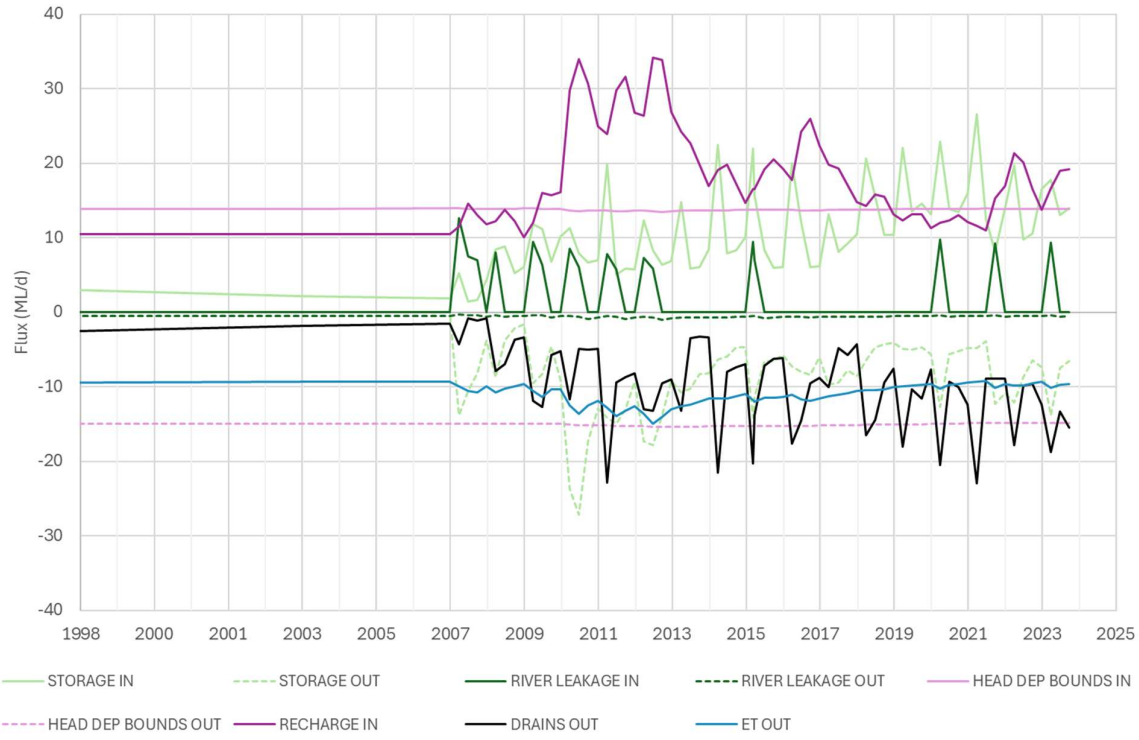


Figure 7-10 Transient Calibration Period Water Balance

7.2.5 Calibrated Hydraulic Parameters

Table 7-7 and **Table 7-8** summarise the calibrated parameter values for the MLE realisation, including horizontal hydraulic conductivity (Kx) and vertical to horizontal hydraulic conductivity ratio (Kz/Kx), Specific Storage (Ss) and Specific Yield (Sy). A depth dependence equation for the coal measures was used in the numerical groundwater model as described in detail in SLR (2025d), and therefore the calibrated hydraulic conductivity values vary across the model domain. Maximum depths used for the depth dependence equation for each unit as well as hydraulic parameters for the fault zones are shown on **Appendix C.**

Pilot points were used to model the spatial variability of horizontal and vertical hydraulic conductivity parameters (and specific yield, in the case of the Isaac River Alluvium) in some modelled geologic units, as described in detail in SLR (2025d). Pilot points were placed in the Isaac Alluvium and weathered formations, as well as any coal bearing formation, or formation with at least ten observation bores in the calibration observation database.

Table 7-7 Calibrated Hydraulic Parameters (Hydraulic Conductivity) – MLE Realisation

Geology Unit	Unit	Layer	Min Kx (m/d)	Max Kx (m/d)	Average Kx (m/d)	Min Kz (m/d)	Max Kz (m/d)	Average Kz (m/day)
Alluvium [1]	Surface Cover	1	3.7 x10-02	3.7 x10-02	3.7 x10-02	1.0 x10-03	1.0 x10-03	1.0 x10-03
Isaac River Alluvium [2]	Isaac River Alluvium	1	1.1 x10-03	1.9 x10+00	4.5 x10-02	2.2 x10-07	2.4 x10-02	2.9 x10-04
Regolith [1]	Surface Cover	1	2.4 x10-03	7.3 x10-01	6.1 x10-02	9.9 x10-07	5.6 x10-02	7.0 x10-04
Weathered Permian [1]	Surface Cover	1 & 2	3.9 x10-01	3.9 x10-01	3.9 x10-01	7.6 x10-03	7.6 x10-03	7.6 x10-03
Duaringa [1]	Surface Cover	1 & 2	4.8 x10-01	4.8 x10-01	4.8 x10-01	1.0 x10-02	1.0 x10-02	1.0 x10-02
Tertiary Basalt [1]	Tertiary Basalt	1 & 2	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.4 x10-05	3.4 x10-05	3.4 x10-05
Regolith [2]	Surface Cover	2	2.8 x10-03	7.3 x10-01	5.9 x10-02	2.0 x10-06	5.6 x10-02	6.7 x10-04
Rewan [2]	Triassic	3	6.2 x10-05	9.4 x10+00	9.8 x10-02	8.4 x10-08	3.2 x10-01	6.6 x10-04
Rangal Coal Measures [1]	Interburden	4	6.9 x10-04	6.5 x10-02	7.9 x10-03	9.6 x10-06	9.0 x10-04	1.1 x10-04
Rangal Coal Measures [2]	Leichhardt Seam	5	3.1 x10-05	9.5 x10-01	1.1 x10-02	7.3 x10-08	1.4 x10-02	9.8 x10-05
Rangal Coal Measures [1]	Interburden	6	1.4 x10-07	2.0 x10-04	1.4 x10-05	1.1 x10-09	1.5 x10-06	1.1 x10-07
Rangal Coal Measures [2]	Vermont Seam	7	8.0 x10-06	2.7 x10+00	8.9 x10-03	2.6 x10-08	4.9 x10-02	6.9 x10-05
Rangal Coal Measures [1]	Interburden	8	3.9 x10-06	1.4 x10-03	3.9 x10-05	6.4 x10-08	2.2 x10-05	6.4 x10-07
Fort Cooper Coal Measures [2]	Interburden	9	5.1 x10-05	5.4 x10-01	2.1 x10-02	6.3 x10-08	1.8 x10-02	1.6 x10-04
Fort Cooper Coal Measures [2]	Fort Cooper Seams	10	1.1 x10-05	8.0 x10-01	3.5 x10-03	8.2 x10-09	1.5 x10-02	1.9 x10-05
Fort Cooper Coal Measures [1]	Interburden	11	3.1 x10-05	4.6 x10-04	3.4 x10-05	1.2 x10-06	1.7 x10-05	1.3 x10-06
Moranbah Coal Measures [2]	Q Seam	12	2.0 x10-07	9.4 x10-01	2.5 x10-03	1.5 x10-10	1.9 x10-02	3.0 x10-05
Moranbah Coal Measures [1]	Interburden	13	3.0 x10-05	2.0 x10-02	6.3 x10-04	6.5 x10-07	4.4 x10-04	1.4 x10-05
Moranbah Coal Measures [2]	P Seam	14	3.8 x10-04	1.1 x10+00	2.0 x10-02	2.9 x10-07	2.3 x10-03	7.1 x10-05
Moranbah Coal Measures [1]	Interburden	15	1.3 x10-05	1.1 x10-02	3.1 x10-04	4.3 x10-08	3.7 x10-05	1.0 x10-06
Moranbah Coal Measures [2]	H Seam	16	1.5 x10-04	2.5 x10+00	4.5 x10-02	1.9 x10-07	3.2 x10-02	3.6 x10-04

Geology Unit	Unit	Layer	Min Kx (m/d)	Max Kx (m/d)	Average Kx (m/d)	Min Kz (m/d)	Max Kz (m/d)	Average Kz (m/day)
Moranbah Coal Measures [1]	Interburden	17	8.6 x10-05	1.4 x10-01	5.2 x10-03	4.0 x10-06	6.6 x10-03	2.4 x10-04
Moranbah Coal Measures [2]	D Seam	18	6.4 x10-06	1.3 x10+00	2.8 x10-03	4.4 x10-09	3.2 x10-02	6.2 x10-05
Moranbah Coal Measures [1]	Interburden	19	2.8 x10-04	2.4 x10-02	4.2 x10-04	1.1 x10-05	9.4 x10-04	1.6 x10-05

1 Pilot Points are not included
2 Pilot Points are included

Table 7-8 Calibrated Hydraulic Parameters (Storage) – MLE Realisation

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})
Alluvium	Surface Cover	1	1.1 x10-02	1.1 x10-02	1.1 x10-02	5.6 x10-06	5.6 x10-06	5.6 x10-06
Isaac River Alluvium *	Isaac River Alluvium	1	1.1 x10-03	2.0 x10-01	2.2 x10-02	9.0 x10-07	9.0 x10-07	9.0 x10-07
Regolith	Surface Cover	1	1.5 x10-02	1.5 x10-02	1.5 x10-02	2.1 x10-07	2.1 x10-07	2.1 x10-07
Weathered Permian	Surface Cover	1 & 2	1.1 x10-02	1.1 x10-02	1.1 x10-02	9.4 x10-07	9.4 x10-07	9.4 x10-07
Duaringa	Surface Cover	1 & 2	2.2 x10-03	2.2 x10-03	2.2 x10-03	5.1 x10-06	5.1 x10-06	5.1 x10-06
Tertiary Basalt	Tertiary Basalt	1 & 2	2.6 x10-03	2.6 x10-03	2.6 x10-03	1.9 x10-06	1.9 x10-06	1.9 x10-06
Regolith	Surface Cover	2	1.2 x10-02	1.2 x10-02	1.2 x10-02	9.1 x10-07	9.1 x10-07	9.1 x10-07
Rewan	Triassic	3	1.7 x10-03	1.7 x10-03	1.7 x10-03	3.4 x10-06	3.4 x10-06	3.4 x10-06
Rangal Coal Measures	Interburden	4	2.9 x10-03	2.9 x10-03	2.9 x10-03	7.2 x10-07	7.2 x10-07	7.2 x10-07
Rangal Coal Measures	Leichhardt Seam	5	4.7 x10-03	4.7 x10-03	4.7 x10-03	9.7 x10-07	9.7 x10-07	9.7 x10-07
Rangal Coal Measures	Interburden	6	5.0 x10-03	5.0 x10-03	5.0 x10-03	1.0 x10-06	1.0 x10-06	1.0 x10-06
Rangal Coal Measures	Vermont Seam	7	3.2 x10-03	3.2 x10-03	3.2 x10-03	6.7 x10-07	6.7 x10-07	6.7 x10-07
Rangal Coal Measures	Interburden	8	3.4 x10-04	3.4 x10-04	3.4 x10-04	6.2 x10-07	6.2 x10-07	6.2 x10-07
Fort Cooper Coal Measures	Interburden	9	2.7 x10-04	2.7 x10-04	2.7 x10-04	1.5 x10-06	1.5 x10-06	1.5 x10-06

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})
Fort Cooper Coal Measures	Fort Cooper Seams	10	2.1 x10-03	2.1 x10-03	2.1 x10-03	9.3 x10-07	9.3 x10-07	9.3 x10-07
Fort Cooper Coal Measures	Interburden	11	7.2 x10-03	7.2 x10-03	7.2 x10-03	6.5 x10-07	6.5 x10-07	6.5 x10-07
Moranbah Coal Measures	Q Seam	12	6.5 x10-04	6.5 x10-04	6.5 x10-04	2.4 x10-06	2.4 x10-06	2.4 x10-06
Moranbah Coal Measures	Interburden	13	2.0 x10-04	2.0 x10-04	2.0 x10-04	6.8 x10-07	6.8 x10-07	6.8 x10-07
Moranbah Coal Measures	P Seam	14	3.7 x10-04	3.7 x10-04	3.7 x10-04	4.5 x10-07	4.5 x10-07	4.5 x10-07
Moranbah Coal Measures	Interburden	15	7.5 x10-04	7.5 x10-04	7.5 x10-04	6.4 x10-07	6.4 x10-07	6.4 x10-07
Moranbah Coal Measures	H Seam	16	5.8 x10-04	5.8 x10-04	5.8 x10-04	2.0 x10-06	2.0 x10-06	2.0 x10-06
Moranbah Coal Measures	Interburden	17	4.6 x10-04	4.6 x10-04	4.6 x10-04	6.8 x10-07	6.8 x10-07	6.8 x10-07
Moranbah Coal Measures	D Seam	18	1.5 x10-03	1.5 x10-03	1.5 x10-03	5.6 x10-07	5.6 x10-07	5.6 x10-07
Moranbah Coal Measures	Interburden	19	1.6 x10-03	1.6 x10-03	1.6 x10-03	3.9 x10-06	3.9 x10-06	3.9 x10-06

* Pilot points are included only for the Sy of Isaac River Alluvium

The properties of mine spoil emplacement simulated using the TVM package were adjusted during the calibration process. The spoil parameter values for the MLE realisation are shown in **Table 7-9.**

Table 7-9 Calibrated Spoil Hydraulic Parameters – MLE Realisation

Parameter	Value
Horizontal hydraulic conductivity (m/day)	2.48
Vertical hydraulic conductivity (m/day)	0.05
Specific Yield (%)	0.01
Specific Storage (1/m)	1.4 x10-05

7.2.6 Calibrated Recharge

Table 7-10 presents the calibrated recharge rates for each recharge zone (geological unit outcrop area) in the model. These calibrated recharge rates have been adopted into the predictive model. The mean annual rainfall for the DNM was assumed to be 566 mm/year consistent with SILO grid point data reported in **Section 2.1.**

Table 7-10 Calibrated Rainfall Recharge – MLE Realisation

Model Recharge Zone	% of Rainfall	Long-term Average Rainfall Recharge (mm/yr)
Alluvium Isaac River Channel	0.08%	0.4
Alluvium Isaac River	0.04%	0.2
Alluvium (rest of the model)	0.93%	5.2
Regolith	0.02%	0.1
Weathered Permian	0.09%	0.5
Duaringa Formation (Tertiary)	0.04%	0.2
Tertiary Basalts	0.42%	2.4
Spoil	3.7%	21

7.2.7 Calibrated Evapotranspiration (EVT)

Table 7-11 presents the calibrated EVT extinction depth for each zone in the model. The EVT rate was not calibrated and was applied as per the model design described in SLR (2026b).

Table 7-11 Calibrated EVT Extinction Depth – MLE Realisation

Model EVT Zone	Extinction Depth (m)
Alluvium	1.4
Regolith	14.4
Weathered Permian	1.9
Duaringa Formation	1.4
Tertiary Basalts	5.2
Permian Outcrop	0.9
Spoil	0.6

7.2.8 Other Calibrated Boundary Conditions

Calibrated parameters for general head boundary and riverbed vertical conductivity are provided for each zone on **Appendix C.**

7.3 Model Performance and Limitations

The groundwater modelling was conducted in accordance with the *Australian groundwater modelling guideline* (Barnett et al. 2012) and the MDBC Groundwater Flow Modelling Guideline (MDBC, 2001). These are mostly generic guides and do not include specific guidelines on special applications, such as open cut mine modelling.

The model confidence level (Class 1, Class 2 or Class 3 in order of increasing confidence) based on the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) was previously widely used in the industry. The latest version of the IESC Explanatory Note for Uncertainty Analysis (Peeters and Middlemis, 2023) introduces a new concept on how model confidence can be assessed. The document also indicates that this change will follow in the next iteration of the Australian Modelling Guidelines and the new concept for assessing model confidence is hence applied for this groundwater model.

The latest version of the IESC Explanatory Note for Uncertainty Analysis defines a model fit for purpose when model results are:

- Usable – Relevant to the decision-making process, providing information about the uncertainty in conceptualisations and modelling simulations in a way that allows decision-makers to understand the effects of uncertainty on project objectives and the effects of potential bias. The relevant Quantities of Interests (QoI) in this context are the mine inflows and change in groundwater levels;
- Reliable – Demonstrate that the range of model outcomes is consistent with the system knowledge and honours historical observations and provides objective evidence that uncertainties affecting decision-critical predictions are not underestimated. The calibration performance was deemed acceptable. Although uncertainty analysis was not part of the scope of work, uncertainties are reviewed qualitatively in **Table 7-12**; and
- Feasible – Trade-offs due to budget, time and technical constraints are reasonable and justifiable within the risk context of the project. This groundwater model was built to estimate groundwater inflows to the mine and groundwater levels post closure. The model complexity and calibration process is deemed commensurate with long term risk associated with the post mining landform.

To assess these three points above, the four sources of scientific uncertainty (structural, parametrisation, measurement error, predictions) have been qualitatively assessed with regards key aspects of the groundwater model, as presented **Table 7-12**.

Table 7-12 Groundwater Model and Data Limitations and Potential Recommended Updates

Type	Part	Status	Comment
Structural/ Conceptual	Grid and Model Extent	Fit for purpose.	The groundwater model has an unstructured Voronoi grid that includes detailed cell refinement around the mining area, mapped geological structures and along drainage features. The groundwater model extent was designed to prevent boundary influence on modelled drawdown/mounding.
	Layers	Fit for purpose	Top of Layer 1 uses detailed Digital Elevation Model (DEM) data. Representation of alluvium and regolith based on publicly available mapped geology and Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2015) regolith mapping. Model vertical resolution is sufficient to represent relevant geological units and unstructured grid allows layer pinch out where units not present.
	Conceptualisation – Geological Structure	Fit for purpose Potential for further assessment	The structure of the geology within the mine area is based on mapped geology and existing ground investigation at the Mine, which is limited to bores drilled within different lithologies. Further ground investigation could improve the site conceptualisation, especially for the presence and thickness of alluvium associated with the Isaac River.
	Conceptualisation – GDEs	Fit for purpose Potential for further assessment	GDE data from national assessment was used to identify key receptor areas. Local studies for DNM are to be conducted in 2025 to better identify key GDE areas.
	Conceptualisation – Surface Water Groundwater Interactions	Fit for purpose.	Key groundwater–surface water interaction is related to drainage features and associated alluvium as well as pit lakes.
	Conceptualisation – Saturated Extent of Alluvium and Regolith	Fit for purpose. Potential for further assessment.	Several monitoring bores are present within the alluvium in the Isaac River and monitored regularly. Further investigations and monitoring could help assess flow dynamics along the Isaac River near the DNM.
Parameterisation	Hydraulic Conductivity	Fit for purpose. Future improvements could be made.	Limited site-specific hydraulic conductivity data (horizontal) was available. Additional data (if available) should be utilised to verify and update the model.

Type	Part	Status	Comment
	Rivers	Fit for purpose. Improvements possible.	Major rivers and creeks were represented using the RIV package with smoothed riverbed elevations. Stage data from regional gauging stations were adjusted to reflect the seasonal nature of the Isaac River. Local stage data collection would improve future assessments.
	Recharge	Fit for purpose	Recharge zonation is based on mapped surface geology and regional site conceptualisation
Measurement Error	Observation Data Quality	Fit for purpose Future improvements could be made.	Incorporation of any new groundwater level monitoring to refine the groundwater model in future.
	Landholder Bore Data Quality	Fit for purpose	Publicly available private bore data were incorporated in the model calibration across the model domain.
	Temporal spread	Fit for purpose. Future improvements possible.	Timeseries water level data with varying resolution has been used in the model calibration.
Scenario Uncertainties Future stresses/ conditions	Calibration	Fit for purpose. Future improvement possible.	A transient calibration model was run and calibrated to observed groundwater levels using sequential Monte Carlo analysis. The model calibration could be further refined if additional monitoring bores are installed, and more data is collected in the mining areas.
	Predictive	Fit for purpose.	Model captures open cut mining progression and timing at the DNM Coal Mine based on data provided by Whitehaven. The surrounding mine plans have been included based on the data sharing agreement (i.e. most recent mine plans).
	Uncertainty and sensitivity	NA	Uncertainty and sensitivity analyses were not included as part of this scope of work.

7.4 Mine Pit Inflows

Predicted groundwater inflow estimates for DNM are provided in **Figure 7-11**. The simulated inflows for future approved mining at DNM between 2025 and 2041 were predicted to reach a maximum peak in year 2030 at 737.8 ML/year (2.0 ML/day). Simulated inflows remained relatively consistent between 2032 and 2041 at between approximately 250 and 350 ML/year (0.68 to 0.96 ML/day), excluding 2036 and 2040 which are predicted as 418.8 (1.1 ML/day) and 496.8 (1.4 ML/day) respectively.

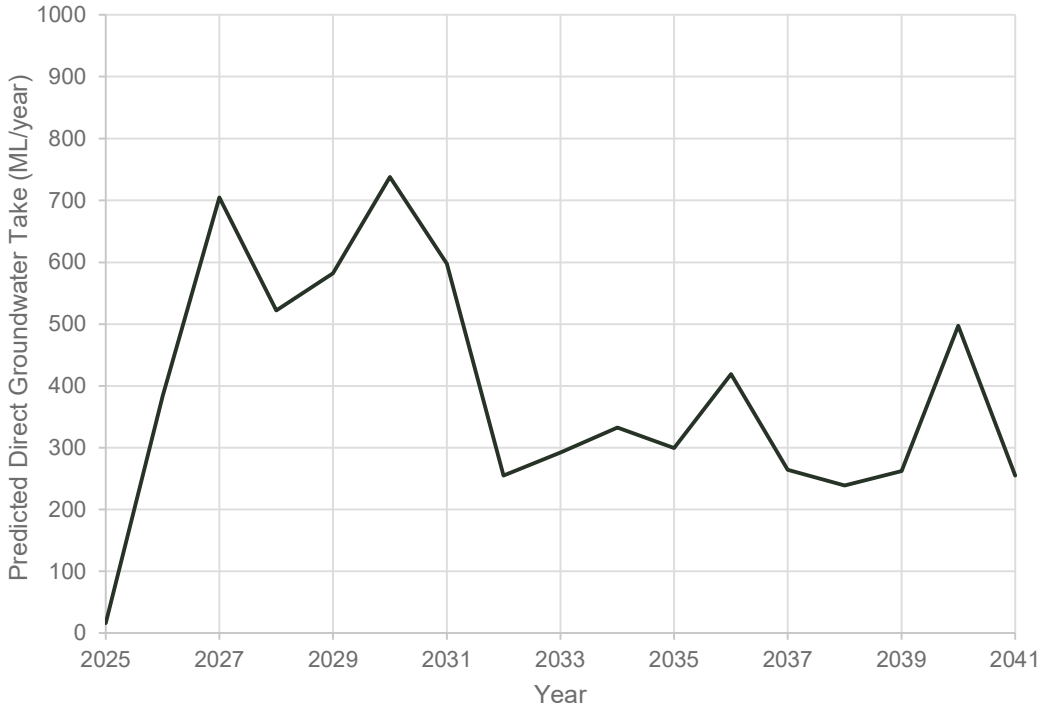


Figure 7-11 Predicted Future Mine Pit Groundwater Inflow at DNM

7.5 PRC Plan Final Landform Model

Post-mining groundwater impacts at DNM were investigated for the purposes of the PRC Plan's hydrogeology assessment with a numerical groundwater recovery model for the final landform (i.e. three residual voids and OOPD; refer **Section 1.2**).

7.5.1 Model Setup

The PRC Plan's proposed final landform was replicated in the model, including areas of spoil emplacement within the mined out pits, OOPD and the three proposed residual voids (**Appendix A**).

The recovery stress periods of the overall model setup commence from the end of mining at DNM (end of the year 2041) and were run for 977 years over 125 model stress periods. The recovery stress period setup is shown in **Table 7-13**. Note the stress period setup also accounts for simulated recovery at other mine voids within the model domain, i.e. is not designed only for the recovery simulation at DNM.

Table 7-13 Recovery Model Stress Periods

Model Period	Date from	Date to
Calibration	1988	October 2024
Prediction - Mining	November 2024	2041
Prediction - Post Mining	2042	3019

The predicted end of mining heads, and thus starting heads for recovery, for each relevant hydrostratigraphic unit are provided in **Appendix A.**

Climate related boundary conditions (i.e. recharge and ET) in the recovery model were set constant for the duration of the recovery model, at their values consistent with the latest version of the predictive model (SLR, 2026b). Recharge and ET were not applied to the final voids themselves in the groundwater model, since the WRM (2025) water balance model used iteratively with the groundwater model (see **Section 7.5.2**) 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 latest version of the model (SLR, 2025c). 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 x 10-6 m-1), to simulate free water movement within the residual void. This approach is often referred to as a 'high-K' lake.

The simulation of mines adjacent to DNM (refer **Figure 1-1**) in the groundwater model, such as Poitrel to the west of the DNM, Millennium to the northwest of the DNM, and Moorvale South to the southeast of the DNM, has the potential to influence the model results. The simulation of Poitrel and Millennium within the groundwater model is unchanged from the latest version of the groundwater model (SLR, 2025d), i.e. mining at both Poitrel and Millennium ceases in the model in the year 2027 (i.e. prior to the DNM recovery model simulation) and the mined-out pits are parameterised as being wholly backfilled with spoil. The simulation of Moorvale South within the groundwater model is consistent with the PRC Plan being developed for that site concurrently with the DNM PRC Plan, i.e. using the same numerical model and incorporating the Moorvale South final landform (including its residual voids) available at the time of the DNM PRC Plan hydrogeology assessment development.

7.5.2 Residual Void Lake Recovery

The residual voids will accumulate water over time due to rainfall, surface water runoff and groundwater inflows from recovered groundwater levels. 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 (WRM, 2025).

The iterative modelling approach was undertaken in a stepwise manner as follows:

1. Initial predicted groundwater inflows with time to the DNM residual voids were estimated by WRM (2025) using analytical inflow calculations that were incorporated in the WRM (2026) water balance model;
2. The pit lake levels with time were then predicted by the WRM (2026) water balance model, incorporating groundwater (Step 1) and surface water fluxes and processes;
3. To refine the Step 1 estimation of residual void groundwater inflows, the daily residual void water elevations derived from the WRM (2026) water balance modelling (Step 2) were then replicated by SLR within the numerical groundwater model for the final landform using the time variant constant head boundary (CHD) condition, adopting a simplified average of the WRM (2026) daily results over the relevant groundwater model stress period length;

Figure 7-12 through **Figure 7-14** provide a graphical representation of the final simulated recovery of water levels in the residual voids, based on the iterative groundwater and surface water balance modelling.

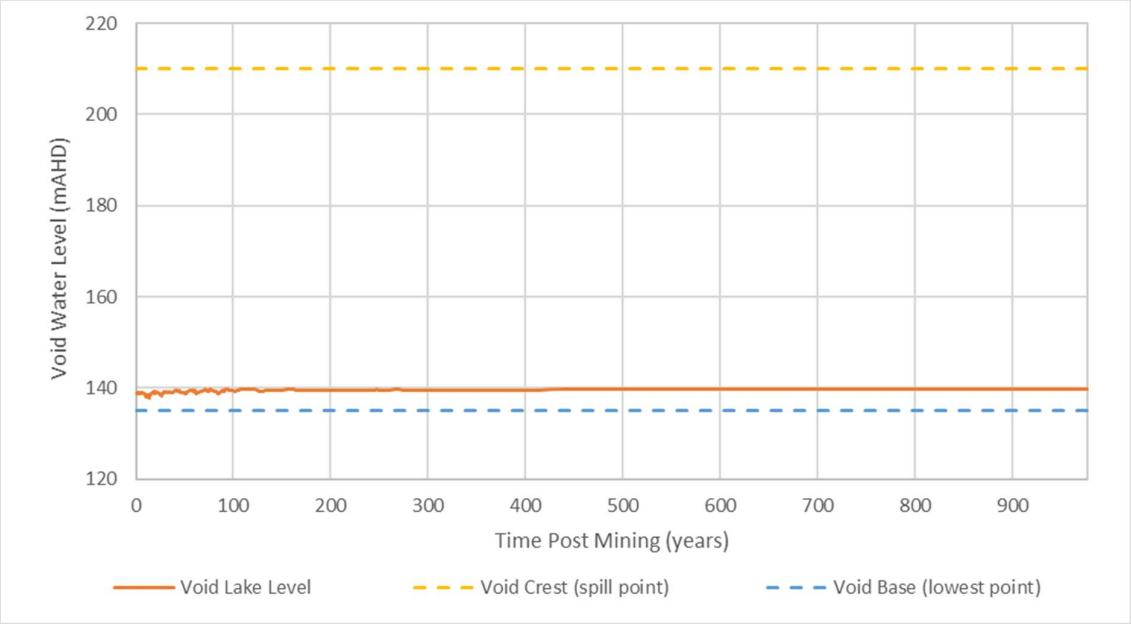


Figure 7-12 Simulated Void Water Level Recovery over Time – Titan North (based on WRM, 2025)

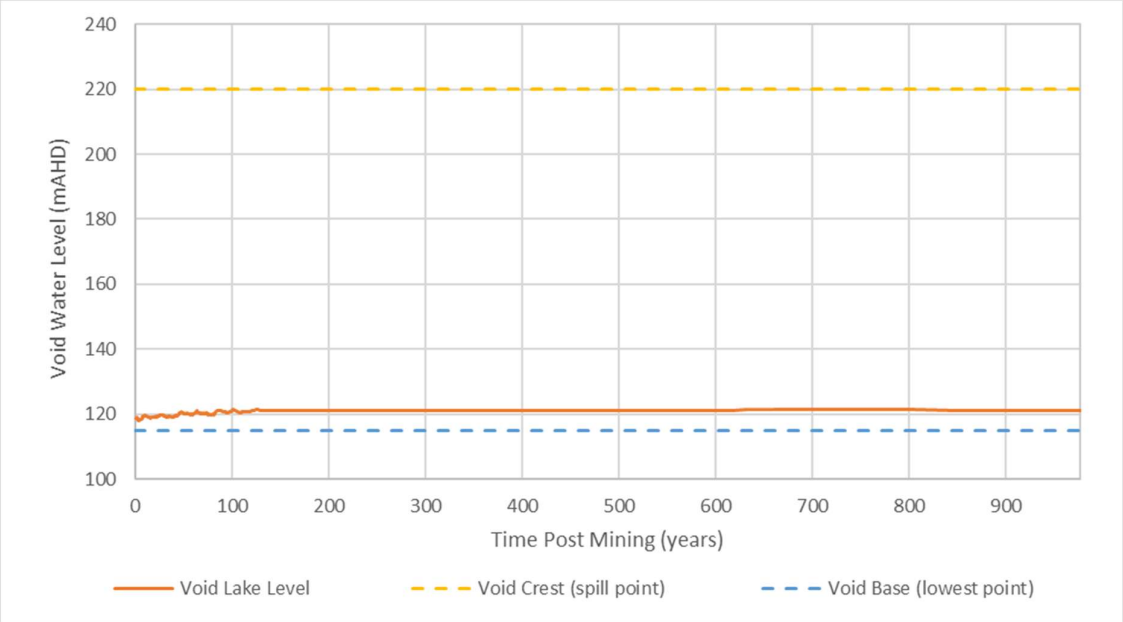


Figure 7-13 Simulated Void Water Level Recovery over Time – Titan East Void (based on WRM, 2025)

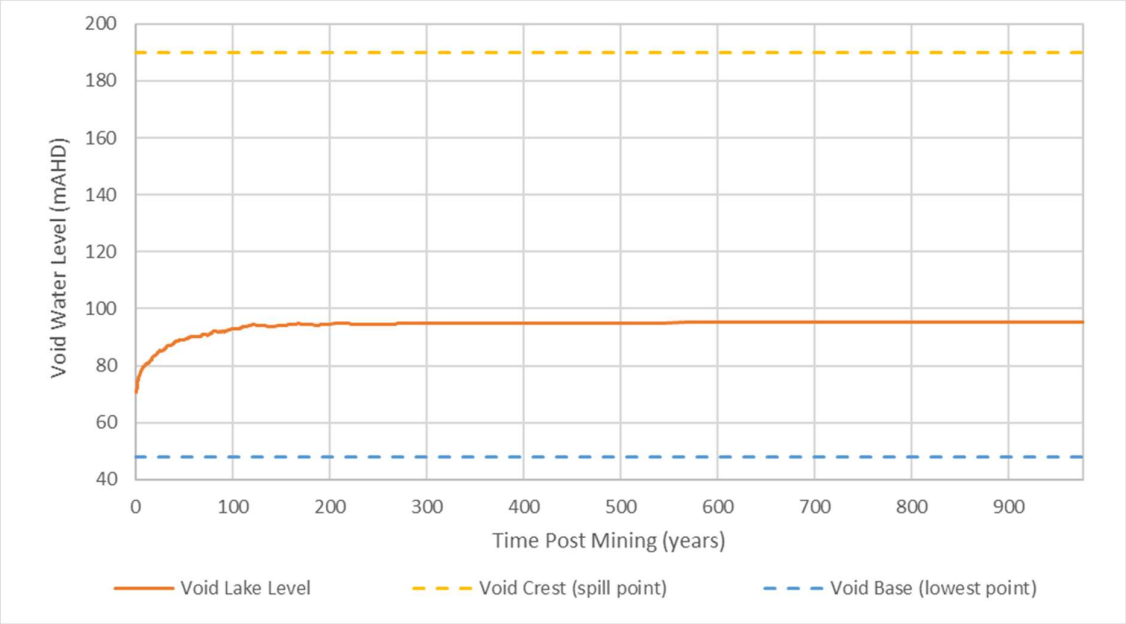


Figure 7-14 Simulated Void Water Level Recovery over Time – Pandora Void (based on WRM, 2025)

Figure 7-12 through **Figure 7-14** show that the residual void water level recovery is a slow process, with the recovery rate declining as the lakes reach equilibrium conditions. The majority of recovery in the voids is achieved within the first 50 years for Titan East and North, and 100 years for Pandora void. Equilibrium water level conditions are reached after approximately 100 to 200 years. Equilibrium is achieved while there are still stress periods of a maximum 1 year duration occurring in the groundwater model. Thus, the groundwater model setup allows for capturing the predicted lake level variability until stabilisation. The predicted equilibrated water levels in the residual voids are shown in **Table 7-14**.

Table 7-14 Equilibrated Water Levels in the Residual Voids (based on WRM, 2025)

Residual Void	Initial water level (mAHD)	Approximate time to equilibrium (years)	Equilibrium water level (mAHD)
Titan North	139	100	140
Titan East	119	150	121
Pandora	71	200	95

The freeboard for each of the residual voids (i.e. the difference in elevation between the long-term water levels in the residual voids and the landform crest elevation) is as shown in **Table 7-15**. Predicted void lake levels remain significantly below the surface 'spill' level for each of the residual voids.

Table 7-15 Predicted Freeboard in the Residual Voids at Equilibrium

Climate Scenario	Residual Void	Freeboard (m)
Wetter	Titan North	70
	Titan East	99
	Pandora	95

The difference in elevation between the long-term water levels in the residual voids and the lowest point of the base of the shallow geologic formations (weathered regolith; model Layer 2) adjacent the voids is as shown in **Table 7-16**. Predicted residual void lake levels remain significantly below the base of the shallow geologic formations for each of the residual voids, even with the temporal fluctuations in void water levels predicted by the WRM (2025) water balance model. That is, there is never the potential for a flux of water to leave the residual voids and enter the shallow geologic formations.

Table 7-16 Predicted Difference between Residual Void Water Levels and Shallow Formations

Residual Void	Lowest Elevation of base of Model Layer 2 adjacent Void (mAHD)	Difference between void lake level and lowest elevation of base of Model Layer 2 adjacent Void (m)[1]	
		Start of Post-Mining	Post-Mining Equilibrium
Titan North	189.8	50.8	49.8
Titan East	196.3	77.3	75.3
Pandora	162.3	91.3	67.3

[1]A positive number means the base of Model Layer 2 is that many metres higher than the void lake level

7.5.3 Residual Void Groundwater Inflow

The final predicted groundwater inflows to the residual voids from the groundwater model are shown on **Figure 7-15** through **Figure 7-17**, with inflows partitioned between that which flows into the residual voids through spoil, and that which flows into the residual voids through surrounding natural geological formations.

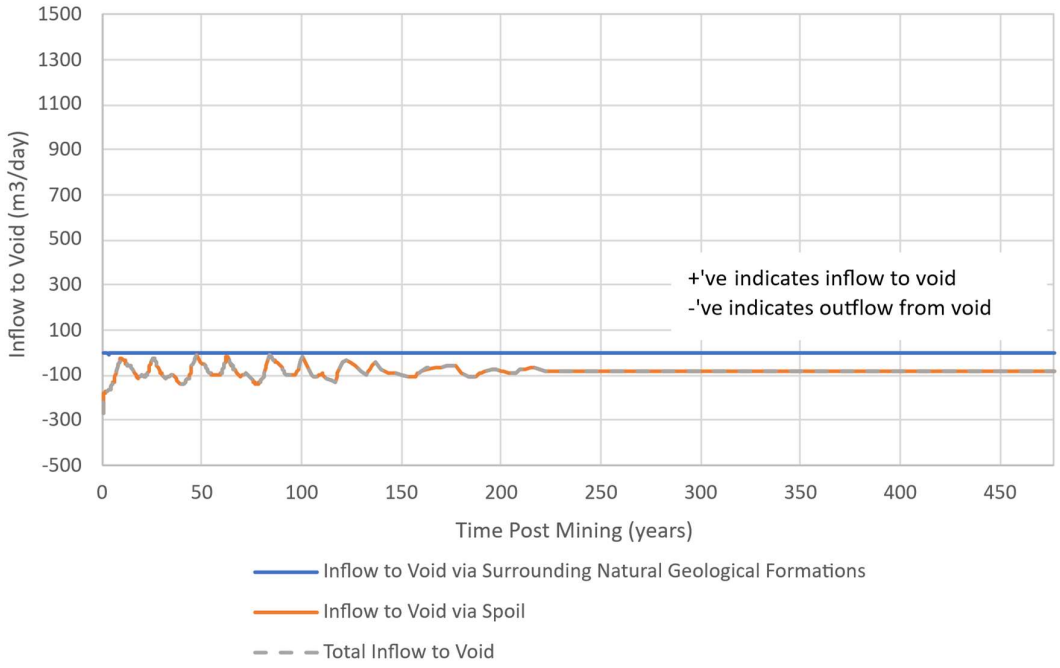


Figure 7-15 Predicted Residual Void Groundwater Inflows – Titan North

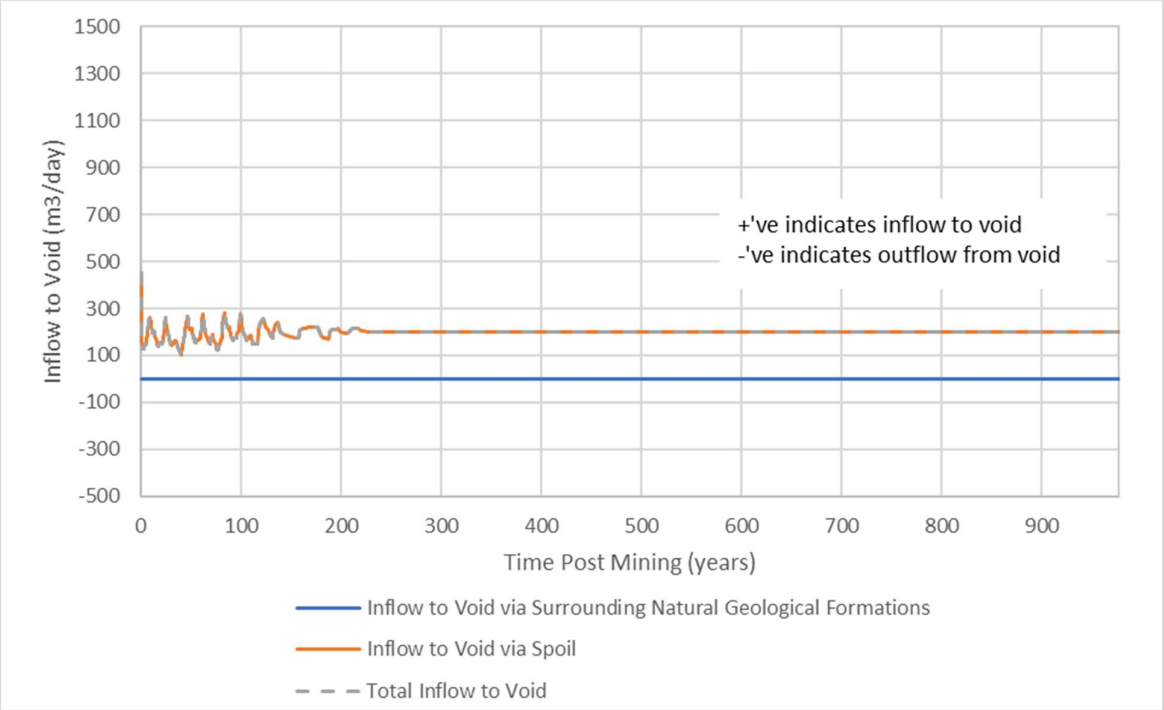


Figure 7-16 Predicted Residual Void Groundwater Inflows – Titan East Void

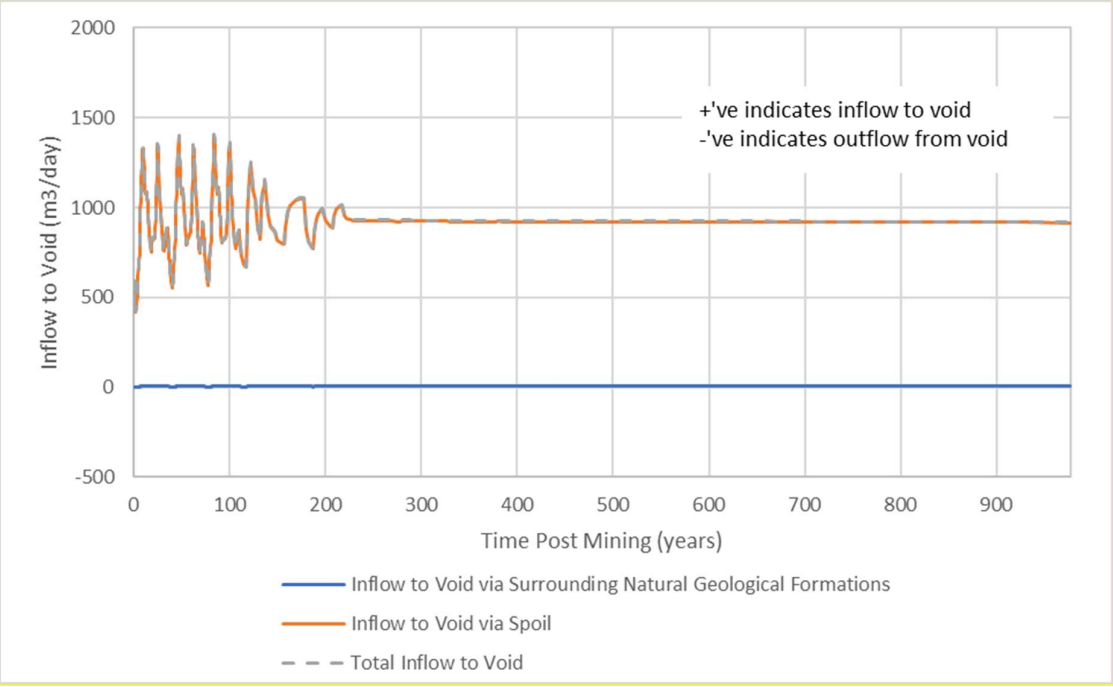


Figure 7-17 Predicted Residual Void Groundwater Inflows – Pandora Void

There is some variability in the predicted inflow magnitudes over approximately the first 250 years post-mining for all voids (refer **Figure 7-12** through **Figure 7-14**).

At Titan North, groundwater inflows are typically negative, indicating an outflow (from the void toward the spoil), however a very small positive inflow (i.e., from the spoil to the void) is simulated in some years within the 0 to 100 years recovery period. Outflows at Titan North are predicted to stabilise after 280 years. At Titan East and Pandora voids, inflows are predicted to stabilise after 240 years. Model results indicate that most of the long-term groundwater inflow to the voids comes via the spoil at all three voids, originating mainly as local recharge applied to the spoil. Potential impacts associated with predicted outflows are evaluated with particle tracking in **Section 7.5.5.**

Predicted equilibrium groundwater inflows to each of the voids are presented in **Table 7-17**.

Table 7-17 Equilibrium Groundwater Inflow to the Residual Voids

Residual Void	Equilibrium Inflow Rate – Spoil (m^3/day)	Equilibrium Inflow Rate – Natural Geological Formations (m^3/day)	Equilibrium Inflow Rate – Total (m^3/day)
Titan North	-77.6	0.2	-77.4
Titan East	201.7	0.003	201.7
Pandora	916.2	4.5	921.1

7.5.4 Predicted Groundwater Levels

7.5.4.1 Groundwater Levels – General

The predicted post-mining equilibrium water table elevation is shown on **Figure 7-18**. Predicted groundwater levels for the Leichhardt and Vermont Seams of the Rangal Coal Measures (model layers 5 and 7, respectively) outside of the residual voids are shown on **Figure 7-19** and **Figure 7-20**. Note that the simulated influence of the Moorvale South Project residual voids to the west-southwest of the DNM is clearly evident in **Figure 7-18** through **Figure 7-20**.

As shown on **Figure 7-18**, within the DNM (including areas of spoil backfill in the DNM) the water table is predicted to remain depressed in the long term, driven by the ongoing groundwater discharge to the residual void lakes governed by the relatively low lake elevations. That is, long term inwards groundwater flow gradients to the residual voids are maintained post-mining due to the low lake levels from which there is continual evaporation. The steepest water table gradients outside the voids themselves occur northeast of the DNM adjacent the Titan East Void, whereas gradients north and west of Titan North and surrounding the Pandora Void are generally somewhat shallower.

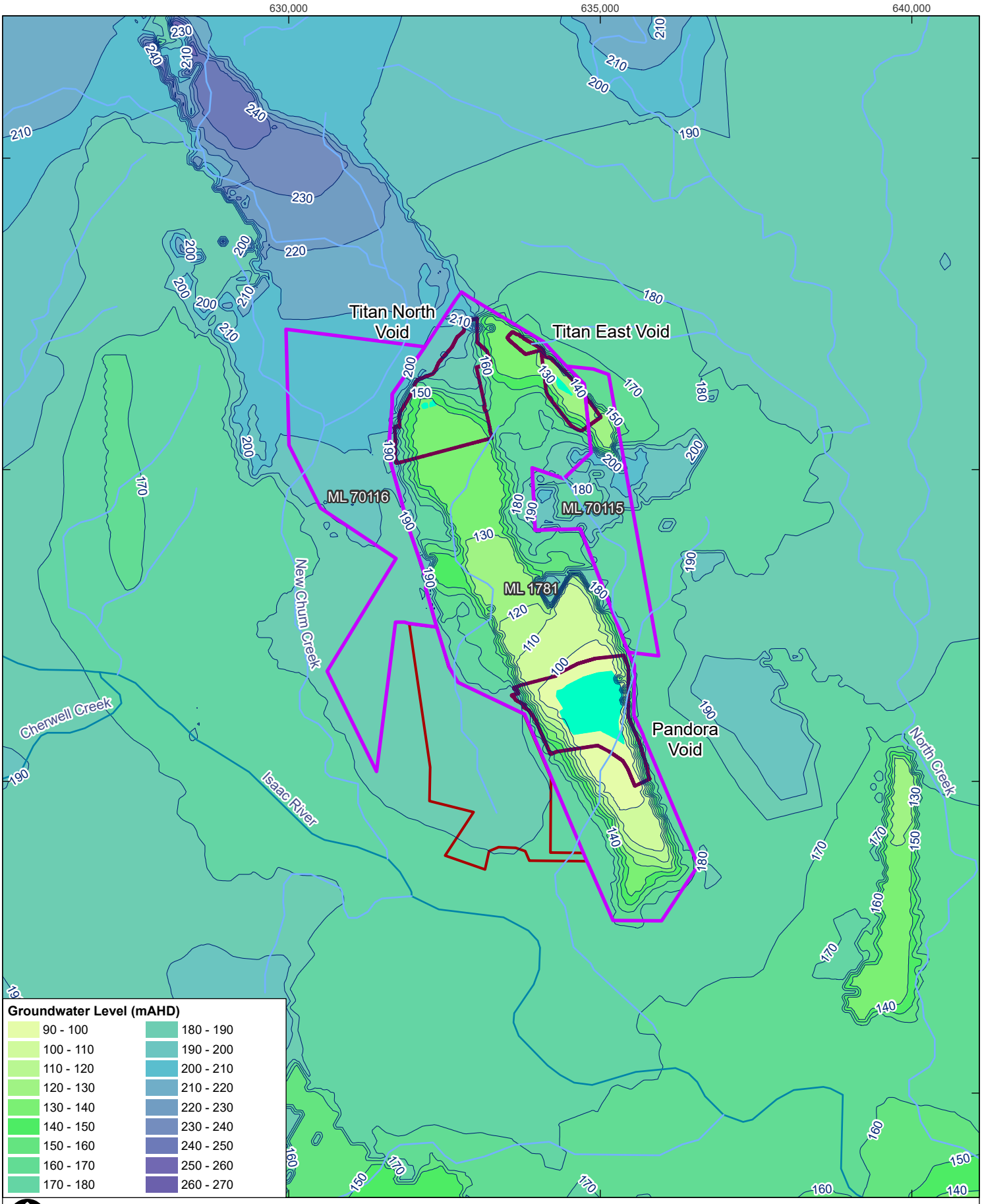
Predicted groundwater levels for the Leichhardt and Vermont Seams of the Permian Coal Measures indicate again that groundwater levels in the Permian sequence are predicted to remain depressed in the long term, driven by the ongoing evaporation-driven groundwater discharge to the residual void lakes and governed by the low lake elevations. Generally, predicted groundwater levels are very similar between the Leichhardt and Vermont seams. The effect of the significant structural geology (see **Section 3.2.4**) can be seen in **Figure 7-19** and **Figure 7-20.**

There are broad areas to the west, east and south of DNM where the seams are geologically absent. There are also fringing areas where the seams are predicted to be ‘dry’ (unsaturated) in the long-term post-mining, particularly on and immediately adjacent to the DNM.

Predictive hydrographs showing the change in groundwater levels over time for the Leichhardt and Vermont Seams of the Permian Coal Measures just outside the residual voids (within approximately 150 m of the residual void crests) are shown as **Figure 7-21** through **Figure 7-24,** with the hydrograph locations shown on Figure 7-19 and **Figure 7-20.**

The hydrographs demonstrate that the majority of groundwater level drawdown in the Permian Coal Measures occurs during mining operations, with post-closure groundwater levels in the Permian coal seams adjacent Titan North and Titan East voids recovering slightly from their lowest point that occurred during mining.

Post-closure groundwater levels adjacent Pandora Void are not predicted to recover from the lowest point predicted to occur shortly after the cessation of mining, with the Leichhardt Seam in the vicinity of Pandora Void predicted to be fully unsaturated in the long term and the Vermont Seam predicted to slowly become unsaturated post closure. The hydrographs also demonstrate very little effect on groundwater levels from the residual void inflow variability in the early post-closure period as shown and discussed in **Section 1.0**. Predicted residual void lake levels remain significantly below predicted groundwater levels surrounding DNM at all times, indicating no potential for outwards movement of void water to the Leichhardt or Vermont Seams outside the residual voids.



SLR

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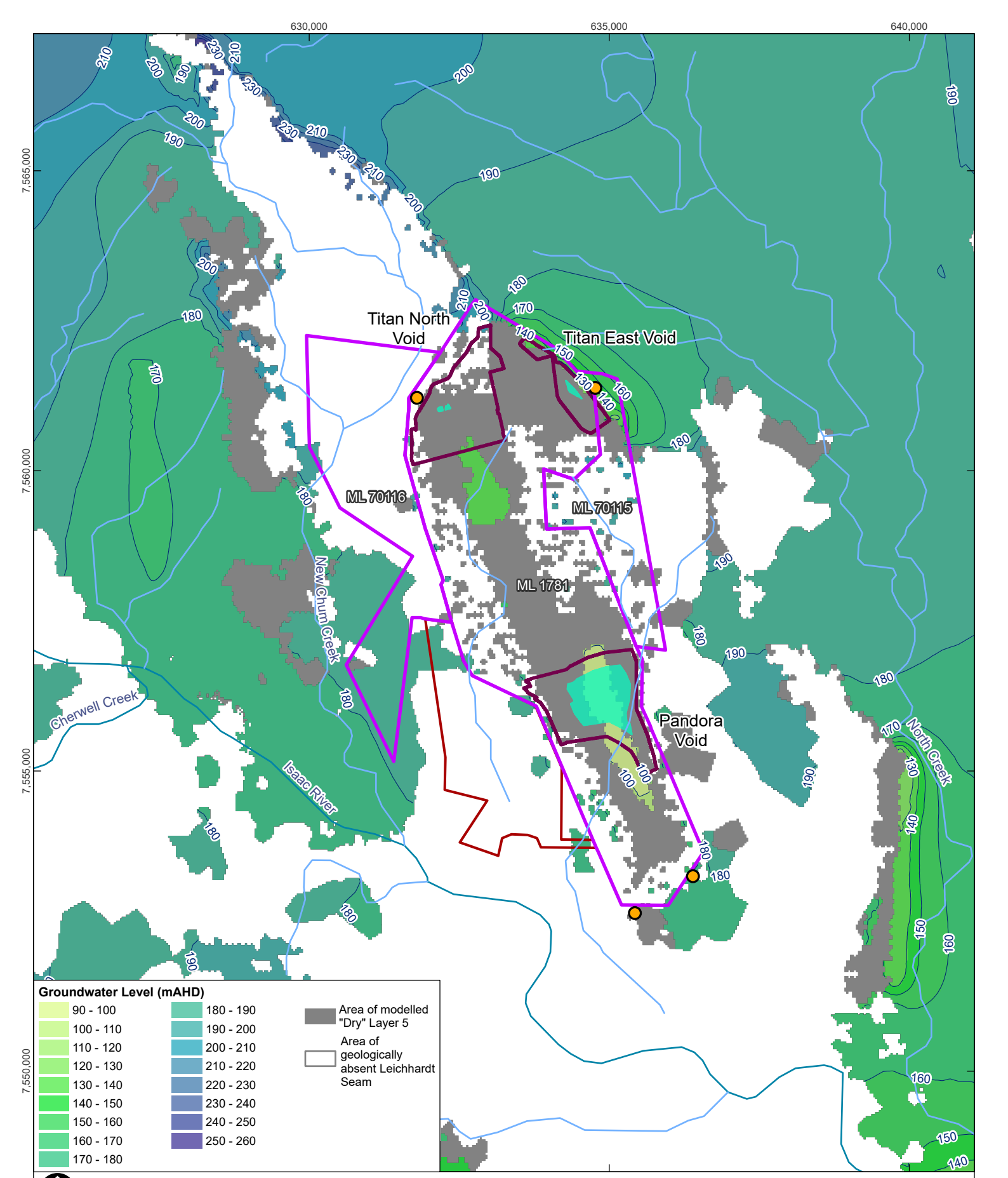
FIGURE 7-18

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-17_Predicted Water Table Elevation – Post-Mining Equilibrium



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Hydrograph Location Point
- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area
- Void Extent
- Void Lake

DAUNIA MINE
TRANSITIONAL PRCP

PREDICTED GROUNDWATER LEVELS IN THE LEICHHARDT SEAM (LAYER 5) – POST-MINING EQUILIBRIUM

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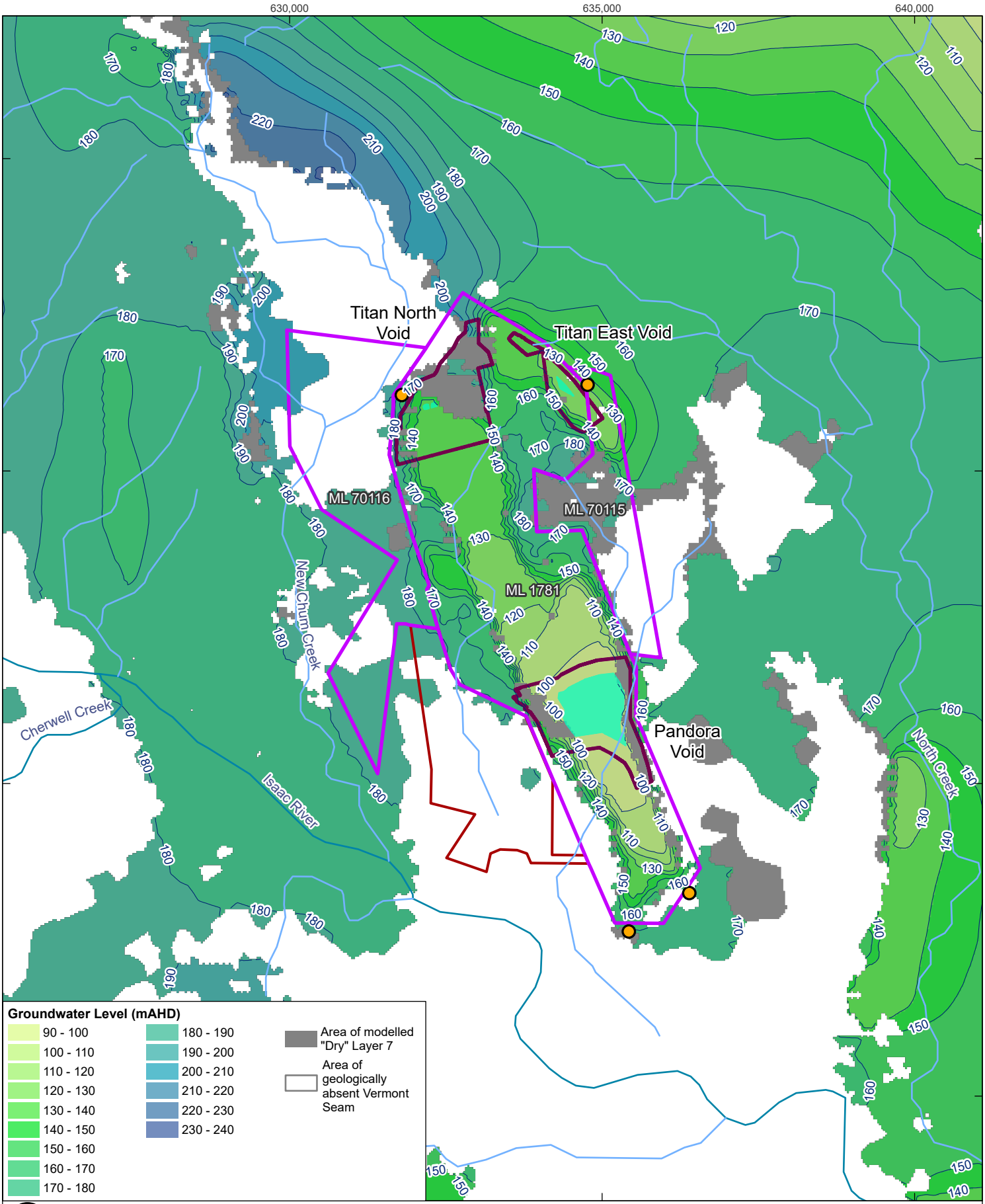
FIGURE 7-19

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-18_Predicted GW Levels in Leichhardt Seam (L5) – Post-Mining Equilibrium



DAUNIA MINE
TRANSITIONAL PRCP

PREDICTED GROUNDWATER LEVELS IN THE VERMONT SEAM (LAYER 7) – POST-MINING EQUILIBRIUM

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FIGURE 7-20

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-19_Predicted GW Levels in Vermont Seam (L7) – Post-Mining Equilibrium

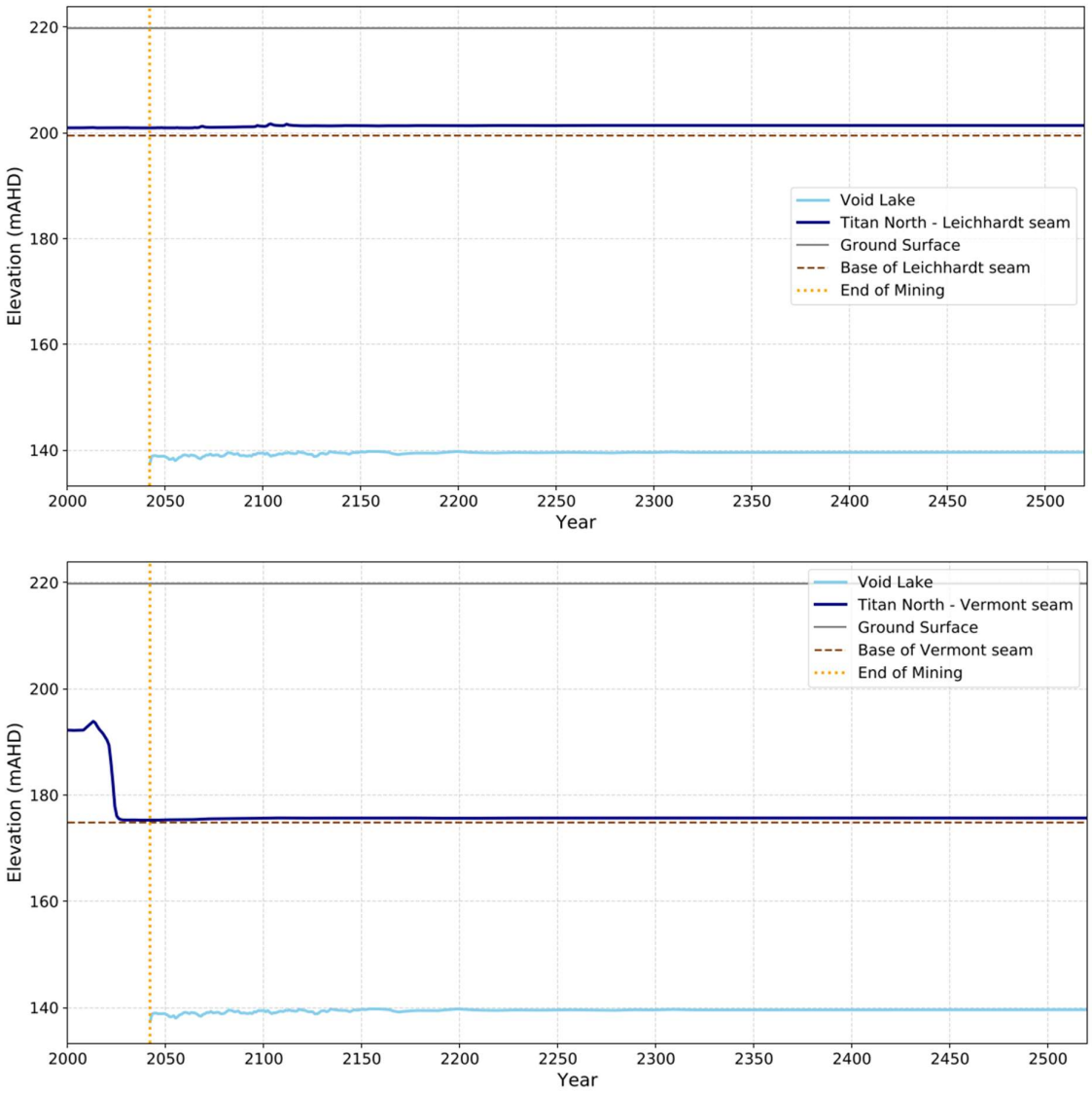

Figure 7-21 Permian Coal Measures Predictive Hydrographs adjacent Titan North

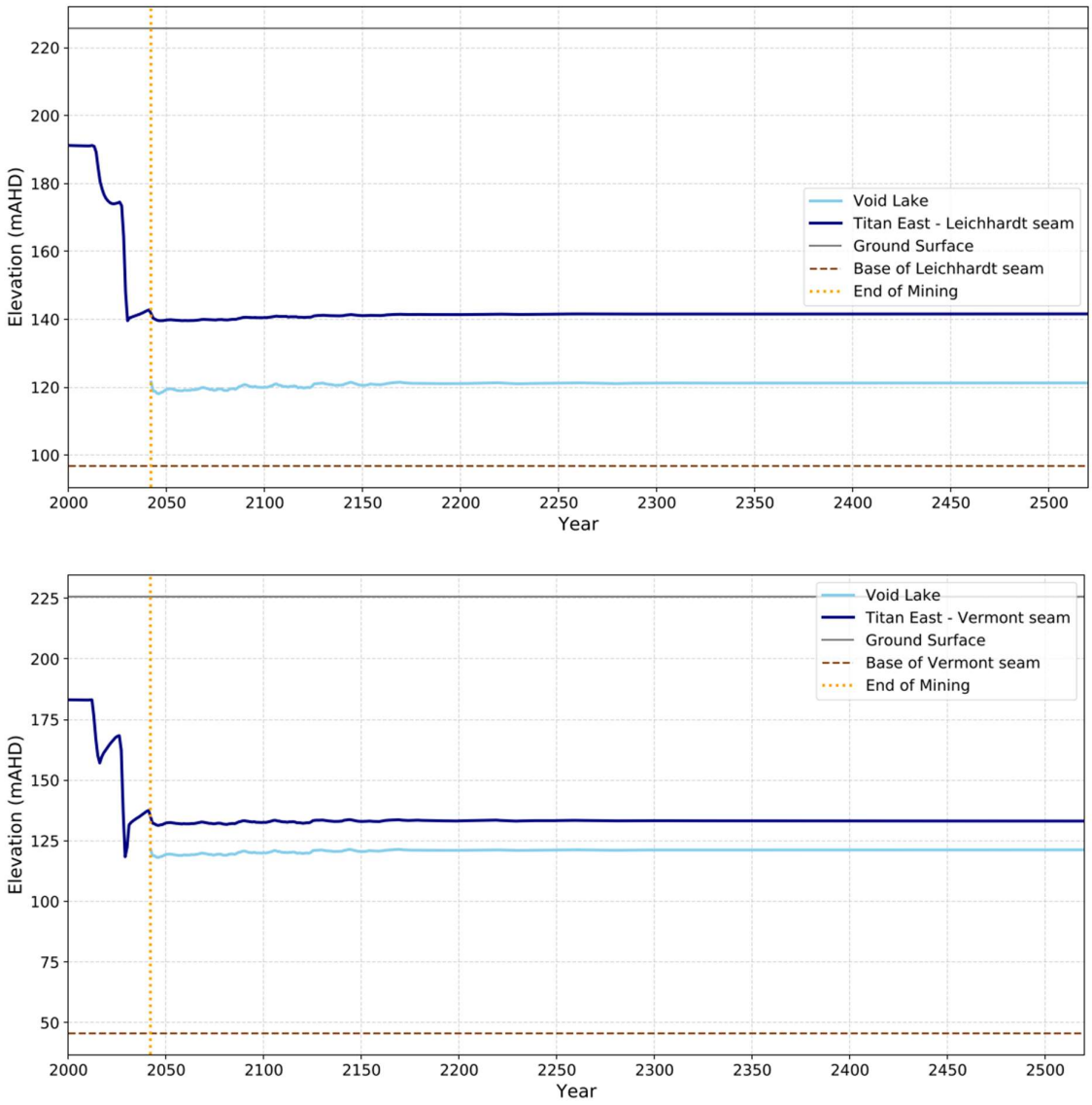

Figure 7-22 Permian Coal Measures Predictive Hydrographs adjacent Titan East Void

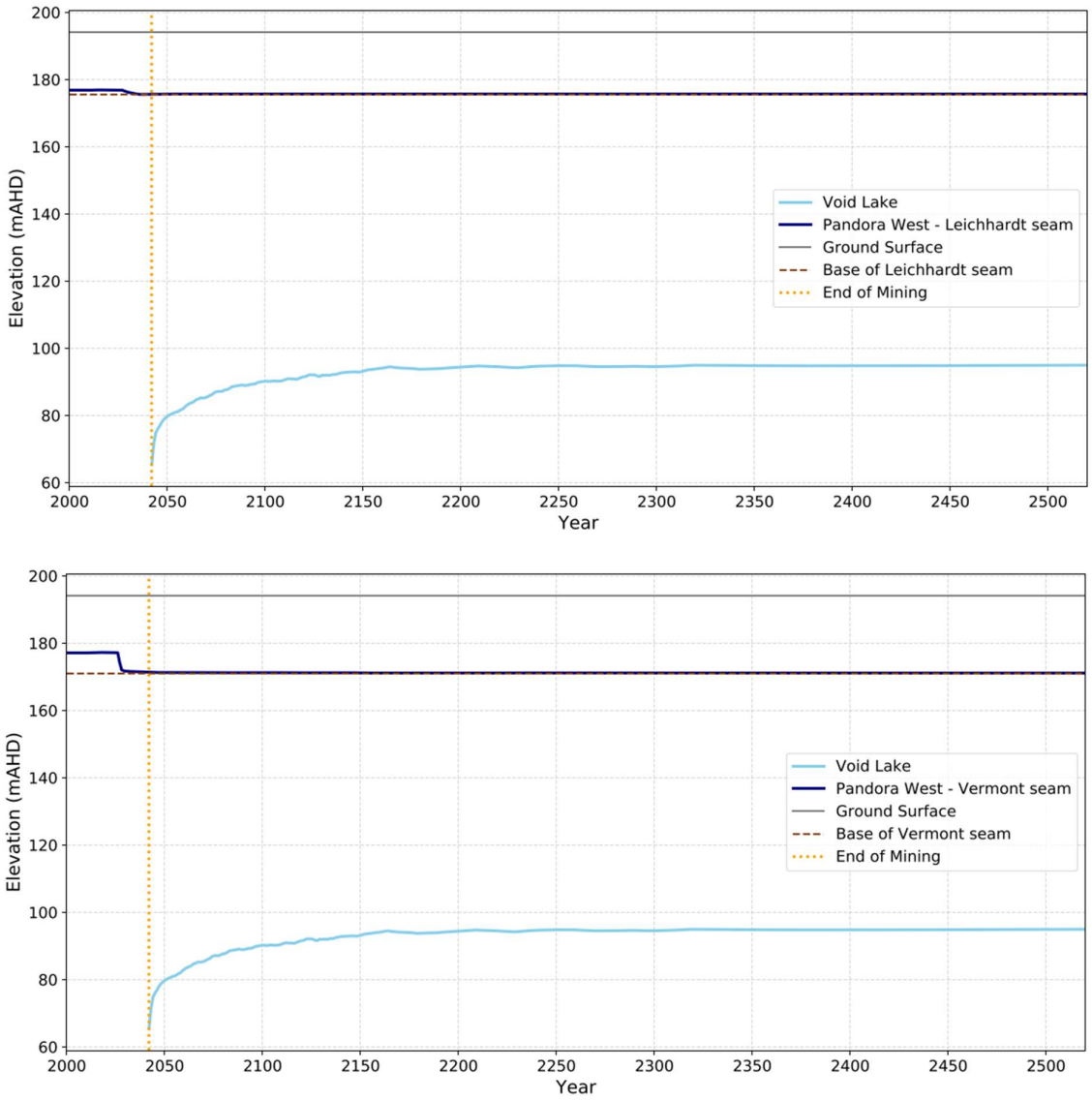

Figure 7-23 Permian Coal Measures Predictive Hydrographs adjacent Pandora Void (West)

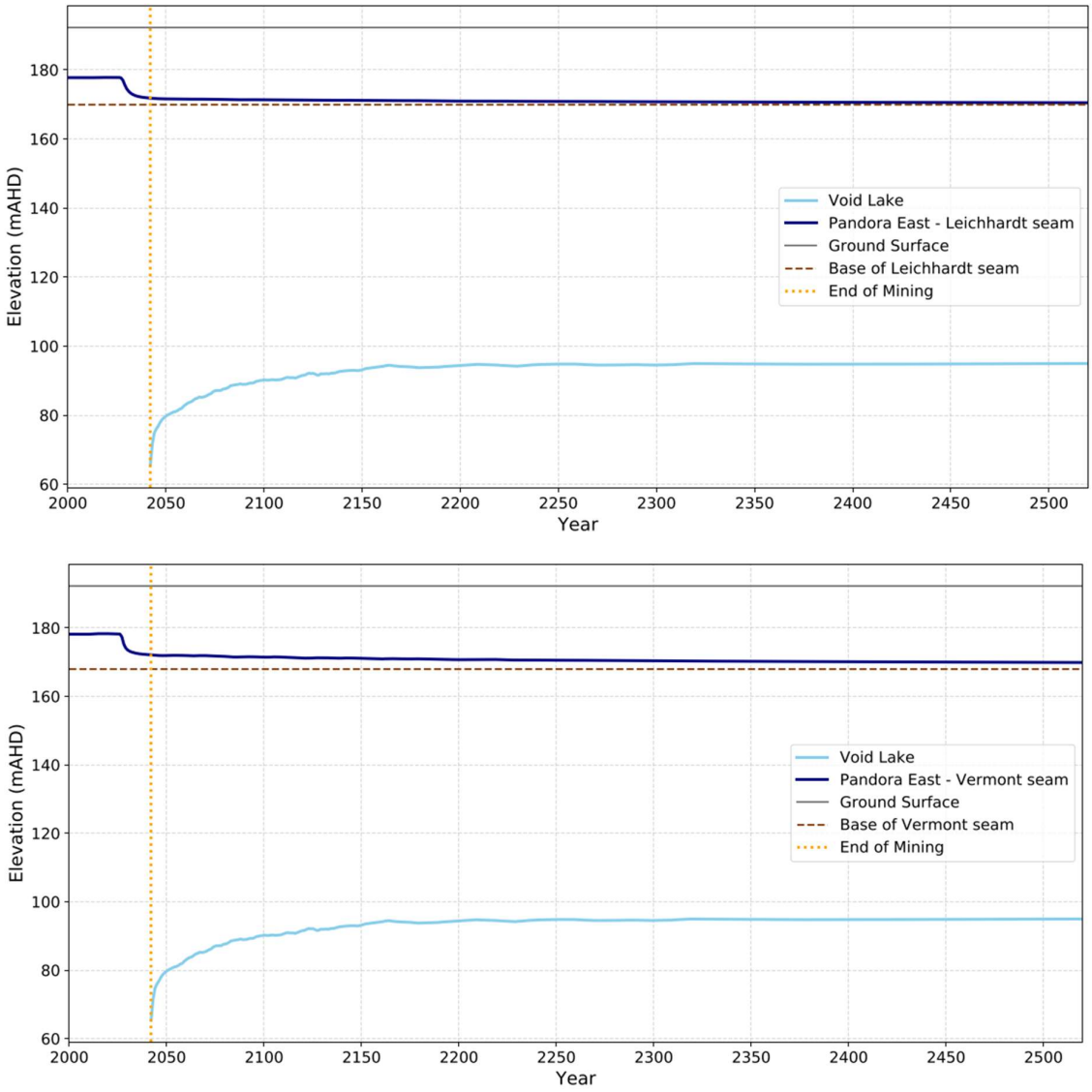

Figure 7-24 Permian Coal Measures Predictive Hydrographs adjacent Pandora Void (East)

Groundwater Level Impacts to 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 DNM. 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 PRC Plan's proposed final landform. **Figure 7-25** provides the hydrograph locations.

Predictive hydrographs for the water table at the potential GDE sites identified near to the DNM (refer **Section 4.5.2**) are provided on **Figure 7-26** through to **Figure 7-28**. The end of DNM mining / start of the DNM post-mining period is identified on the hydrographs. Since there is evidence from previous studies that much of the deeper-rooted terrestrial vegetation immediately beside the Isaac River may in part access shallow alluvial groundwater, predictive hydrographs have been generated at equally spaced intervals along the GDE Atlas mapped extent of potential GDEs at the River. Predictive hydrographs have also been generated at equally spaced intervals along the GDE Atlas mapped extent of potential GDEs along North Creek east of DNM.

The water table hydrographs indicate that for potential GDE sites along the Isaac River (GDE1 through GDE4), up to 10 m (GDE 4) of additional water table drawdown is predicted to occur over the post-mining period. The predicted post mining drawdown is cumulative, meaning that it includes impacts from neighbouring mines, primarily from Poitrel, Winchester South, Moorvale South, Millenium and Olive Downs. Most predicted water table drawdown post DNM mining occurs at site GDE4, which is close to Moorvale South and Olive Downs mines.

Hydrographs sites GDE5, GDE6 and GDE7 on North Creek are located in significantly closer proximity to the Moorvale South Project than DNM. It is expected therefore that the Moorvale South final landform represented in the groundwater model is controlling the water table responses seen at those hydrographs. At these sites, up to 5 m of post mining drawdown is predicted (GDE 5).

Hydrographs sites GDE8, GDE9 and GDE10 on the upper reaches of North Creek show that the area is unsaturated (dry) pre-mining and remain unsaturated post mining.

The general downward trend in water level in the alluvium post mining can generally be attributed to regional declines as a result of regional mining impacts. Also, the timing of drawdown propagation and the long-term result of final voids regionally acting as sinks to regional groundwater.

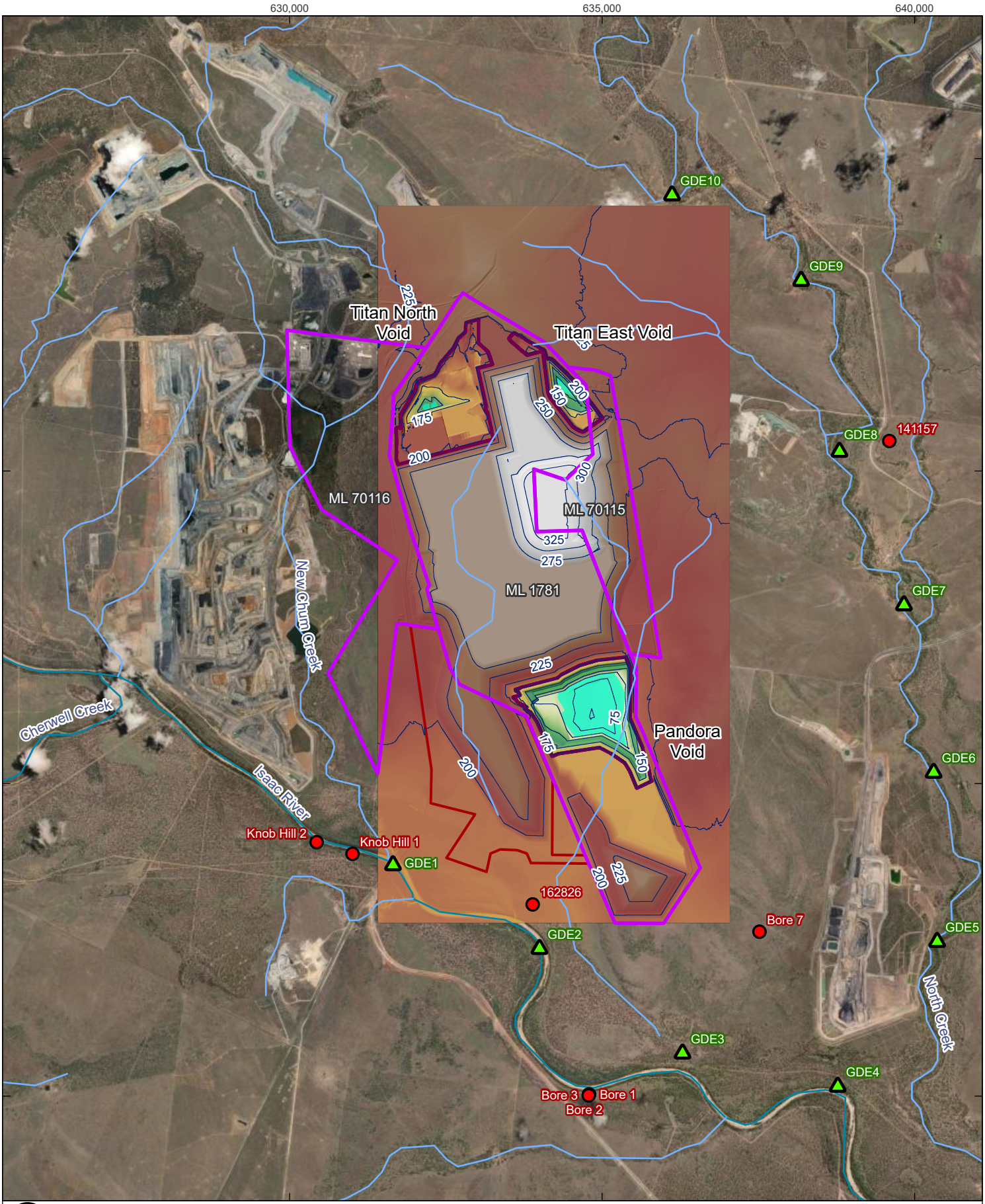
630,000
635,000
640,000
7,565,000
7,560,000
7,555,000
7,550,000
Titan North Void
Titan East Void
Pandora Void
ML 70116
ML 70115
ML 1781
New Chum Creek
Cherwell Creek
Isaac River
North Creek
GDE10
GDE9
GDE8
GDE7
GDE6
GDE5
GDE4
GDE3
GDE2
GDE1
141157
Bore 7
Bore 3
Bore 1
Bore 2
Knob Hill 2
Knob Hill 1
162826
225
175
200
150
250
300
325
275
75
0
1
2
km
LEGEND
Final Landform Contour (mAHD)
Major Watercourse
Minor Watercourse
Void Extent
Void Lake
DNM Mining Lease
Mining Lease Application Area
Hydrograph Location Point - Receptor
Surveyed Bore with Known Source Aquifer
Potential GDE (GDE Atlas)
Final Landform Elevation (mAHD)
326
48
Coordinate System: GDA2020 MGA Zone 55
Scale: 1:80,000 at A4
Project Number: 640.031614
Date Drawn: 20-Feb-2026
Drawn by: RB
DAUNIA MINE
TRANSITIONAL PRCP
RECEPTOR PREDICTIVE HYDROGRAPH LOCATIONS
SLR
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FIGURE 7-25
Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-24_Receptor Predictive Hydrograph Locations

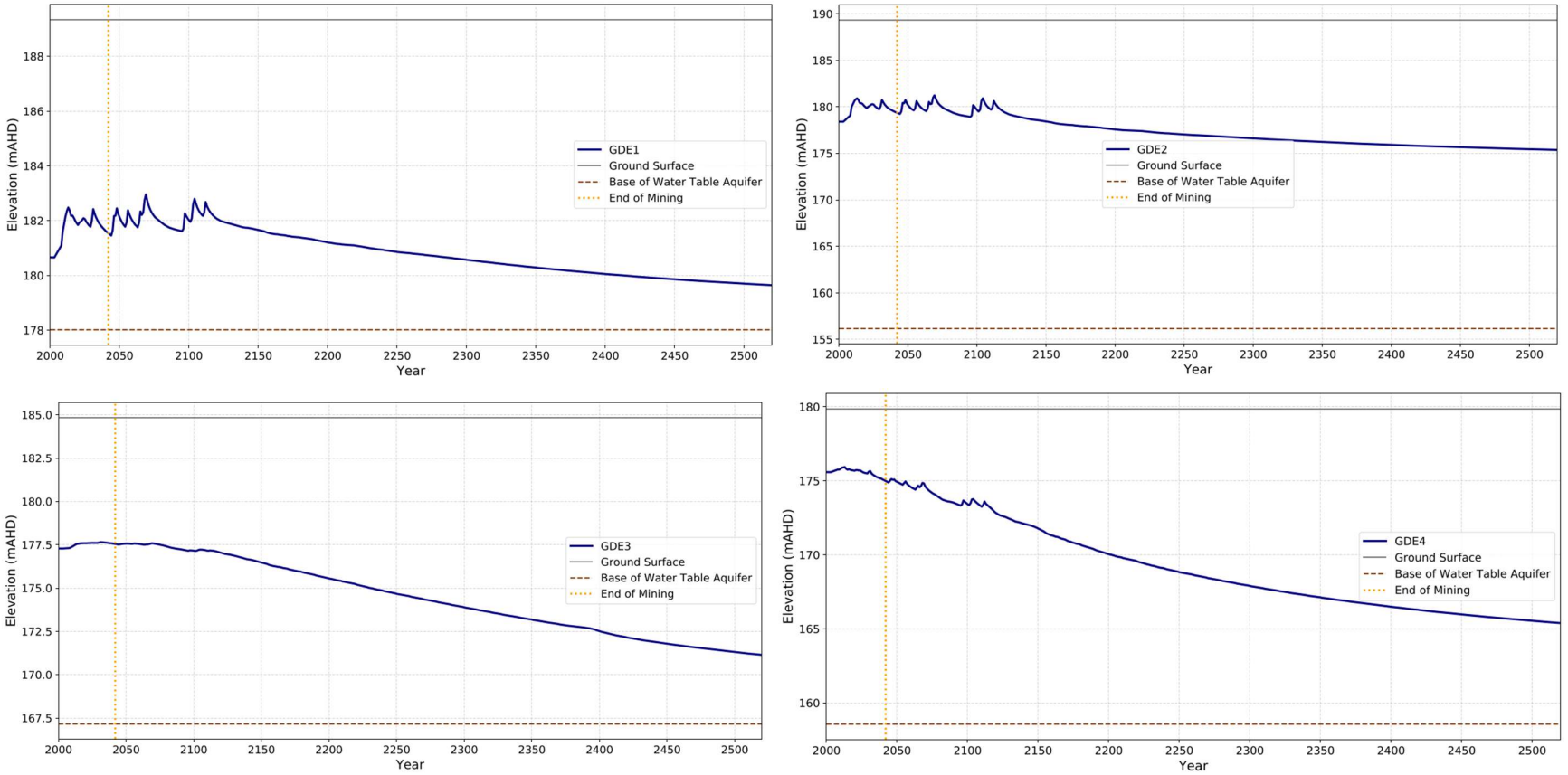


Figure 7-26 Water Table Hydrographs at Potential GDEs (Observation Point 1, 2, 3 and 4)

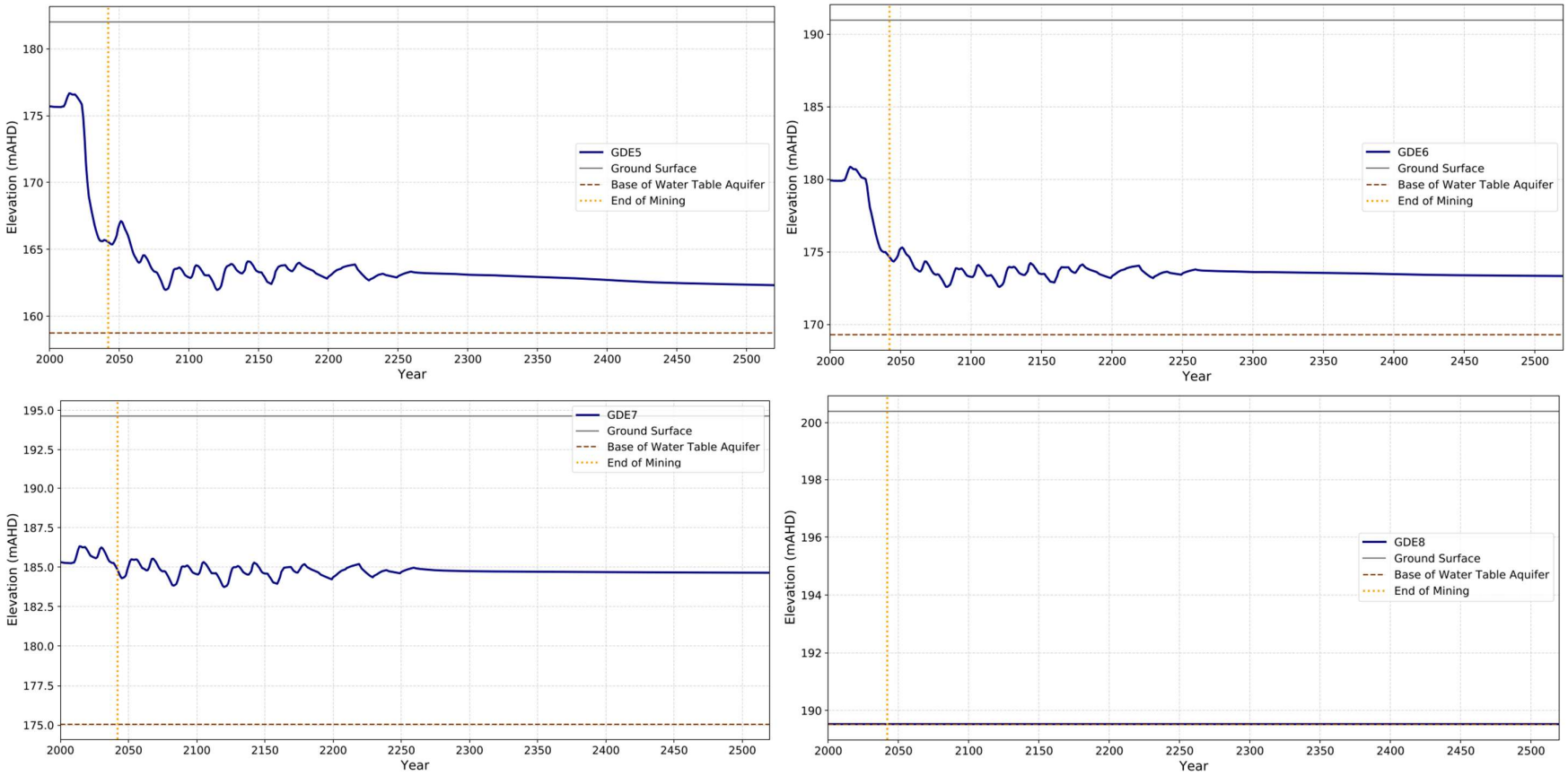


Figure 7-27 Water Table Hydrographs at Potential GDEs (Observation Point 5, 6, 7 and 8)

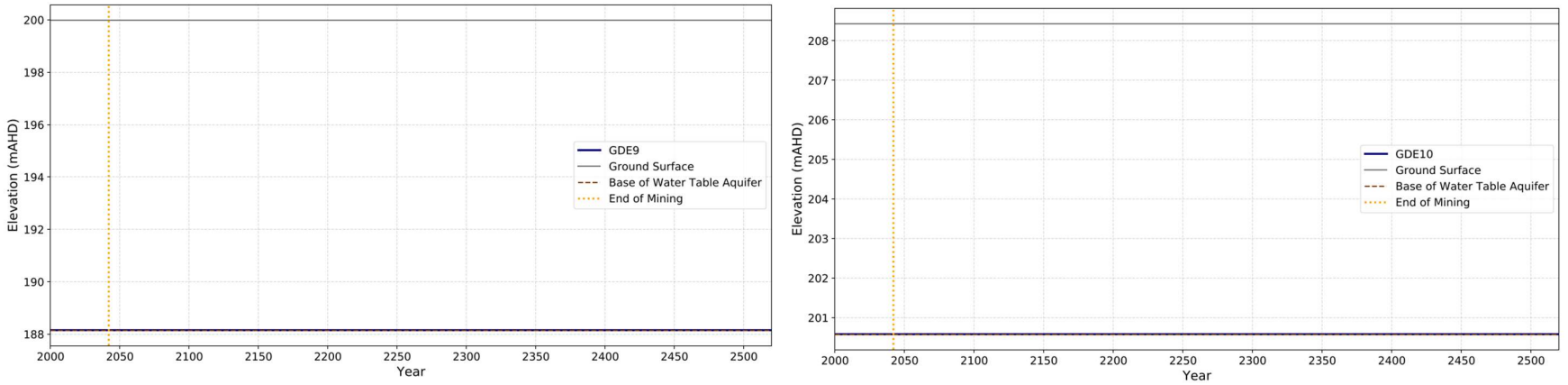


Figure 7-28 Water Table Hydrographs at Potential GDEs (Observation Point 9 and 10)

Predictive hydrographs for the ten third party water supply bores identified in thebore census' (SLR, 2023) with sufficient information to attribute a source aquifer (refer **Section 4.5.1**) are provided from **Figure 7-29** through to **Figure 7-31**. The end of DNM mining / start of the DNM post-mining period is identified on the hydrographs. Most groundwater bores are predicted to experience drawdown post mining, likely attributable to cumulative regional groundwater drawdown. At bore 141157, drawdown will be negligeable in the long term. For all other bores, drawdown varies from approximately 2 m at 5 mile bore, Knob Hill 1 and Knob Hill 2 to 11 m at 141677. Bores that are predicted to experience drawdown greater than 5 m (drawdown 'bore trigger threshold' for consolidated aquifers (i.e. the Fort Cooper Coal Measures) identified in Chapter 3 of the Water Act 2000) include Bore 1, Bore 2, Bore 3, and 141677.

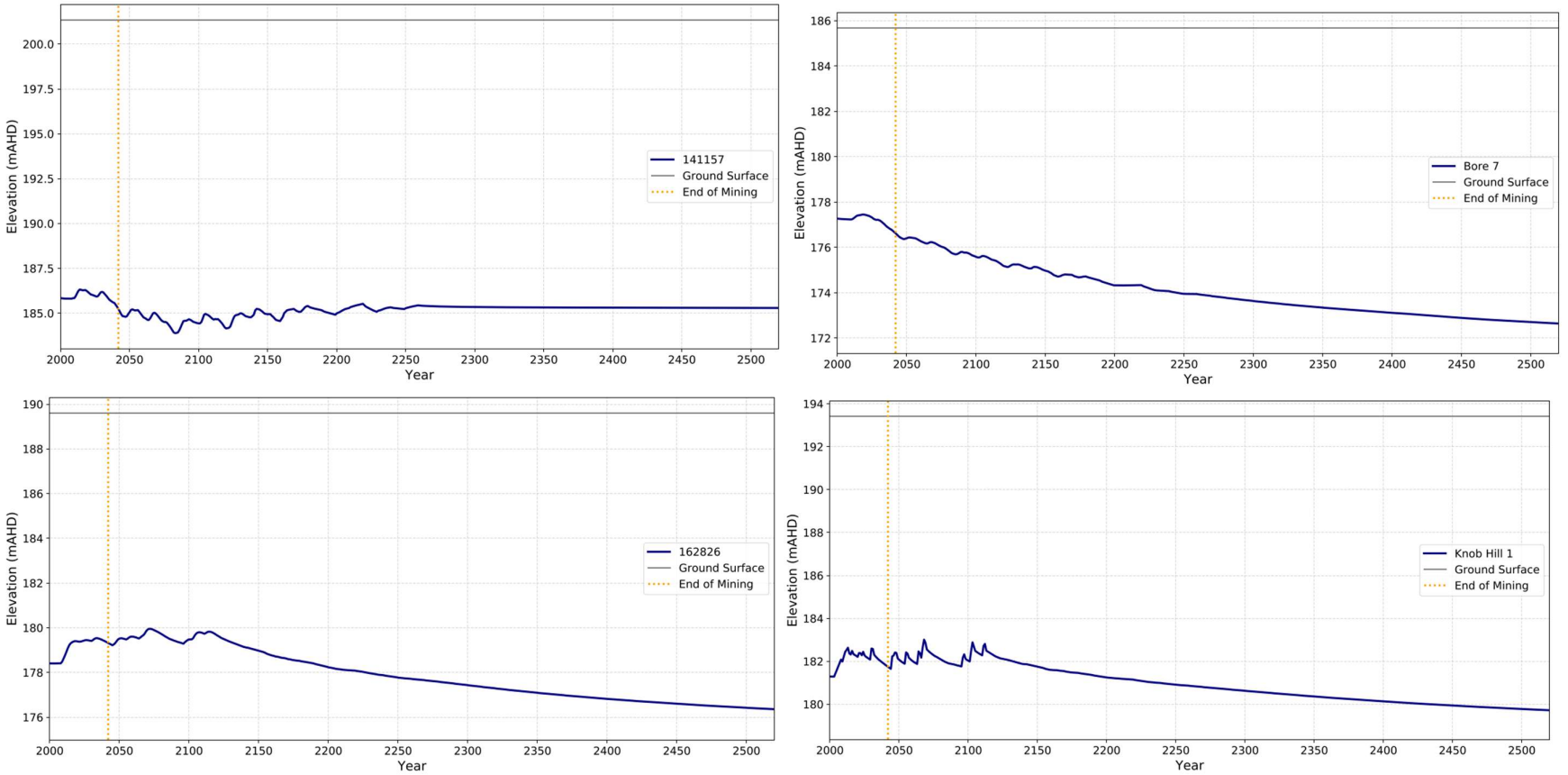


Figure 7-29 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer (Bores RN141157, RN162826, Bore 7 and Knob Hill 1)

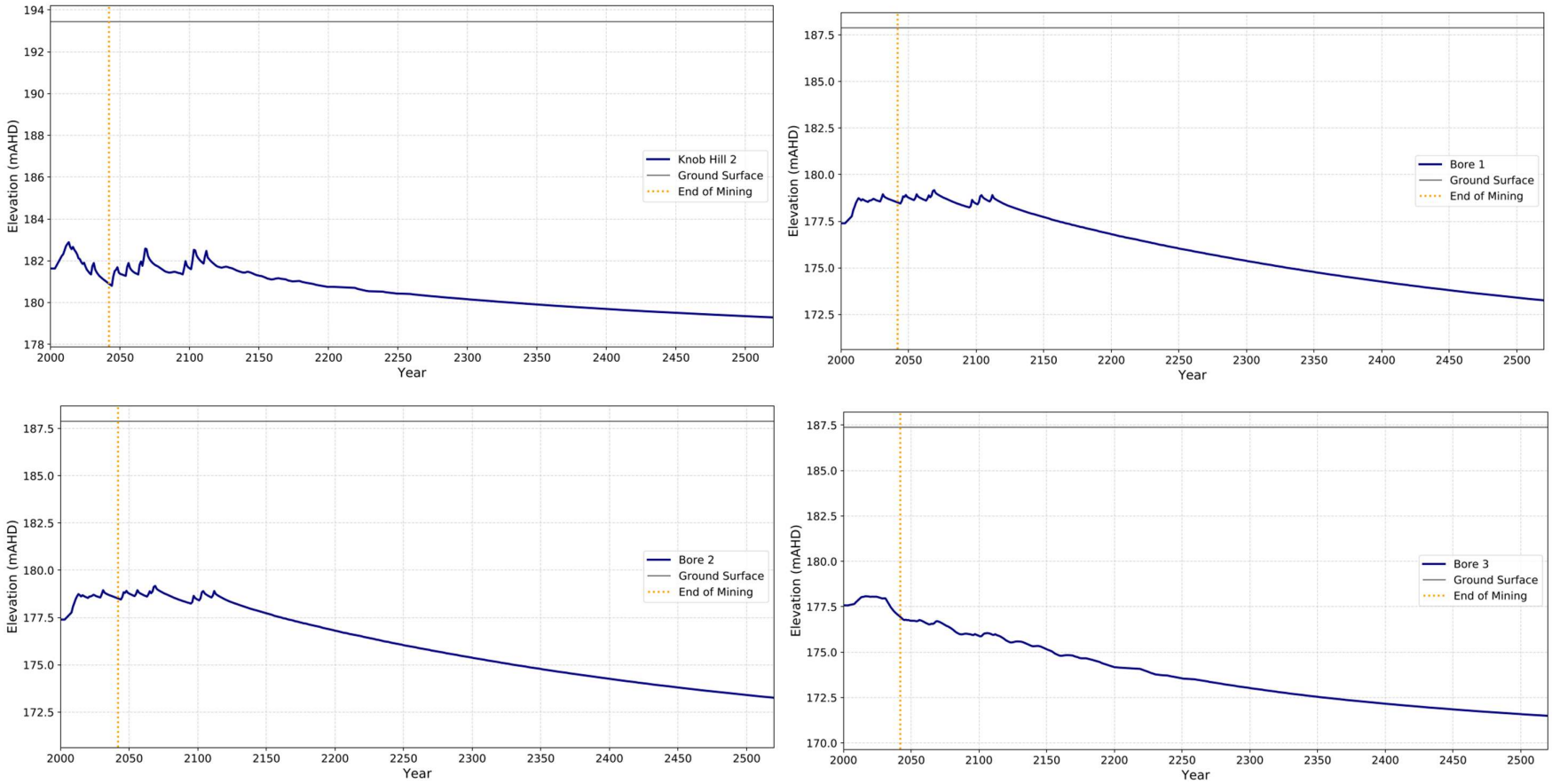


Figure 7-30 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer (Bore 1, Bore 2, Bore 3 and Knob Hill 2)

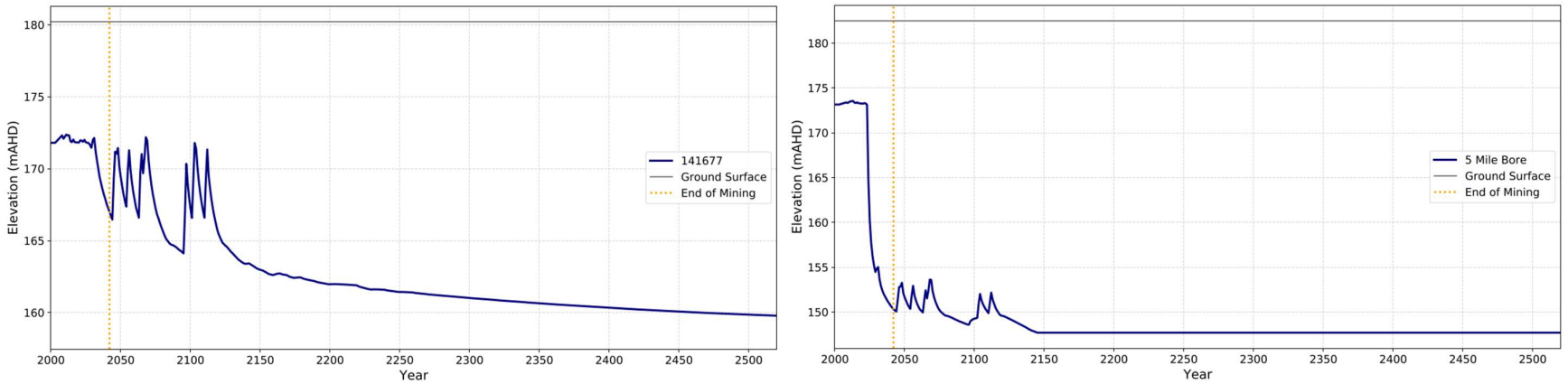


Figure 7-31 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer (Bore RN141677 and 5 Mile Bore)

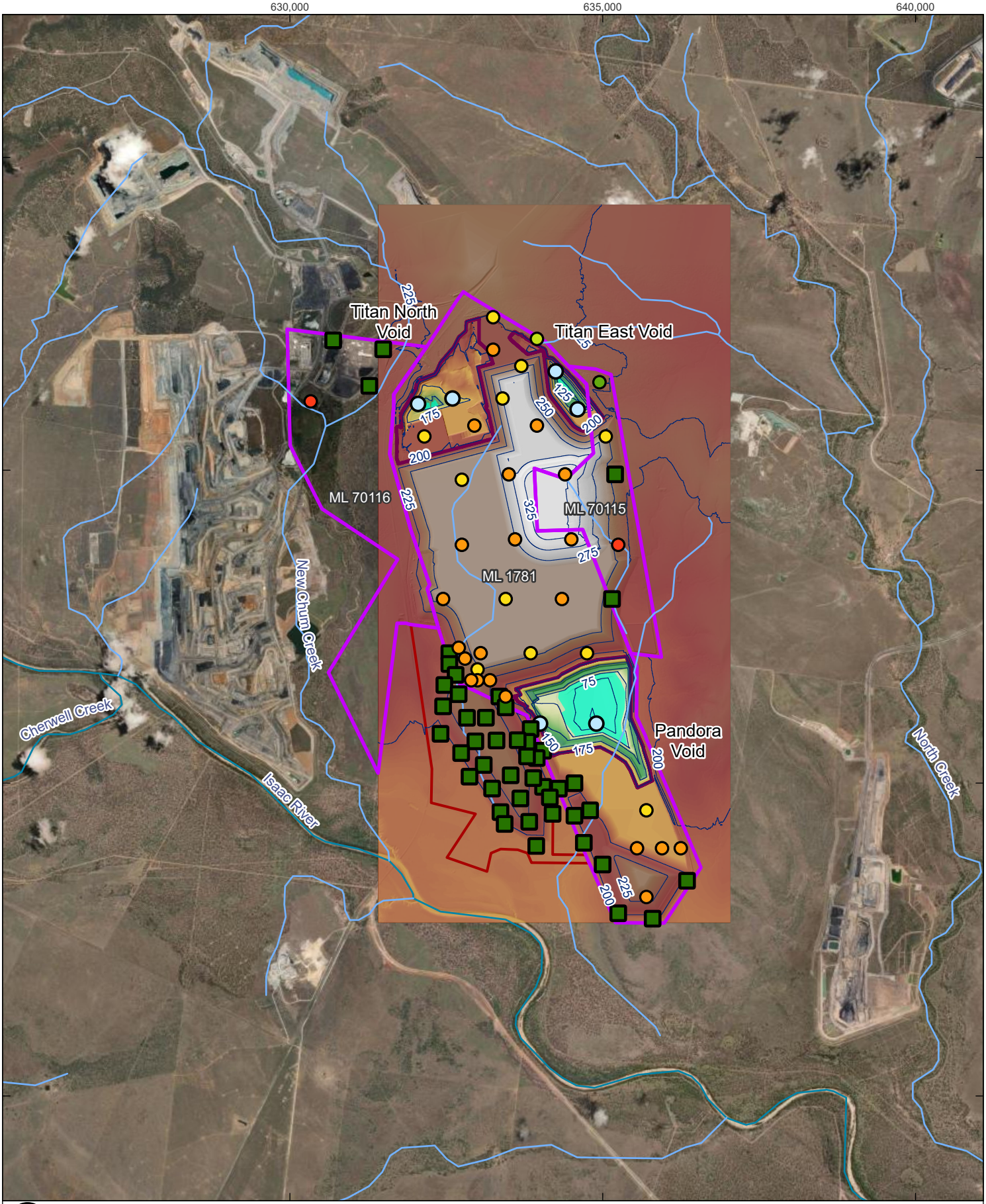
7.5.5 Flow Path Simulation

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 voids in the recovery groundwater model. The mod-PATH3DU code (S.S. Papadopulos & Associates, Inc., 2018) was used to simulate particle pathways through the groundwater flow field during recovery (i.e. 977 years). To run the mod-PATH3DU code the transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flowpath lines.

Figure 7-32 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. The mod-PATH3DU code automatically moves the particle from the model surface to the shallowest saturated layer at the commencement of the simulation**.** For many of the particles this represents the Permian layers (including areas of spoil backfill in model layers that represent Permian units pre-mining) as the shallow layers (Layers 1 and 2) are unsaturated across much of the DNM 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 Mine Infrastructure Area (MIA) on the northwestern side of the DNM, along the southwestern boundary of the mine and adjacent to the Pandora Pit Void beneath the OOPD (refer **Figure 7-32**).

Figure 7-33 shows the predicted movement of water particles in the 977-year recovery simulation of the final landform. The colours along the predicted particle flow paths indicate the model layer the particle was simulated to be moving through, with the green to red scale classification representing particles moving from shallow to deeper model layers.

The colour changes along the paths on **Figure 7-33** 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 Permian coal measures (or backfilled spoil where the coal measures has been mined out) over the post-mining period. The flow path analysis indicates the particles generally move toward the void lakes, with many of the particles remaining in the voids once they have entered the void lakes. Particles that move into the voids during the post-mining simulation remain within the voids for the duration of the simulation. Particles starting in voids themselves remain within the voids for the duration of the simulation.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Final Landform Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake
- DNM Mining Lease
- Mining Lease Application Area

Final Landform Elevation (mAHD)

326

48

Starting Location and Layer of Particle Simulation

- Void Lake
- 2
- 3
- 4
- 6
- 7
- 9

DAUNIA MINE TRANSITIONAL PRCP

STARTING LOCATION OF PARTICLES

SLR

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FIGURE 7-32

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_F07-31_Starting Location of Particles

There is a clear groundwater divide below the OOPD, with particles across the eastern ~65% of the OOPD footprint moving eastward and being captured by the Pandora Pit void. Below the western margin of the OOPD there is some movement away from the Pandora Pit void, at least initially while the particles travel through layer 2. All particles start in layer 2 and descend to the underlying layer 9 (Fort Cooper Coal Measures overburden) which underlies layer 2 in this area. Most of the particles on the western margin of the OOPD, on entering layer 9, turn eastwards, or south and then eastwards, back towards the Pandora Pit void. Only 3 particles on the very western margin of the OOPD continue to move south to south-east away from DNM in the general direction of deeper groundwater flow in this area. However, these particles remain in layer 9 (Fort Cooper Coal Measures overburden) and travel for the full model run time, i.e. they remain within the deeper Permian groundwater system and do not migrate to shallow depths down gradient of the OOPD.

The particle tracking indicates that the majority of seepage from the OOPD is likely to migrate back towards the Pandora Pit void where it will be captured within the residual void lake. Only seepage from the very western margin of the OOPD is likely to migrate away from DNM and the Pandora Pit void, however the downward vertical hydraulic gradient in this area results in this groundwater remaining within the deep Permian coal measures and not entering the shallow unconsolidated strata (model Layers 1 and 2) in the range of the water table.

Some particles located on the MIA area to the west-northwest of Titan North do not become captured within the final landform over the 977-year simulation but move southwards approximately 2 km over the 977-year simulation and marginally leave the DNM. It is considered that this relates to the hydraulic influence of the adjacent Poitrel Mine within the groundwater model over the post-mining simulation. The potential environmental risks associated with groundwater beneath the MIA potentially moving out of the DNM will be addressed within the PRC Plan's Contaminated Land Assessment. No particles are shown to move significantly away from the DNM Area to the broader receiving environment.

Given that the particle pathlines are simulated from the start of the post-mining period, they generally follow predicted head gradients shown on **Figure 7-33**. However, the particle directions at times appear to be in opposition to the head contours/gradients shown on **Figure 7-33**, or travel from near to one residual void to another residual void. It should be noted that the head contours shown on **Figure 7-33** only represents the final head distribution when groundwater levels have reached equilibrium and hence does not show the transient head changes occurring during the 977-years post-mining simulation that may result in short term particle movement counter to the long term equilibrium head contours/gradients shown on **Figure 7-33**.

Overall, the particle movement simulation indicates that most groundwater on DNM, would remain within the final landform (e.g. backfilled spoil and voids) in the long term with no groundwater predicted to flow to the receiving environment, i.e. the voids would remain groundwater sinks and groundwater would not flow from the residual voids off-site. Some groundwater in the western extent of the OOPD is expected to migrate away from DNM, however will seep into the deep Permian Coal Measures and will not impact the shallow groundwater receptors.

8.0 Conceptual Site Model – Post-Mining

8.1 Overview

A visual representation of the post-mining CSM is provided as **Figure 8-1** and **Figure 8-2**, based on the end of mining CSM discussed in **Section 5.0** and the post-mining groundwater modelling presented in **Section 7.0**.

Figure 8-1 presents the CSM for the northern final void (Titan North and Titan East), in which the residual pit lake is maintained below the regional groundwater table, thus acting as a groundwater sink. In this case, 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 below the pre-mining groundwater elevations and any shallow post-Permian strata regardless of climate scenario modelled, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium and regolith);
- Residual groundwater drawdown within the Rangal Coal Measures as caused by the approved DNM mining operation, with ongoing evaporative discharge from the residual void lakes, resulting in continued inwards hydraulic flow gradients in the coal measures to the residual voids and no outflow in the long term;
- Residual voids continue to capture any seepage from spoil emplacements with the exception of seepage from the western margin of the OOPD;
- Moderate potential for groundwater beneath the MIA to not be captured by the final landform due the hydraulic influence of the adjacent Poitrel Mine;
- Little to no additional impacts (beyond those resultant from approved mining) on surficial aquifers, including the alluvial aquifers, caused by the PRC Plan's final landform;
- Little to no additional impacts (beyond those resultant from approved mining) on environmental receptors caused by the PRC Plan's final landform; and
- Little to no additional impact on anthropogenic receptors caused by the PRC Plan's final landform.

Figure 8-3 presents the CSM associated specifically with the OOPD and Pandora Void, in which there is potential for seepage from the OOPD to the west and of-site (rather than being captured in entirety by the residual voids).

Due to the more permeable and unstructured nature of waste rock the anticipated higher infiltration rate over the OOPD (compared to the natural ground), may result in greater recharge in the form of seepage from the OOPD to the underlying strata. Whilst most of the seepage will be captured by the adjacent Pandora Pit residual void, which acts as a strong groundwater sink, particle tracking shows that there is the potential for off-site migration of seepage from the western margin of the OOPD via the Permian coal measures. This groundwater would migrate to the south and south-east in the Permian coal measures but not affect the shallow Quaternary-Tertiary groundwater system. However, there are several mitigating factors that minimise the potential impact from any off-site migration of groundwater containing seepage from the OOPD:

- Geochemical studies on DNM waste rock (Terrenus, 2025) demonstrate that:
    - it is expected to generate pH-alkaline to highly alkaline contact water (run-off and seepage), which is typical for mine spoil in the Bowen Basin.

  - It has a very low potential to generate acid and metalliferous drainage (AMD).
  - The expected proportions of non carbonaceous, carbonaceous and coal materials in the OOPD are 90%, 9% and 1% respectively.
  - The non-carbonaceous spoil component poses a “Low” AMD source hazard, with the small proportions of carbonaceous spoil and coal posing a “Low-Moderate” AMD source hazard.
  - The spoil is overwhelmingly non acid forming (NAF) with excess acid neutralising capacity (ANC) and has a negligible risk of developing AMD, including acid drainage (AD), neutral metalliferous drainage (NMD) and/or saline drainage (SD).
  - The proposed OOPD poses a “Low” AMD hazard”, with AMD generation rated as “Highly Unlikely”

- Leachability tests on the waste rock (which, due to their nature are likely to overestimate leachate concentrations within the OOPD), resulted in concentrations below the Water Quality Objectives for Isaac Groundwaters (Zone 34), indicating that seepage from the OOPD does not pose a threat to local groundwater values.
- Particle tracking demonstrates that groundwater from below the OOPD that does migrate off-site to the south and south-east remains at depth in the Permian coal measures and does not enter the shallow Quaternary and Tertiary sediments along the Isaac River within which groundwater (where present) may be utilised facultatively by terrestrial GDEs immediately fringing the river channel.
- Similarly, private bores to the south of the site are screened within the shallow Quaternary and Tertiary sediments along the Isaac River, and will therefore not be affected by groundwater migrating from below the western margin of the OOPD through the underlying Permian coal measures interburden.

The post mining equilibrium lake level in the Pandora Pit residual void is anticipated to be in the order of 95 mAHD, some 85m below the pre-mining groundwater level, and therefore represents a strong groundwater sink in the DNM final landform that will capture the majority of seepage entering groundwater below the OOPD as well as groundwater draining from the surrounding in-pit spoil. In this case, the risks to the groundwater environment, particularly the identified receptors, via the OOPD final landform at Pandora are considered low, and therefore is suitable 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 below the pre-mining groundwater elevations and any shallow post-Permian strata regardless of climate scenario modelled, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium and regolith);
- Residual groundwater drawdown within the Rangal Coal Measures as caused by the approved DNM mining operation, with ongoing evaporative discharge from the residual void lakes, resulting in continued inwards hydraulic flow gradients in the coal measures to the residual voids and no outflow in the long term;
- Any off site migration of seepage from spoil emplacements will be minimal (with majority captured by the residual voids), and will remain at depth in the Permian Coal measures and not enter the shallow Quaternary or Tertiary sediments;
- Little to no additional impacts (beyond those resultant from approved mining) on surficial aquifers, including the alluvial aquifers, caused by the PRC Plan’s final landform;

- Little to no additional impacts (beyond those resultant from approved mining) on environmental receptors caused by the PRC Plan's final landform; and
- Little to no additional impact on anthropogenic receptors caused by the PRC Plan's final landform

8.2 Source-Pathway-Receptor Analysis

A graphical representation of the CSM in source-pathway-receptor (SPR) format, with particular focus on the post-mining period, is presented as **Figure 8-3**.

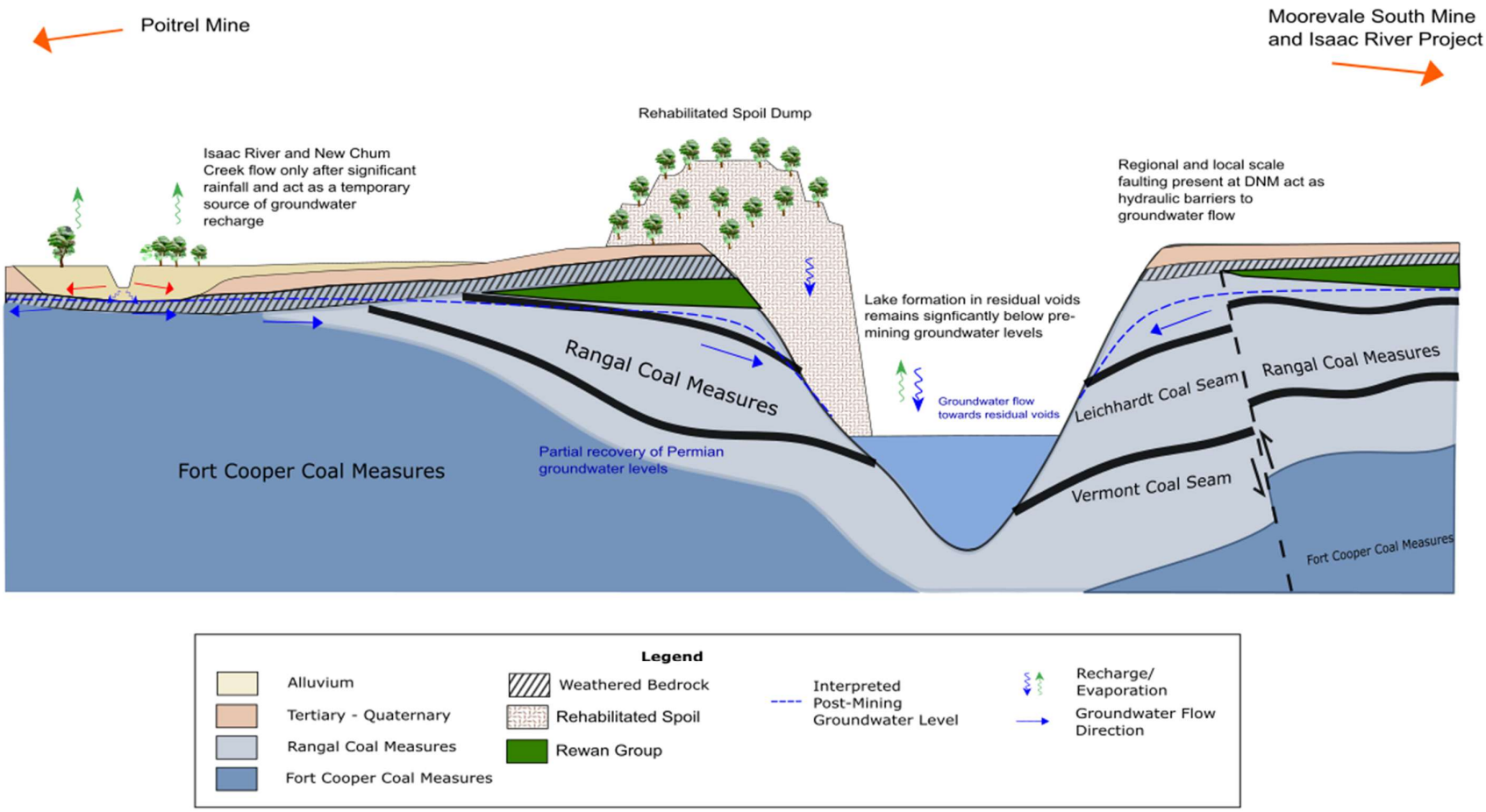

Figure 8-1 Conceptual Model of the Groundwater System (northern pits) – Post-Closure

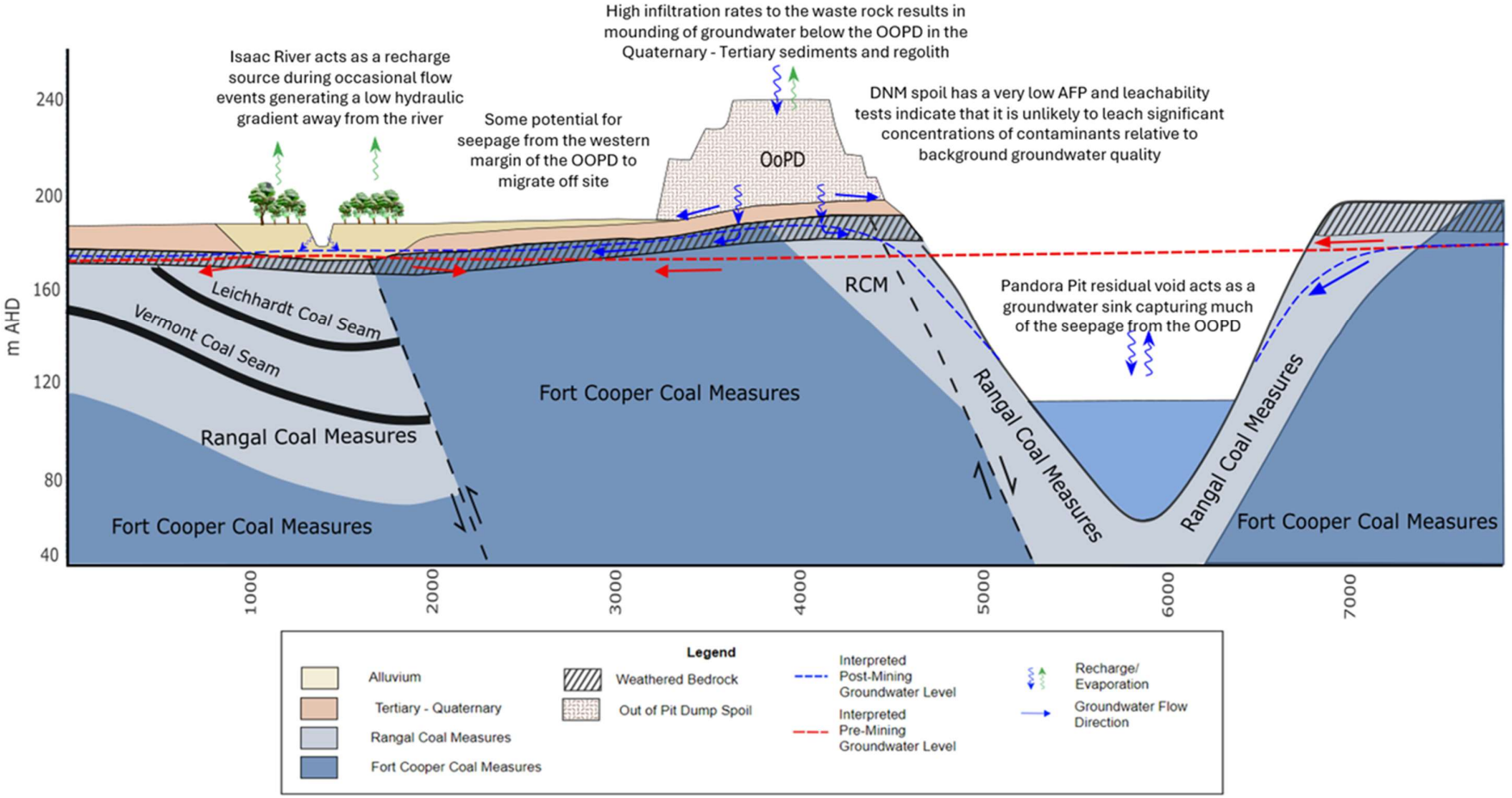

Figure 8-2 Conceptual Model of the OOPD – Post -Closure

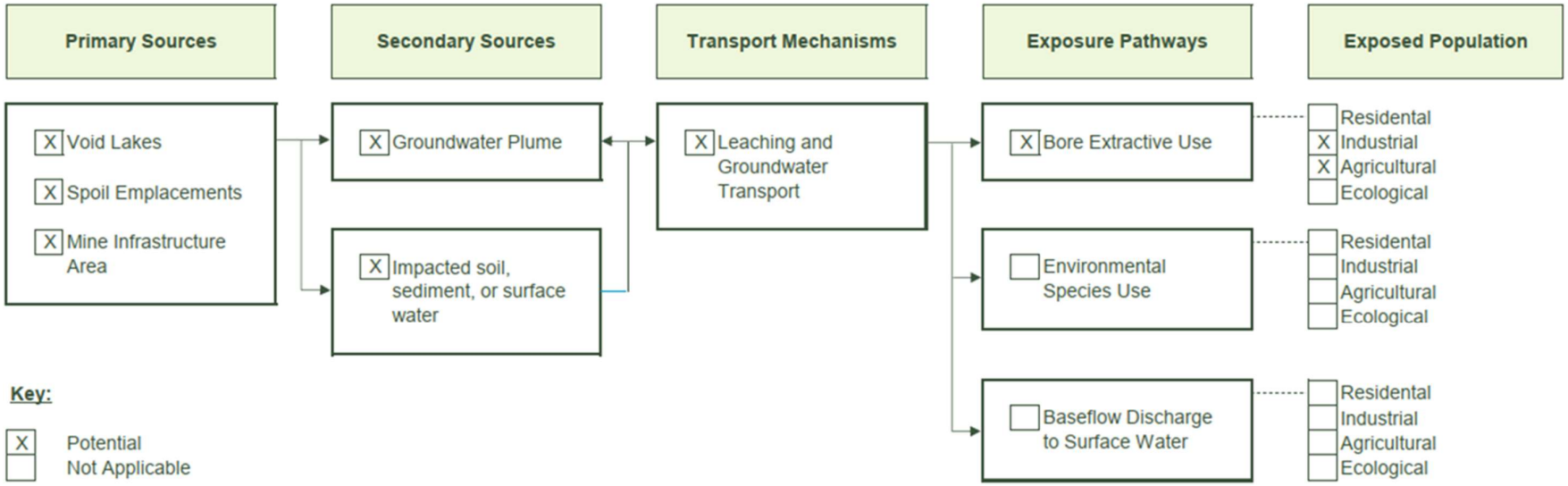

Figure 8-3 Source-Pathway-Receptor Presentation of CSM

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Appendix A Recovery Model Starting Heads

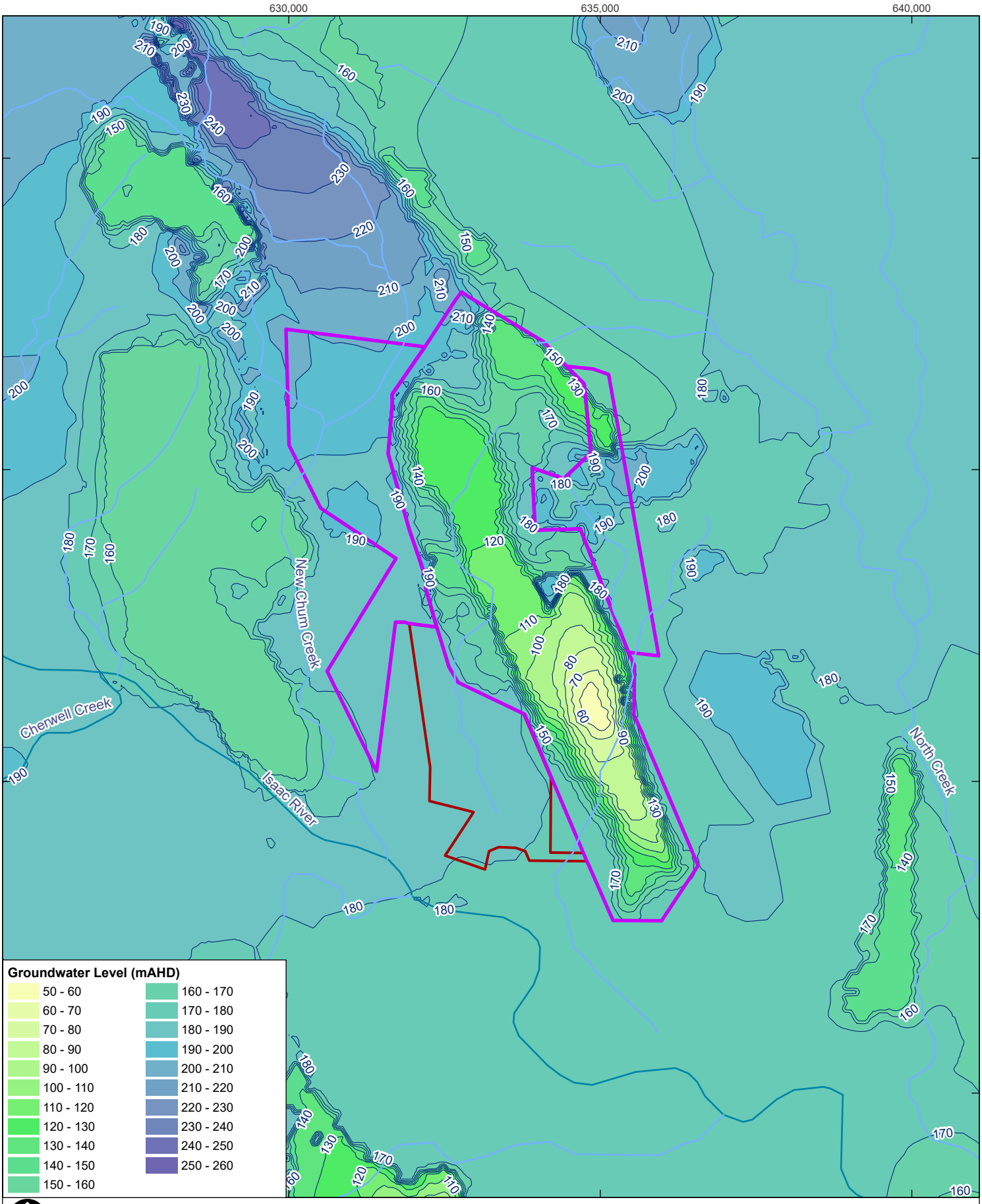
Daunia Mine

Transitional PRC Plan Hydrogeology – Revision 3

Whitehaven Coal Pty Ltd

SLR Project No.: 640.31614.00003

24 March 2026



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Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
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Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

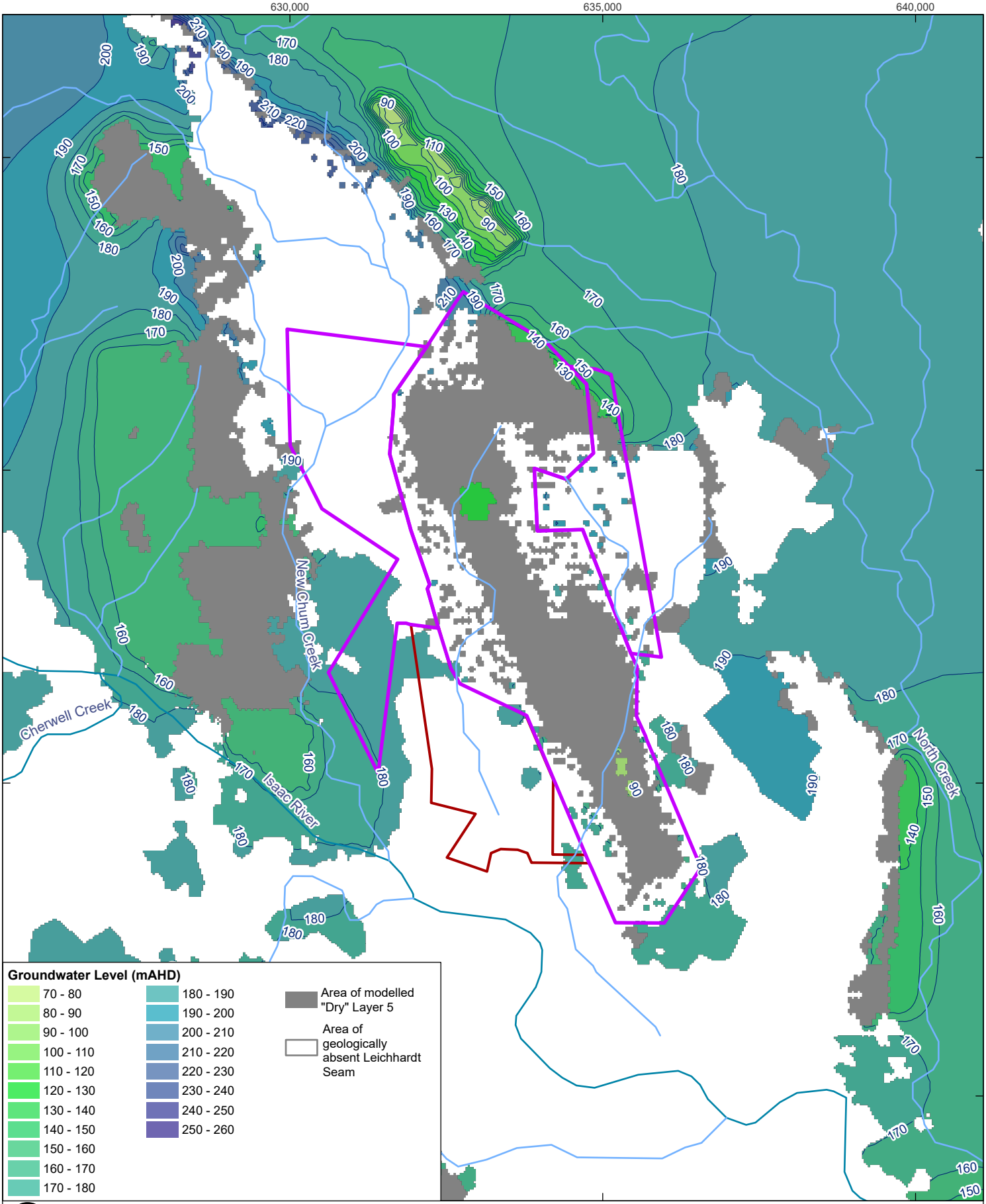
END OF MINING GROUNDWATER LEVELS - WATER TABLE

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 A-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_FA-01_End of Mining GW Levels - Water Table



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Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease
- Mining Lease Application Area

DAUNIA MINE
TRANSITIONAL PRCP

END OF MINING GROUNDWATER LEVELS – LEICHHARDT SEAM (LAYER 5)

SLR

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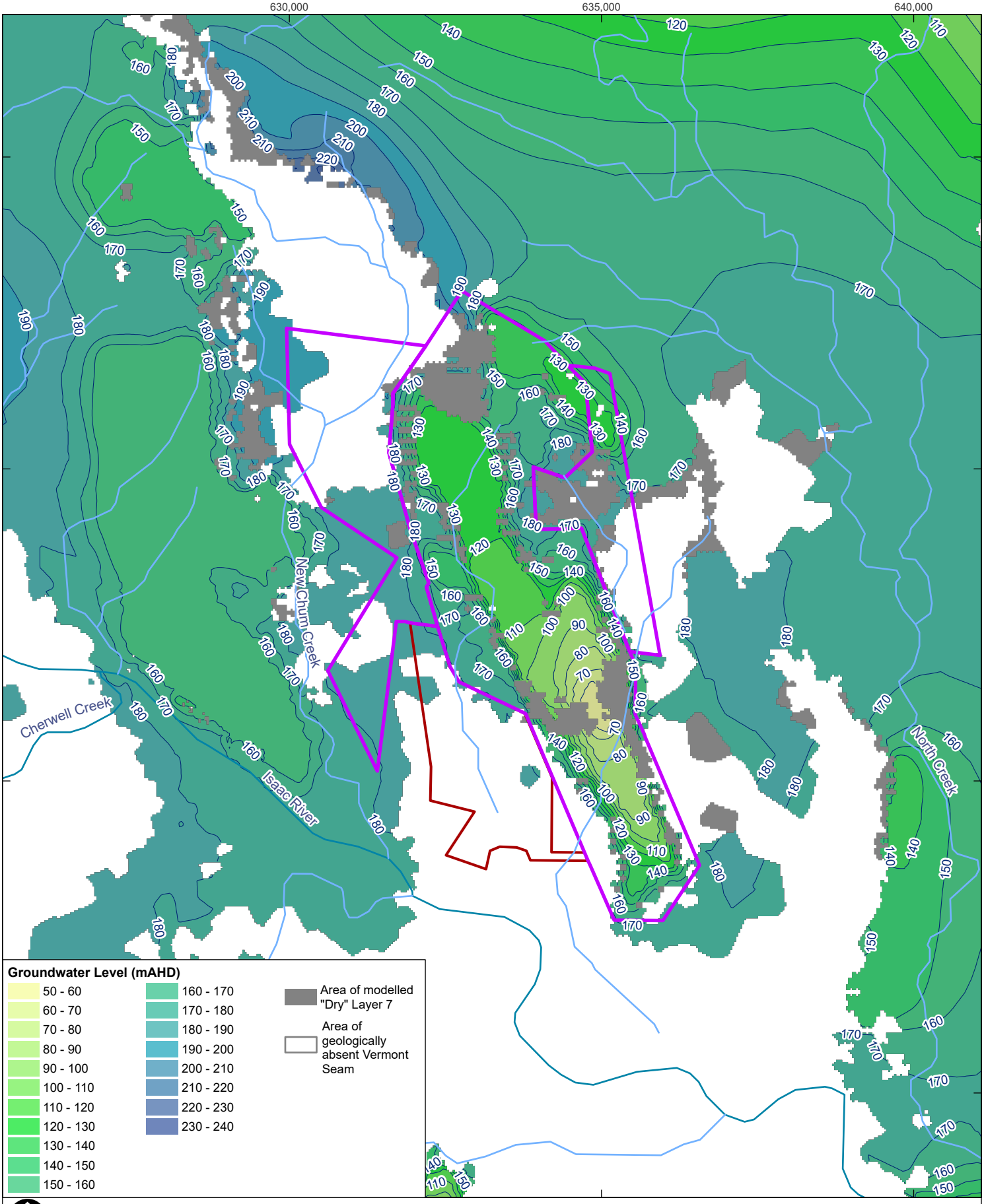
FIGURE A-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_FA-02_End of Mining GW Levels - Leichhardt Seam (L5)



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Coordinate System:	GDA2020 MGA Zone 55
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Project Number:	640.031614
Date Drawn:	19-Feb-2026
Drawn by:	RB

LEGEND

- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- DNM Mining Lease

DAUNIA MINE
TRANSITIONAL PRCP

END OF MINING GROUNDWATER LEVELS – VERMONT SEAM (LAYER 7)

SLR

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FIGURE A-3

Path: H:\Projects-SLR\640-MEL\640-MEL\640.031614.00001 DNM PRCP Update Groundwater\06 SLR Data\01 GIS\GIS\DNM PRCP Update GW\DNM PRCP Update GW.aprx\640031614_FA-03_End of Mining GW Levels - Vermont Seam (L7)

Appendix B Calibration Hydrographs

Daunia Mine

Transitional PRC Plan Hydrogeology – Revision 3

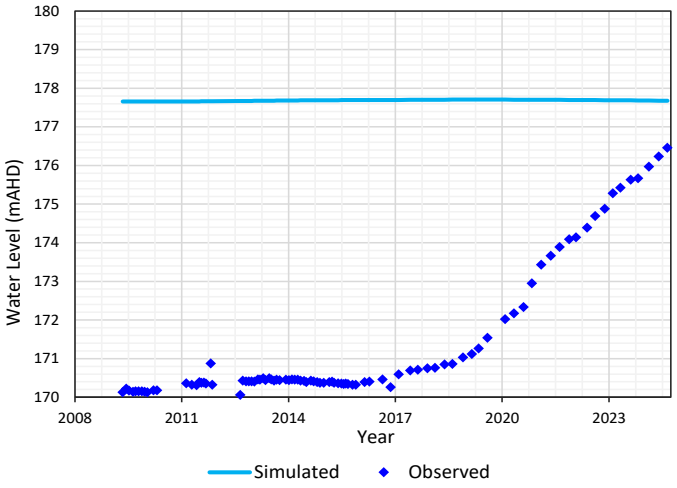
Whitehaven Coal Pty Ltd

SLR Project No.: 640.31614.00003

24 March 2026

Appendix B - Calibration Hydrographs

PZ04_DNM



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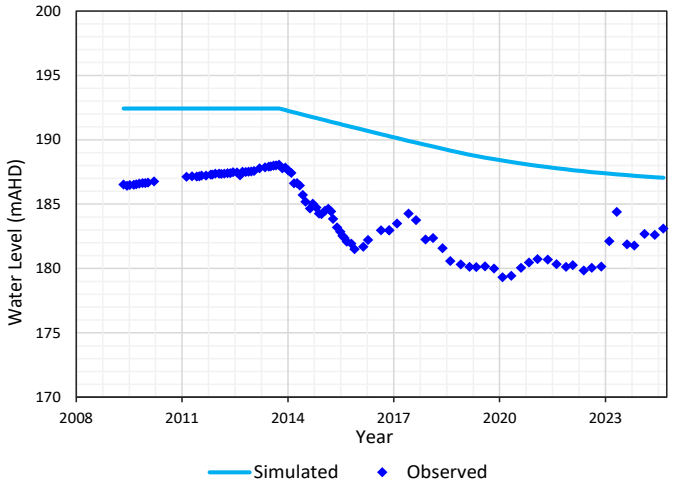

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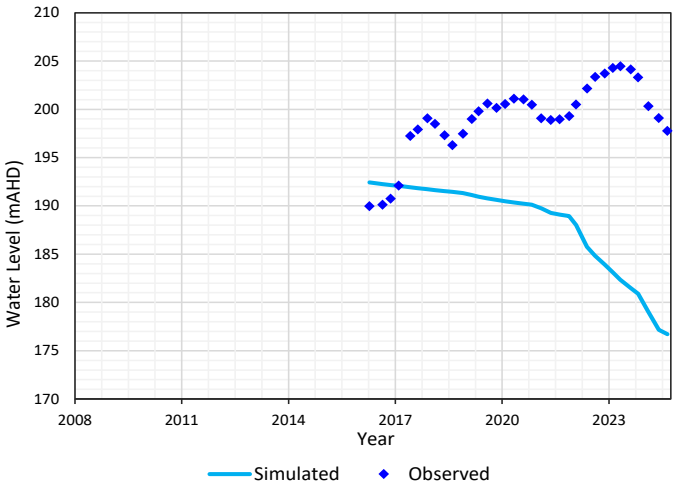

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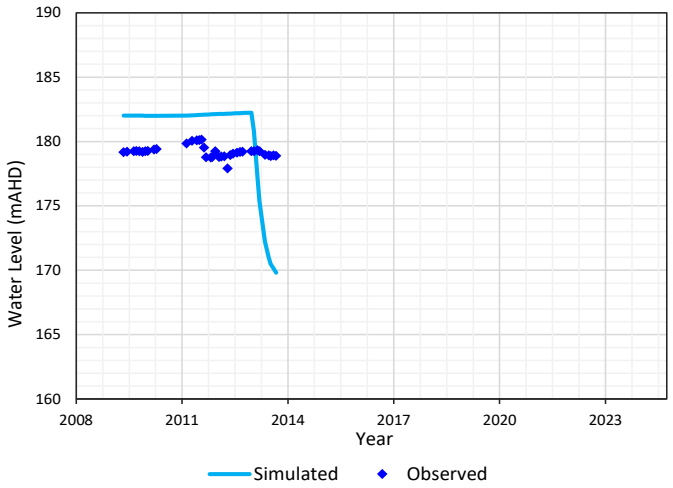

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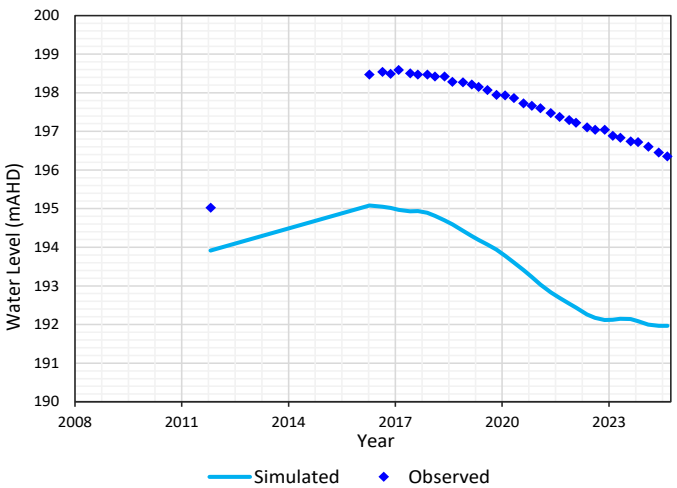

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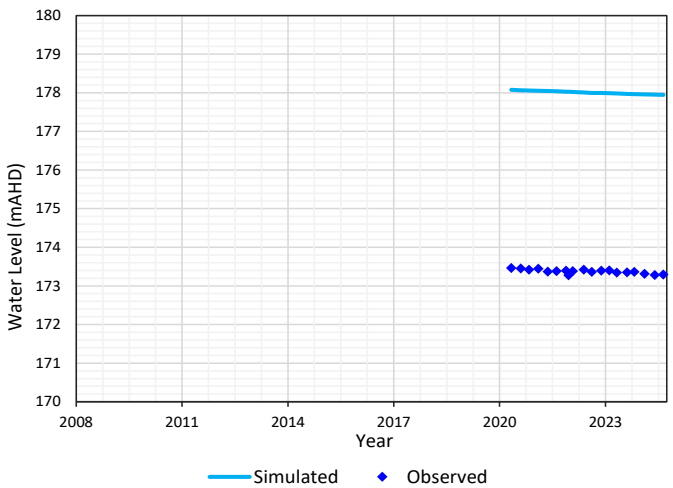
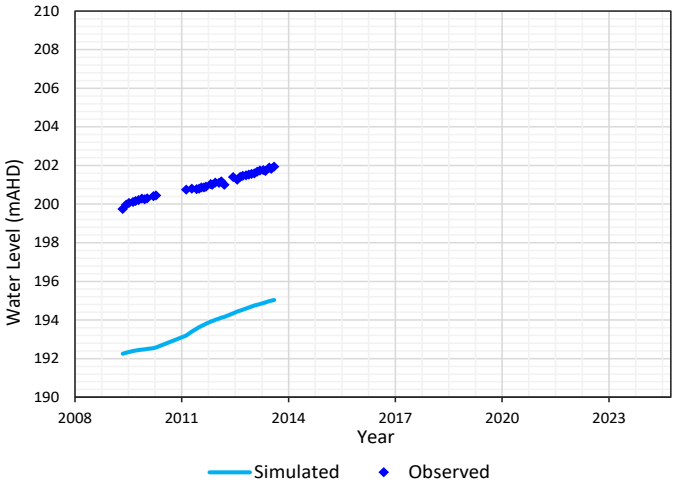


Appendix B - Calibration Hydrographs

PZ01_DNM



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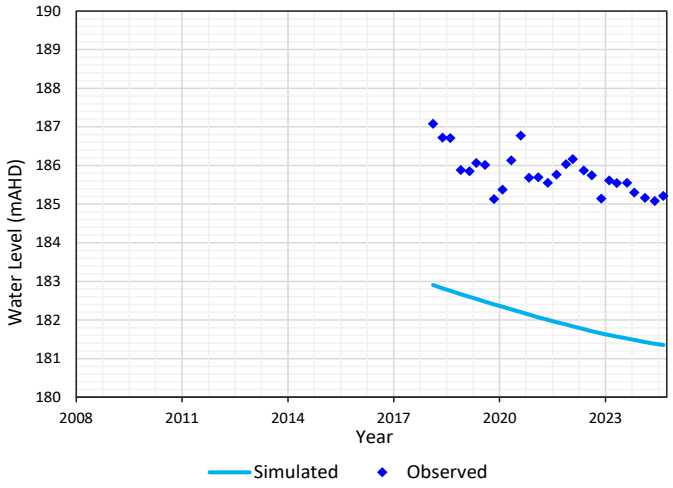

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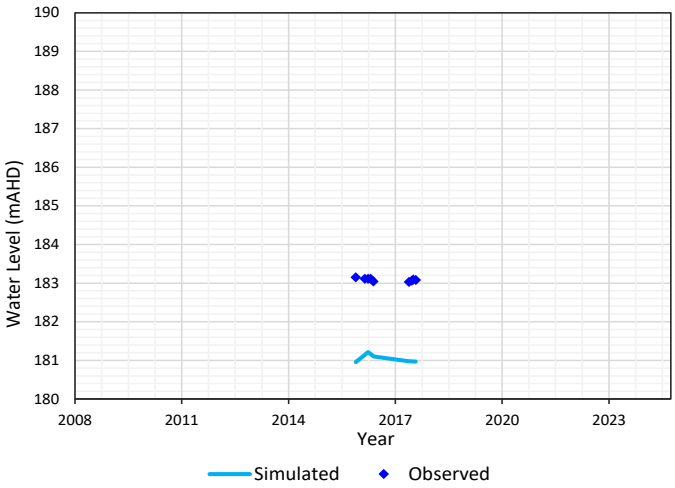

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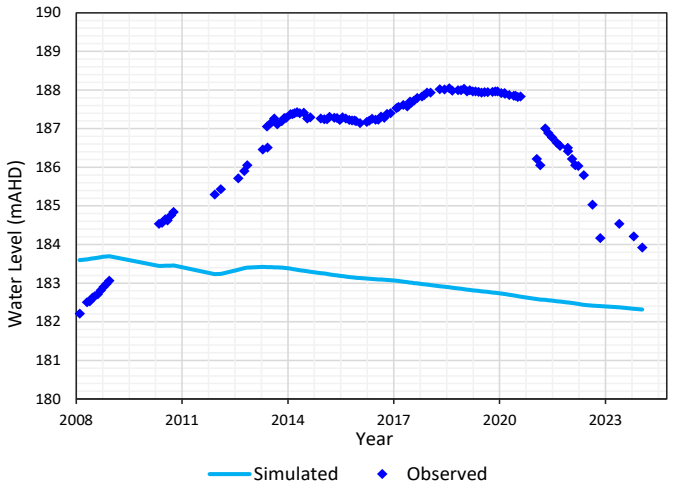

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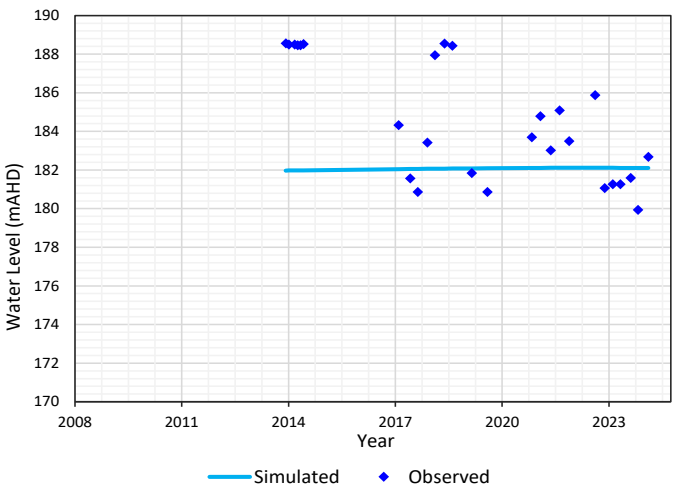

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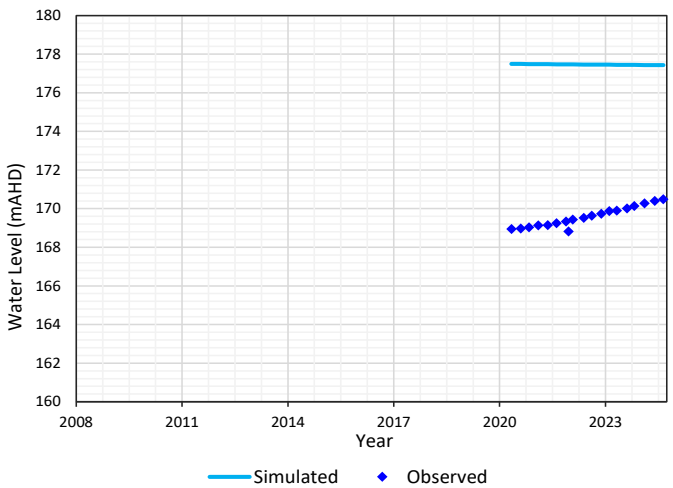
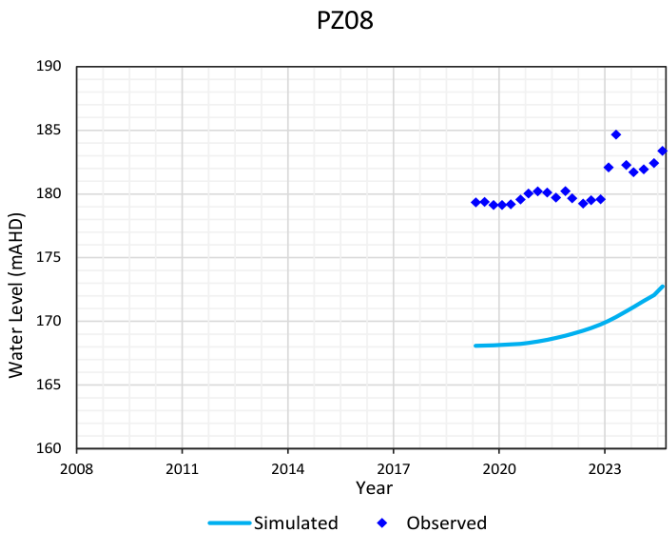


Appendix B - Calibration Hydrographs



Appendix C Calibrated Parameters

Daunia Mine

Transitional PRC Plan Hydrogeology – Revision 3

Whitehaven Coal Pty Ltd

SLR Project No.: 640.31614.00003

24 March 2026

Calibrated Hydraulic Parameters

Table C1 Calibrated Hydraulic Parameters (Hydraulic Conductivity) – MLE Realisation

Geology Unit	Unit	Layer	Min Kx (m/day)	Max Kx (m/day)	Average Kx (m/day)	Min Kz (m/day)	Max Kz (m/day)	Average Kz (m/day)	Maximum Depth for Depth Dependence Correction(m)
Alluvium [1]	Surface Cover	1	3.7 x10-02	3.7 x10-02	3.7 x10-02	1.0 x10-03	1.0 x10-03	1.0 x10-03	-
Isaac River Alluvium [2]	Isaac River Alluvium	1	1.1 x10-03	1.9 x10+00	4.5 x10-02	2.2 x10-07	2.4 x10-02	2.9 x10-04	-
Regolith [1]	Surface Cover	1	2.4 x10-03	7.3 x10-01	6.1 x10-02	9.9 x10-07	5.6 x10-02	7.0 x10-04	-
Weathered Permian [1]	Surface Cover	1 & 2	3.9 x10-01	3.9 x10-01	3.9 x10-01	7.6 x10-03	7.6 x10-03	7.6 x10-03	-
Duaringa [1]	Surface Cover	1 & 2	4.8 x10-01	4.8 x10-01	4.8 x10-01	1.0 x10-02	1.0 x10-02	1.0 x10-02	-
Tertiary Basalt [1]	Tertiary Basalt	1 & 2	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.4 x10-05	3.4 x10-05	3.4 x10-05	-
Regolith [2]	Surface Cover	2	2.8 x10-03	7.3 x10-01	5.9 x10-02	2.0 x10-06	5.6 x10-02	6.7 x10-04	-
Rewan [2]	Triassic	3	6.2 x10-05	9.4 x10+00	9.8 x10-02	8.4 x10-08	3.2 x10-01	6.6 x10-04	175
Rangal Coal Measures [1]	Interburden	4	6.9 x10-04	6.5 x10-02	7.9 x10-03	9.6 x10-06	9.0 x10-04	1.1 x10-04	119
Rangal Coal Measures [2]	Leichhardt Seam	5	3.1 x10-05	9.5 x10-01	1.1 x10-02	7.3 x10-08	1.4 x10-02	9.8 x10-05	117
Rangal Coal Measures [1]	Interburden	6	1.4 x10-07	2.0 x10-04	1.4 x10-05	1.1 x10-09	1.5 x10-06	1.1 x10-07	192
Rangal Coal Measures [2]	Vermont Seam	7	8.0 x10-06	2.7 x10+00	8.9 x10-03	2.6 x10-08	4.9 x10-02	6.9 x10-05	140
Rangal Coal Measures [1]	Interburden	8	3.9 x10-06	1.4 x10-03	3.9 x10-05	6.4 x10-08	2.2 x10-05	6.4 x10-07	161

Geology Unit	Unit	Layer	Min Kx (m/day)	Max Kx (m/day)	Average Kx (m/day)	Min Kz (m/day)	Max Kz (m/day)	Average Kz (m/day)	Maximum Depth for Depth Dependence Correction(m)
Fort Cooper Coal Measures [2]	Interburden	9	5.1 x10-05	5.4 x10-01	2.1 x10-02	6.3 x10-08	1.8 x10-02	1.6 x10-04	33
Fort Cooper Coal Measures [2]	Fort Cooper Seams	10	1.1 x10-05	8.0 x10-01	3.5 x10-03	8.2 x10-09	1.5 x10-02	1.9 x10-05	121
Fort Cooper Coal Measures [1]	Interburden	11	3.1 x10-05	4.6 x10-04	3.4 x10-05	1.2 x10-06	1.7 x10-05	1.3 x10-06	89
Moranbah Coal Measures [2]	Q Seam	12	2.0 x10-07	9.4 x10-01	2.5 x10-03	1.5 x10-10	1.9 x10-02	3.0 x10-05	254
Moranbah Coal Measures [1]	Interburden	13	3.0 x10-05	2.0 x10-02	6.3 x10-04	6.5 x10-07	4.4 x10-04	1.4 x10-05	175
Moranbah Coal Measures [2]	P Seam	14	3.8 x10-04	1.1 x10+00	2.0 x10-02	2.9 x10-07	2.3 x10-03	7.1 x10-05	30
Moranbah Coal Measures [1]	Interburden	15	1.3 x10-05	1.1 x10-02	3.1 x10-04	4.3 x10-08	3.7 x10-05	1.0 x10-06	175
Moranbah Coal Measures [2]	H Seam	16	1.5 x10-04	2.5 x10+00	4.5 x10-02	1.9 x10-07	3.2 x10-02	3.6 x10-04	67
Moranbah Coal Measures [1]	Interburden	17	8.6 x10-05	1.4 x10-01	5.2 x10-03	4.0 x10-06	6.6 x10-03	2.4 x10-04	190
Moranbah Coal Measures [2]	D Seam	18	6.4 x10-06	1.3 x10+00	2.8 x10-03	4.4 x10-09	3.2 x10-02	6.2 x10-05	140
Moranbah Coal Measures [1]	Interburden	19	2.8 x10-04	2.4 x10-02	4.2 x10-04	1.1 x10-05	9.4 x10-04	1.6 x10-05	115
Structure	Faults [1]	4 to 13	5.3 x10-04	2.7 x10-02	1.1 x10-03	1.2 x10-05	5.8 x10-04	2.3 x10-05	219
Structure	Faults [1]	4 to 13	2.1 x10-06	6.1 x10-03	4.1 x10-04	2.0 x10-07	5.7 x10-04	3.8 x10-05	135
Structure	Faults [1]	4 to 13	2.1 x10-04	2.7 x10-02	1.1 x10-03	1.3 x10-06	1.8 x10-04	7.1 x10-06	164

Geology Unit	Unit	Layer	Min Kx (m/day)	Max Kx (m/day)	Average Kx (m/day)	Min Kz (m/day)	Max Kz (m/day)	Average Kz (m/day)	Maximum Depth for Depth Dependence Correction(m)
Structure	Faults [1]	4 to 13	1.1 x10-04	2.9 x10-02	6.1 x10-04	6.2 x10-07	1.6 x10-04	3.4 x10-06	188
Structure	Faults [1]	4 to 6	3.6 x10-03	1.3 x10-01	4.3 x10-02	1.6 x10-04	5.9 x10-03	1.9 x10-03	34
Structure	Faults [2]	3	9.7 x10-06	2.3 x10-03	6.4 x10-04	2.1 x10-10	6.6 x10-07	1.1 x10-07	101
Structure	Faults [2]	5	4.0 x10-06	2.2 x10-02	1.9 x10-03	1.1 x10-08	1.4 x10-04	7.1 x10-06	174
Structure	Faults [2]	7	3.7 x10-05	7.1 x10-02	5.3 x10-03	5.0 x10-08	8.4 x10-04	1.9 x10-05	113
Structure	Faults [2]	9	2.8 x10-05	5.4 x10-03	8.7 x10-04	1.2 x10-07	1.9 x10-04	1.8 x10-05	132
Structure	Faults [2]	10	4.3 x10-06	9.3 x10-04	8.9 x10-05	5.2 x10-09	3.6 x10-06	2.6 x10-07	136
Structure	Faults [2]	12	2.8 x10-05	1.3 x10-03	3.7 x10-04	3.3 x10-10	1.0 x10-06	1.2 x10-07	97
Structure	Faults [2]	14	9.2 x10-06	6.5 x10-04	1.8 x10-04	1.3 x10-09	3.0 x10-07	7.0 x10-08	149
Structure	Faults [2]	16	4.8 x10-09	2.3 x10-07	6.0 x10-08	1.0 x10-10	6.6 x10-10	1.8 x10-10	236
Structure	Faults [2]	18	9.2 x10-06	1.2 x10-04	4.8 x10-05	6.5 x10-09	4.5 x10-07	8.1 x10-08	109
Structure	Faults [2]	3	2.4 x10-03	1.9 x10+00	1.2 x10-01	8.6 x10-07	6.0 x10-03	1.1 x10-04	153
Structure	Faults [2]	5	2.0 x10-05	1.2 x10-02	1.2 x10-03	5.9 x10-08	2.7 x10-04	9.5 x10-06	47
Structure	Faults [2]	7	1.3 x10-07	2.3 x10-04	7.4 x10-06	1.0 x10-10	5.0 x10-08	4.9 x10-09	169
Structure	Faults [2]	9	1.6 x10-05	1.7 x10-02	1.0 x10-03	7.6 x10-10	2.4 x10-06	1.3 x10-07	163
Structure	Faults [2]	10	2.0 x10-06	4.6 x10-05	1.4 x10-05	1.9 x10-10	2.3 x10-08	4.4 x10-09	110
Structure	Faults [2]	12	4.9 x10-07	2.8 x10-02	7.0 x10-04	1.0 x10-10	1.4 x10-05	2.8 x10-07	192
Structure	Faults [2]	14	6.0 x10-10	9.7 x10-05	9.8 x10-07	1.0 x10-10	4.0 x10-08	3.3 x10-10	276
Structure	Faults [2]	16	1.7 x10-07	3.4 x10-05	6.7 x10-06	1.2 x10-09	5.1 x10-07	5.8 x10-08	196
Structure	Faults [2]	18	2.4 x10-06	2.9 x10-03	6.3 x10-05	1.0 x10-10	4.3 x10-08	1.7 x10-09	84
Structure	Faults [2]	3	1.5 x10-05	1.8 x10-02	4.4 x10-04	4.0 x10-08	4.8 x10-05	1.4 x10-06	196

Geology Unit	Unit	Layer	Min Kx (m/day)	Max Kx (m/day)	Average Kx (m/day)	Min Kz (m/day)	Max Kz (m/day)	Average Kz (m/day)	Maximum Depth for Depth Dependence Correction(m)
Structure	Faults [2]	5	2.3 x10-08	8.9 x10-05	6.9 x10-06	1.0 x10-10	2.7 x10-07	2.3 x10-08	160
Structure	Faults [2]	7	4.6 x10-05	5.4 x10-02	5.1 x10-03	3.4 x10-07	1.1 x10-03	1.5 x10-04	81
Structure	Faults [2]	9	1.1 x10-06	5.1 x10-04	4.8 x10-05	3.0 x10-09	6.6 x10-06	7.6 x10-07	118
Structure	Faults [2]	10	2.2 x10-06	1.9 x10-02	1.2 x10-03	4.3 x10-08	1.5 x10-03	1.1 x10-04	174
Structure	Faults [2]	12	2.5 x10-06	2.1 x10-03	2.9 x10-04	3.2 x10-09	2.6 x10-06	2.9 x10-07	235
Structure	Faults [2]	14	1.8 x10-08	5.7 x10-05	5.7 x10-06	1.0 x10-09	5.9 x10-06	4.9 x10-07	198
Structure	Faults [2]	16	3.2 x10-04	1.5 x10-02	2.4 x10-03	6.0 x10-07	3.6 x10-05	4.9 x10-06	170
Structure	Faults [2]	18	6.6 x10-08	1.4 x10-06	4.9 x10-07	1.0 x10-10	2.3 x10-09	4.2 x10-10	156
Structure	Faults [2]	3	8.2 x10-06	2.0 x10-02	2.1 x10-03	2.5 x10-08	2.6 x10-04	1.4 x10-05	174
Structure	Faults [2]	5	1.2 x10-04	4.2 x10-03	1.0 x10-03	5.5 x10-07	7.7 x10-05	1.0 x10-05	32
Structure	Faults [2]	7	2.0 x10-08	2.1 x10-03	8.5 x10-05	1.0 x10-10	1.6 x10-05	4.7 x10-07	253
Structure	Faults [2]	9	1.6 x10-06	2.2 x10-03	2.8 x10-04	1.5 x10-10	7.5 x10-06	6.9 x10-07	192
Structure	Faults [2]	10	8.5 x10-08	4.3 x10-05	3.6 x10-06	1.0 x10-10	6.4 x10-09	4.9 x10-10	214
Structure	Faults [2]	12	5.8 x10-09	2.8 x10-07	7.6 x10-08	1.0 x10-10	1.9 x10-10	1.0 x10-10	264
Structure	Faults [2]	14	6.9 x10-07	8.4 x10-05	1.0 x10-05	1.0 x10-10	8.6 x10-09	8.5 x10-10	188
Structure	Faults [2]	16	6.6 x10-07	5.2 x10-06	2.3 x10-06	5.9 x10-10	1.3 x10-08	4.1 x10-09	219
Structure	Faults [2]	18	1.7 x10-07	4.0 x10-06	4.8 x10-07	1.0 x10-10	3.4 x10-09	1.4 x10-10	165
Structure	Faults [2]	3	1.6 x10-02	1.7 x10-01	6.7 x10-02	1.1 x10-05	4.0 x10-04	1.8 x10-04	87
Structure	Faults [2]	5	1.9 x10-04	7.1 x10-03	1.8 x10-03	9.1 x10-08	6.2 x10-06	1.2 x10-06	239
Structure	Faults [2]	7	4.5 x10-06	4.2 x10-04	4.4 x10-05	2.3 x10-08	3.2 x10-06	2.2 x10-07	121

1 Pilot Points are not included
2 Pilot Points are included

Table C2 Calibrated Hydraulic Parameters (Storage) – MLE Realisation

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})	Maximum Depth for Depth Dependence Correction(m)
Alluvium	Surface Cover	1	1.1 x10-02	1.1 x10-02	1.1 x10-02	5.6 x10-06	5.6 x10-06	5.6 x10-06	-
Isaac River Alluvium *	Isaac River Alluvium	1	1.1 x10-03	2.0 x10-01	2.2 x10-02	9.0 x10-07	9.0 x10-07	9.0 x10-07	-
Regolith	Surface Cover	1	1.5 x10-02	1.5 x10-02	1.5 x10-02	2.1 x10-07	2.1 x10-07	2.1 x10-07	-
Weathered Permian	Surface Cover	1 & 2	1.1 x10-02	1.1 x10-02	1.1 x10-02	9.4 x10-07	9.4 x10-07	9.4 x10-07	-
Duaringa	Surface Cover	1 & 2	2.2 x10-03	2.2 x10-03	2.2 x10-03	5.1 x10-06	5.1 x10-06	5.1 x10-06	-
Tertiary Basalt	Tertiary Basalt	1 & 2	2.6 x10-03	2.6 x10-03	2.6 x10-03	1.9 x10-06	1.9 x10-06	1.9 x10-06	-
Regolith	Surface Cover	2	1.2 x10-02	1.2 x10-02	1.2 x10-02	9.1 x10-07	9.1 x10-07	9.1 x10-07	-
Rewan	Triassic	3	1.7 x10-03	1.7 x10-03	1.7 x10-03	3.4 x10-06	3.4 x10-06	3.4 x10-06	175
Rangal Coal Measures	Interburden	4	2.9 x10-03	2.9 x10-03	2.9 x10-03	7.2 x10-07	7.2 x10-07	7.2 x10-07	119
Rangal Coal Measures	Leichhardt Seam	5	4.7 x10-03	4.7 x10-03	4.7 x10-03	9.7 x10-07	9.7 x10-07	9.7 x10-07	117
Rangal Coal Measures	Interburden	6	5.0 x10-03	5.0 x10-03	5.0 x10-03	1.0 x10-06	1.0 x10-06	1.0 x10-06	192
Rangal Coal Measures	Vermont Seam	7	3.2 x10-03	3.2 x10-03	3.2 x10-03	6.7 x10-07	6.7 x10-07	6.7 x10-07	140
Rangal Coal Measures	Interburden	8	3.4 x10-04	3.4 x10-04	3.4 x10-04	6.2 x10-07	6.2 x10-07	6.2 x10-07	161
Fort Cooper Coal Measures	Interburden	9	2.7 x10-04	2.7 x10-04	2.7 x10-04	1.5 x10-06	1.5 x10-06	1.5 x10-06	33

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})	Maximum Depth for Depth Dependence Correction(m)
Fort Cooper Coal Measures	Fort Cooper Seams	10	2.1 x10-03	2.1 x10-03	2.1 x10-03	9.3 x10-07	9.3 x10-07	9.3 x10-07	121
Fort Cooper Coal Measures	Interburden	11	7.2 x10-03	7.2 x10-03	7.2 x10-03	6.5 x10-07	6.5 x10-07	6.5 x10-07	89
Moranbah Coal Measures	Q Seam	12	6.5 x10-04	6.5 x10-04	6.5 x10-04	2.4 x10-06	2.4 x10-06	2.4 x10-06	254
Moranbah Coal Measures	Interburden	13	2.0 x10-04	2.0 x10-04	2.0 x10-04	6.8 x10-07	6.8 x10-07	6.8 x10-07	175
Moranbah Coal Measures	P Seam	14	3.7 x10-04	3.7 x10-04	3.7 x10-04	4.5 x10-07	4.5 x10-07	4.5 x10-07	30
Moranbah Coal Measures	Interburden	15	7.5 x10-04	7.5 x10-04	7.5 x10-04	6.4 x10-07	6.4 x10-07	6.4 x10-07	175
Moranbah Coal Measures	H Seam	16	5.8 x10-04	5.8 x10-04	5.8 x10-04	2.0 x10-06	2.0 x10-06	2.0 x10-06	67
Moranbah Coal Measures	Interburden	17	4.6 x10-04	4.6 x10-04	4.6 x10-04	6.8 x10-07	6.8 x10-07	6.8 x10-07	190
Moranbah Coal Measures	D Seam	18	1.5 x10-03	1.5 x10-03	1.5 x10-03	5.6 x10-07	5.6 x10-07	5.6 x10-07	140
Moranbah Coal Measures	Interburden	19	1.6 x10-03	1.6 x10-03	1.6 x10-03	3.9 x10-06	3.9 x10-06	3.9 x10-06	115
Structure	Faults	4 to 13	1.2 x10-04	1.2 x10-04	1.2 x10-04	1.6 x10-06	1.6 x10-06	1.6 x10-06	219
Structure	Faults	4 to 13	2.4 x10-04	2.4 x10-04	2.4 x10-04	1.6 x10-06	1.6 x10-06	1.6 x10-06	135
Structure	Faults	4 to 13	1.2 x10-03	1.2 x10-03	1.2 x10-03	1.5 x10-06	1.5 x10-06	1.5 x10-06	164
Structure	Faults	4 to 13	1.3 x10-02	1.3 x10-02	1.3 x10-02	4.1 x10-07	4.1 x10-07	4.1 x10-07	188
Structure	Faults	4 to 6	2.4 x10-03	2.4 x10-03	2.4 x10-03	2.8 x10-07	2.8 x10-07	2.8 x10-07	34

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})	Maximum Depth for Depth Dependence Correction(m)
Structure	Faults	3	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	101
Structure	Faults	5	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	174
Structure	Faults	7	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	113
Structure	Faults	9	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	132
Structure	Faults	10	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	136
Structure	Faults	12	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	97
Structure	Faults	14	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	149
Structure	Faults	16	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	236
Structure	Faults	18	1.3 x10-02	1.3 x10-02	1.3 x10-02	3.2 x10-06	3.2 x10-06	3.2 x10-06	109
Structure	Faults	3	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	153
Structure	Faults	5	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	47
Structure	Faults	7	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	169
Structure	Faults	9	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	163
Structure	Faults	10	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	110
Structure	Faults	12	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	192
Structure	Faults	14	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	276
Structure	Faults	16	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	196
Structure	Faults	18	1.3 x10-02	1.3 x10-02	1.3 x10-02	8.6 x10-07	8.6 x10-07	8.6 x10-07	84
Structure	Faults	3	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	196
Structure	Faults	5	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	160
Structure	Faults	7	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	81

Geology Unit	Unit	Layer	Min Sy (-)	Max Sy (-)	Average Sy (-)	Min Ss (d^{-1})	Max Ss (d^{-1})	Average Ss (d^{-1})	Maximum Depth for Depth Dependence Correction(m)
Structure	Faults	9	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	118
Structure	Faults	10	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	174
Structure	Faults	12	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	235
Structure	Faults	14	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	198
Structure	Faults	16	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	170
Structure	Faults	18	2.5 x10-02	2.5 x10-02	2.5 x10-02	4.2 x10-06	4.2 x10-06	4.2 x10-06	156
Structure	Faults	3	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	174
Structure	Faults	5	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	32
Structure	Faults	7	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	253
Structure	Faults	9	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	192
Structure	Faults	10	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	214
Structure	Faults	12	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	264
Structure	Faults	14	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	188
Structure	Faults	16	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	219
Structure	Faults	18	1.8 x10-02	1.8 x10-02	1.8 x10-02	6.4 x10-06	6.4 x10-06	6.4 x10-06	165
Structure	Faults	3	1.3 x10-02	1.3 x10-02	1.3 x10-02	2.0 x10-06	2.0 x10-06	2.0 x10-06	87
Structure	Faults	5	1.3 x10-02	1.3 x10-02	1.3 x10-02	2.0 x10-06	2.0 x10-06	2.0 x10-06	239
Structure	Faults	7	1.3 x10-02	1.3 x10-02	1.3 x10-02	2.0 x10-06	2.0 x10-06	2.0 x10-06	121

* Pilot points are included only for the Sy of Isaac River Alluvium

Table C3 Calibrated Spoil Hydraulic Parameters – MLE Realisation

Parameter	Value
Horizontal hydraulic conductivity (m/day)	2.48
Vertical hydraulic conductivity (m/day)	0.05
Specific Yield (%)	0.01
Specific Storage (1/m)	1.40 x10-05

Calibrated Recharge

Table C4 Calibrated Rainfall Recharge – MLE Realisation

Model Recharge Zone	% of Rainfall	Long-term Average Rainfall Recharge (mm/yr)
Alluvium Isaac River Channel	0.08%	0.4
Alluvium Isaac River	0.04%	0.2
Alluvium (rest of the model)	0.93%	5.2
Regolith	0.02%	0.1
Weathered Permian	0.09%	0.5
Duaringa Formation (Tertiary)	0.04%	0.2
Tertiary Basalts	0.42%	2.4
Spoil	3.7%	21

Calibrated Evapotranspiration (EVT)

Table C5 Calibrated EVT Extinction Depth – MLE Realisation

Model EVT Zone	Extinction Depth (m)
Alluvium	1.4
Regolith	14.4
Weathered Permian	1.9
Duaringa Formation	1.4
Tertiary Basalts	5.2
Permian Outcrop	0.9
Spoil	0.6

Calibrated General Head Boundary

Table C6 Calibrated General Head Boundary (GHB) Properties – MLE Realisation

Layer	Zone	GHB Head (m)	GHB Conductance Factor
1	1	18.04	0.05
1	2	25.69	305.16
1	3	4.95	37.45
2	4	38.62	2.12
2	5	25.37	0.80
2	6	49.30	3.37
3	7	46.84	9.23
3	8	40.75	0.02
3	9	42.06	0.21
4	10	30.78	3.00
4	11	46.72	22.82
4	12	36.16	0.00
4	13	39.75	0.35
5	14	33.21	0.02
5	15	67.58	0.02
5	16	44.73	0.02
5	17	29.09	42.77
6	18	42.57	1.17
6	19	35.38	2.78
6	20	35.31	1.60
6	21	27.45	0.17
7	22	41.52	2.35
7	23	43.07	34.94
7	24	48.38	2.21
7	25	27.42	0.01
8	26	20.35	0.06
8	27	57.57	0.02
8	28	34.58	0.23
8	29	13.26	0.04
9	30	47.53	0.02
9	31	34.20	0.20
9	32	60.55	0.75
9	33	42.68	1.37
10	34	21.61	0.29

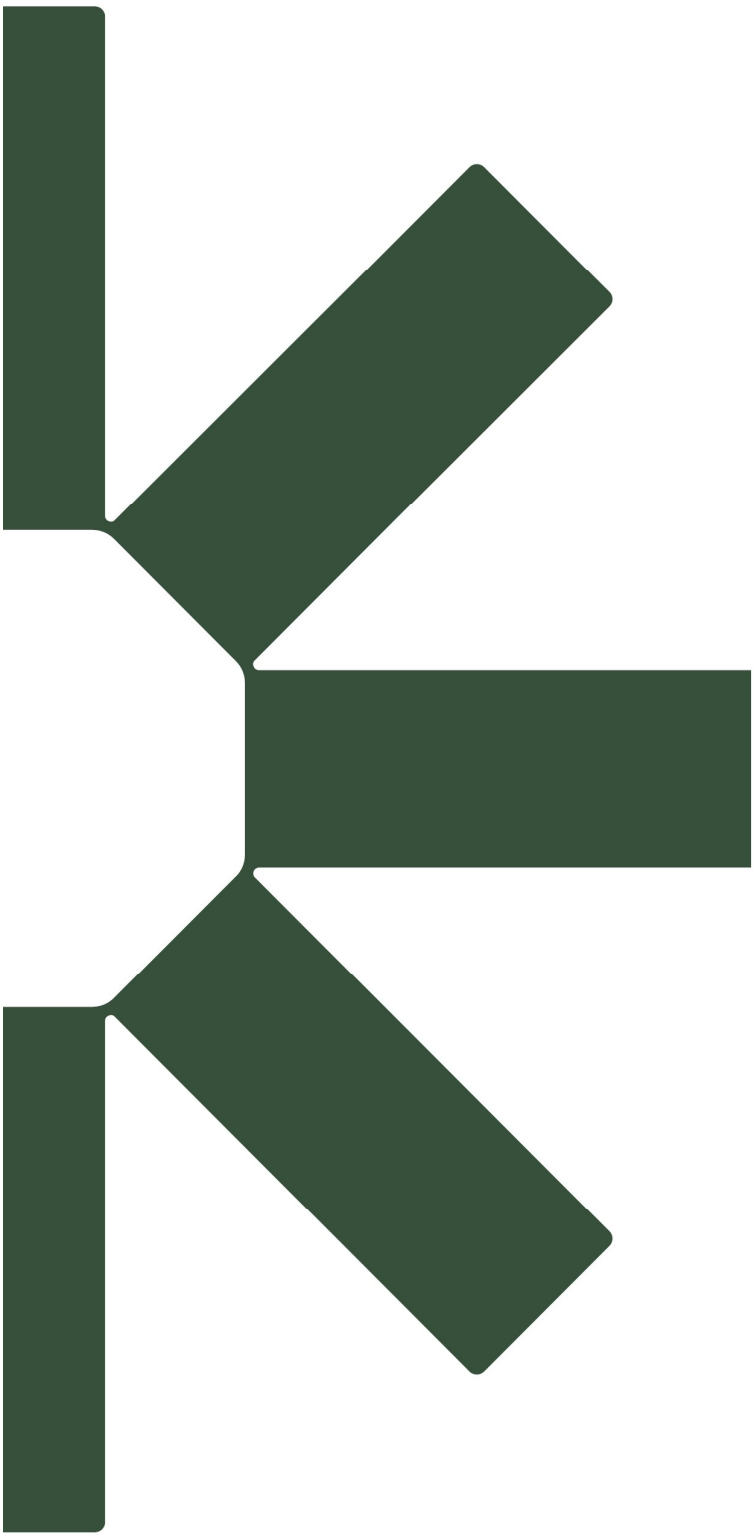
Layer	Zone	GHB Head (m)	GHB Conductance Factor
10	35	33.53	14.22
10	36	39.69	0.34
10	37	29.08	0.08
11	38	19.24	0.12
11	39	27.94	0.03
11	40	23.37	0.06
11	41	18.92	0.02
12	42	5.27	0.15
12	43	17.26	0.06
12	44	16.45	0.08
12	45	51.48	14.44
13	46	31.06	0.09
13	47	27.13	0.13
13	48	27.34	0.04
13	49	32.98	2.51
14	50	21.74	1.24
14	51	37.88	1.82
14	52	42.93	9.09
14	53	38.36	0.34
15	54	44.29	2.34
15	55	35.11	779.64
15	56	48.96	0.28
15	57	28.38	0.17
16	58	42.48	1.08
16	59	22.26	2.20
16	60	34.87	1.15
16	61	39.71	2.95
17	62	49.37	0.05
17	63	23.52	2.10
17	64	7.31	6.77
17	65	17.16	0.03
18	66	47.84	3.71
18	67	11.84	3.92
18	68	52.22	0.40
18	69	24.59	0.50
19	70	36.12	1.78
19	71	19.99	0.01

Layer	Zone	GHB Head (m)	GHB Conductance Factor
19	72	44.90	34.30
19	73	18.00	0.03

Calibrated Riverbed Vertical Conductivity

Table C7 Calibrated Riverbed Vertical Conductivity – MLE Realisation

Model River Zone	Riverbed Vertical Conductivity (m/day)
Isaac River_Goonyella	0.0074
Isaac River_Deverill	0.0002
Grosvenor Creek	0.0537
Conrock Gully	0.0025
Cherwell Creek	0.0030
Ripstone	0.0006
Phillips Creek	0.1370
Smoky Creek	0.0152
Billy's Gully	0.0022
New Chum Creek	0.0074
North Creek	0.0004



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