



Daunia West Infrastructure Project

Groundwater Impact Assessment

Whitehaven Daunia Limited

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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Whitehaven Daunia Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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1.0 Introduction

Daunia Mine (DNM) is located approximately 25 kilometres (km) southeast of Moranbah in Central Queensland, on mining leases (ML) 1781, ML70115, and ML70116. Whitehaven Daunia Limited (WHC) owns DNM, which was approved in 2009 and operates under the Environmental Authority (EA) EPML00561913 and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval 2008/4418.

A change to the mine plan across the southern mining area of DNM (Pandora Pit) has resulted in the need for several mine infrastructure changes including an out of pit waste rock dump. WHC proposes to construct this off-lease and immediately adjacent to the west of Pandora Pit (ML 1781). A new MLA will be submitted for the area proposed for the out of pit dump (OOPD).

SLR Consulting Australia Pty Ltd (SLR) was engaged by WHC to support the environmental approval process for the Daunia West Infrastructure Project (the Project). This report presents a groundwater impact assessment for the Project and specifically the OOPD including a conceptual hydrogeological model (CHM); numerical groundwater modelling; and an assessment of the potential risks posed by the OOPD to the groundwater environment and associated receptors.

Note that this assessment is based on the Project Description including the form of the OOPD and the final landform, together with the mine progression provided by WHC in June 2025.

1.1 Project Overview

Current operations at DNM are carried out under the conditions of EA EPML00561913 and EPBC approval 2008/4418. The location and layout of DNM is presented in **Figure 1-1**.

The Project is required to support ongoing open cut mining in the Pandora Pit, which contains the 'Pandora' resource, one of the remaining undeveloped resources within DNM. The Pandora resource is located within ML1781 at the southern extent of the ML. The proximity of this resource to the ML boundary, along with limited available space within the existing MLs, necessitates the development of supporting infrastructure outside the current MLs. Considering this, the Project will require the construction of additional haul roads to transport material to facilitate and support ongoing mining operations at DNM. The layout of the Project is presented in **Figure 1-2**.

The Project does not include any change to the currently permitted extent or depth of mining at DNM.

1.2 Scope and Objectives

One of the potential environmental risks identified for the Project is the potential impact on groundwater from the OOPD on / adjacent to the alluvial flood plain of the Issac River. To assess the risks the following tasks have been completed:

- Development of a hydrogeological conceptual model focusing on the area of the proposed OOPD and its immediate surrounds including:
 - A review of the geological, hydrogeological, and hydrological setting, groundwater levels and groundwater chemistry.
 - A review and appraisal of local groundwater values (groundwater users, potential groundwater dependent ecosystems (GDEs)).
 - A description of the location, extent, form, and likely properties (hydraulic and geochemical) of the OOPD.
 - A review of previous hydrogeological studies for DNM.



- A predictive numerical modelling exercise assessing the potential risks to the local groundwater environment from the OOPD including an assessment of hydraulic gradients and potential contaminant migration pathways, in the context of the surrounding mining activity.
- An assessment of predicted impacts from the OOPD to potential groundwater receptors.

Development of the CHM and assessment of baseline conditions was undertaken in accordance with the Queensland government requirements and the EPBC Act “Water Trigger”.

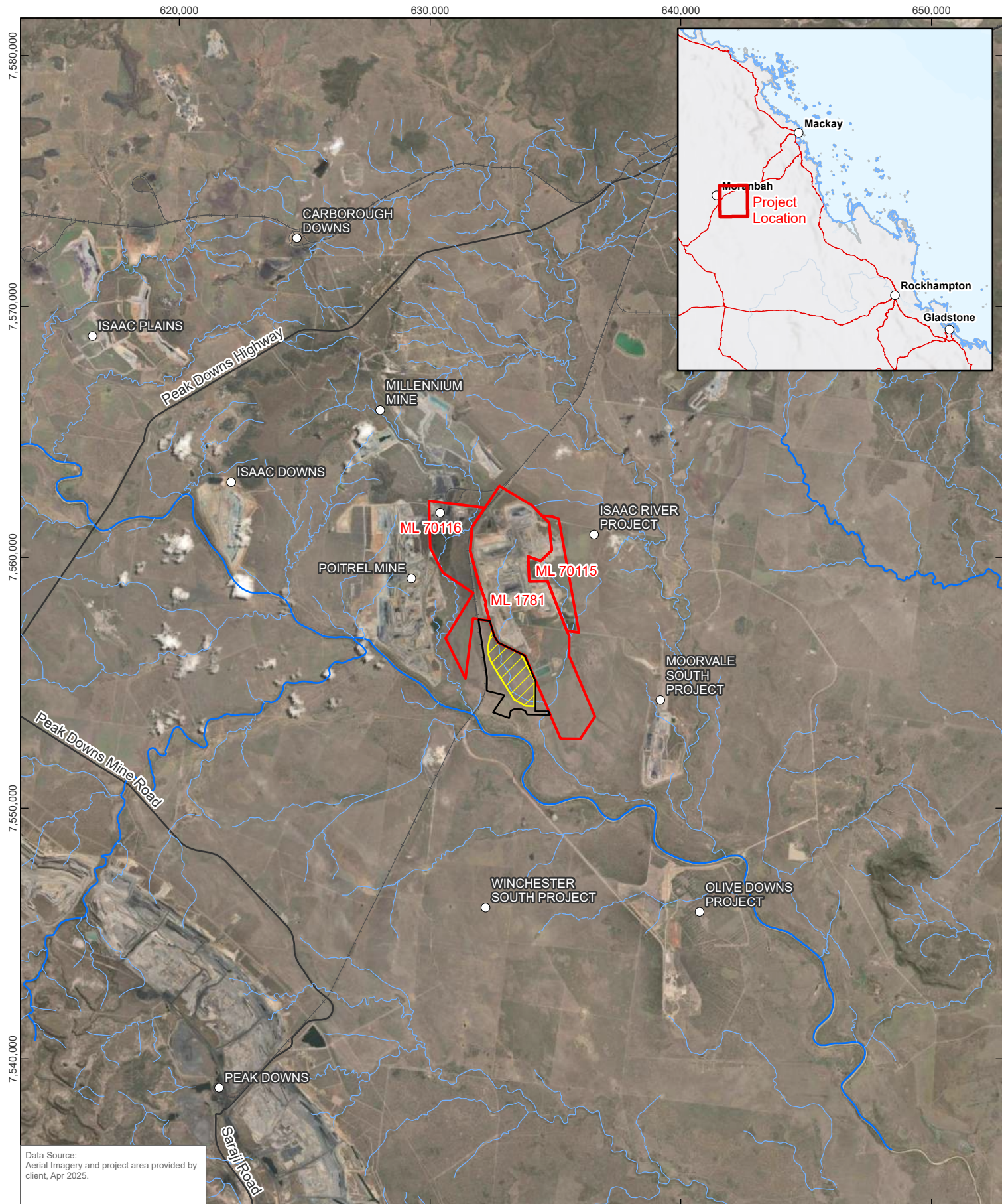
Groundwater modelling was undertaken in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) and Murray Darling Basin Commission guidelines (Middlemis et al., 2001). The numerical model used is an existing, detailed, regional model previously developed for DNM and other nearby operations, and which includes current details of all the mining operations surrounding Pandora Pit and the proposed OOPD.

1.3 Information Sources

The most recent hydrogeological assessment for DNM was that prepared by SLR (2023) for the DNM Progressive Rehabilitation and Closure Plan (PRCP). That groundwater assessment, including conceptual and numerical model development, has been drawn upon for this groundwater assessment.

In addition to publicly available and other Project specific information, this assessment has used data collated as part of recent groundwater assessments for the nearby Winchester South Project (SLR, 2020), Moorvale South Mine (SLR, 2019a, 2019b, 2025b), Olive Downs Mine (HydroSimulations, 2018a and 2018b) and Poitrel Mine (SLR, 2024). WHC has established groundwater data sharing agreements with the owners of each of these projects/mines, to share groundwater data, models, and documentation. Under these agreements, relevant data for these projects/mines has been used in this assessment.





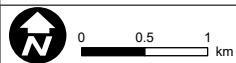
DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

PROJECT LOCATION



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FIGURE 1-1



Coordinate System: GDA2020 MGA Zone 55

Scale: 1:60,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Road
- +— Railway
- Mining Lease
- Mining Lease Application Area / Project Area
- Proposed Operational Out-of-Pit Dump (DWIP)
- Mining Pit

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

OOPD LAYOUT



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FIGURE 1-2

2.0 Legislative Requirements and Relevant Guidelines

This section summarises the Commonwealth and Queensland groundwater legislation and policy relevant to groundwater at the Project. Also summarised are the guidelines relevant to the groundwater assessment required to facilitate the environmental approvals process.

2.1 Commonwealth Regulatory Framework

2.1.1 Commonwealth Environment Protection and Biodiversity Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES). Under the 2013 amendment to the EPBC Act, impacts on water resources were included, and are referred to as the 'Water Trigger'.

Due to the Bilateral Agreement between the Commonwealth of Australia and the State of Queensland (2004), only one impact assessment is required for a project that triggers an assessment under both the EPBC Act and State legislation. However, the impact assessment is reviewed separately by the State and Commonwealth.

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) is a statutory body established under the EPBC Act that provides scientific advice to the Commonwealth Environment Minister and relevant state ministers. Guidelines have been developed to assist the IESC in reviewing Coal Seam Gas (CSG) or large coal mining development proposals that are likely to have significant impacts on water resources. This includes completion of an independent peer review of numerical groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). A checklist against the IESC information guideline requirements is presented in **Appendix A**.

2.2 Queensland Regulatory Framework

2.2.1 Queensland Water Act 2000

The *Water Act 2000* (Water Act), supported by the subordinate *Water Regulation 2016*, is the primary legislation regulating groundwater resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for planning, allocation and use of water.

Management Framework Relevant to the Project

The Water Act is enacted under a framework of catchment specific Water Resource Plans (WRPs). A WRP provides a management framework for water resources in a plan area, and includes outcomes, objectives, and strategies for maintaining balanced and sustainable water use in that area. Resource Operations Plans (ROPs) implement the outcomes and strategies of WRPs. Groundwater Management Areas (GMAs) and their component groundwater units are defined under WRPs. Authorisation is required to take non-associated groundwater from a regulated GMA or groundwater unit for specified purposes. The specified purposes are defined under a WRP, the Water Regulation 2016 or a local water management policy.

The Project falls within the WRP area for the Fitzroy Basin (*Water Plan (Fitzroy Basin) 2011*). The plan covers surface water (zone WQ1301) associated with Isaac River, and groundwater (zone WQ1310 – Fitzroy Basin groundwaters).

WHC is proposing a change to its current exercise of underground water rights under the Water Act as part of the Project, as the Project involves the addition of a new tenure and may interact with groundwater.



The Project may interact with groundwater within the Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. This relates to both Groundwater Unit 1 (containing aquifers of the Quaternary alluvium) and Groundwater Unit 2 (sub-artesian aquifers). The extent of Groundwater Unit 1 (Isaac Connors Alluvium Groundwater Sub-area) is based on the mapped extent of Quaternary alluvium, which, whilst not mapped within the Project footprint, may be connected with aquifers within the Project Area. As discussed further in Section 4.2, the extent of mapped alluvium has been refined based on information specific to the Study Area.

Water Act declared watercourses and drainage

The Water Act includes criteria for determining watercourses that require authorisation under the Water Act to take water, interfere with the flow of water, take quarry material, or excavate and place fill in a watercourse. The Water Act also includes criteria for drainage features that may require authorisation to take or interfere with overland flow. The Isaac River is defined as a watercourse where such authorisations are required under the Water Act, and several small tributaries of the Isaac River that traverse the Project Area are defined as drainage features where interference may also require authorisation under the Water Act.

These declared watercourses and drainage features may be relevant to the groundwater assessment for the Project if the potential for local surface water-groundwater interactions is identified.

2.2.2 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) is the primary Queensland legislation relating to the natural environment. The object of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

Under the EP Act, a groundwater assessment is required as part of the application for an amended EA to undertake an environmentally relevant activity (i.e., the Project). The process assesses the potential environmental impact of the activity, and how impacts should be avoided, minimised and managed. The groundwater assessment also informs subsequent approval decisions under the EP Act and other relevant legislation. The Department of Environment, Tourism, Science and Innovation (DETSI) is responsible for the administration and delivery of EA amendments.

Minimum reporting requirements for EA groundwater assessments under the EP Act are outlined within the *Guideline Requirements for site-specific and amendment applications – underground water rights* (ESR/2016/3275) (DESI, 2024).

2.2.2.1 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The *Environment Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity) aims to achieve objectives set out by the EP Act and applies to all waters of Queensland. EPP Water provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses by:

- Identifying environmental values and management goals for Queensland waters.
- Providing state water quality guidelines and water quality objectives (WQO) to enhance or protect the environmental values.
- Providing a framework for making consistent, equitable and informed decisions.
- Monitoring and reporting on the condition of Queensland waters.



Groundwater resources within the vicinity of the Project are scheduled under the EPP Water and Wetland Biodiversity as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EVs) for these groundwaters are:

- Biological integrity of aquatic ecosystems.
- Human use EVs:
 - Suitability of water supply for irrigation
 - Farm water supply/use
 - Stock watering
 - Primary recreation
 - Drinking water supply
 - Cultural and spiritual values

The EPP Water and Wetland Biodiversity also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the EPP Water and Wetland Biodiversity are classified by groundwater depth and regional chemistry zones.

Surface water resources within the vicinity of the Project are scheduled under the EPP Water and Wetland Biodiversity as:

- Waters of the Isaac northern tributaries of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301)
- Waters of the Isaac and lower Connors River main channel of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301)

The legislated environmental values (EVs) for these surface waters are:

- Biological integrity of aquatic ecosystems
- Human use EVs:
 - Suitability of water supply for irrigation
 - Farm water supply/use
 - Stock watering
 - Human consumption
 - Primary recreation
 - Secondary recreation
 - Visual recreation
 - Drinking water supply
 - Industrial water supply
 - Cultural and spiritual values

The surface water WQOs for both the Isaac northern tributaries of the Isaac River Sub-basin of the Fitzroy Basin water plan and the Isaac and lower Connors River main channel of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301) may be relevant to this groundwater assessment given the proximity of the Isaac River and the potential for groundwater-surface water interaction.



2.2.2.2 Environmental Authority

Under the EP Act, an environmental assessment is required as part of the application for an Environmental Authority (EA), or the application for an amendment to an existing EA, to undertake an environmentally relevant activity. The process assesses the potential environmental impact of the Project, and how impacts should be avoided, minimised, and managed. The Department of Environment, Tourism, Science and Innovation (DETSI) is responsible for the administration and delivery of applications for an EA, and amendment applications. DETSI Guideline ESR/2016/3275 *Requirements for site-specific and amendment applications—underground water rights* is directly relevant to the content of this groundwater assessment.

2.2.3 Relevant Guidelines

There are several guidelines designed to assist project proponents meet the relevant legislative requirements for a groundwater assessment for coal mining and mining related proposals. These guidelines are:

- DETSI (2025) - *Requirements for site-specific and amendment applications—underground water rights* - EP Act;
- IESC (2024) - *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* – EPBC Act;
- IESC (2023) - *Information Guidelines explanatory note. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework* – EPBC Act;
- IESC (2019) - *Information Guidelines Explanatory Note. Assessing groundwater-dependent ecosystems* – EPBC Act;
- Barnett et al. (2012) - *Australian groundwater modelling guidelines*.



3.0 Climate, Topography and Drainage

3.1 Climate

The climate of the Project 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 but 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. **Table 3-1** provides the details of the nearby operational weather stations.

Table 3-1 Operational BoM weather stations near Daunia Mine

Name	Site Number	Record starts	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	25 km NW
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 Landowners) providing interpolated data across a statewide grid based on station observations. Monthly averages for the four nearest stations and the SILO data are listed in **Table 3-2**. SILO Grid point data (Latitude: - 22.05, Longitude: 148.30) from January 1900 until October 2023 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 BoM stations. From this data, the average annual site rainfall is 561 millimetres (mm). The two highest annual rainfall totals were 1998 and 2010, with 996 mm and 1,055 mm, respectively. The lowest annual rainfall total for this period occurred in 2018 with 268.5 mm.

Table 3-2 Average Monthly Rainfall (mm)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Iffley	97.4	83.5	57.8	37.3	16.9	39.6	22.1	36.3	15.4	35.3	56.5	87.4	583
Moranbah Airport	92.5	84.9	83.0	26.7	35.7	18.1	38.5	14.3	9.7	22.6	49.5	65.1	540
Nebo	141.1	134.9	109.4	45.8	34.5	38.3	27.8	18.3	19.3	30.5	53.1	97.0	747
Carfax	109.8	93.6	62.2	31.1	35.8	27.5	22.1	22.4	18.5	35.7	55.0	95.6	615
SILO Grid Point Data	103.6	90.7	66.5	30.4	25.6	26.9	20.9	17.4	14.3	29.3	53.9	81.4	561

Source: <http://www.bom.gov.au/climate/data/index.shtml>

Note: SILO Grid point data coordinates are Latitude: -22.05 and Longitude: 148.30.

Rainfall trends for DNM based on the SILO data are indicated by the plot of cumulative rainfall departure from average rainfall over a given period (**Figure 3-1**). Positive gradients on this plot (rising trend) indicate wetter conditions than normal, while negative gradients (falling trend) indicate dryer than average conditions. Average rainfall conditions are indicated by flatter trends. **Figure 3-1** shows that, over the past 50 years higher than average rainfall occurred from 1973-79, 1988-91, 1998-2001, and 2007-2011. Drier than average periods occurred from 1960-74, 1979-87, 1992-96



and 2001-2006. Since 2017 the CRD indicates average or slightly drier than average conditions at the site.

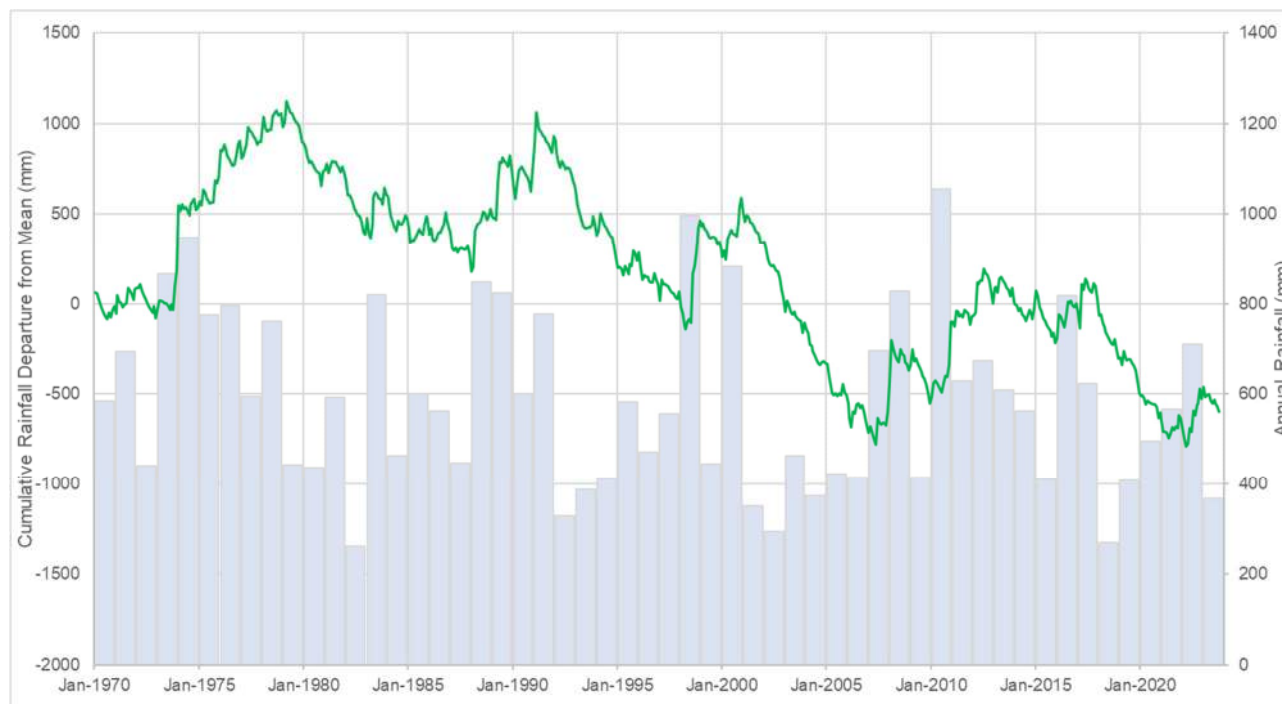


Figure 3-1 Annual Rainfall and Cumulative Rainfall Departure from Mean (SILO data 1970-2023)

The CRD can be compared to groundwater levels and if rainfall is a significant source of groundwater recharge, the changes in groundwater level can reflect the pattern of the CRD.

Actual and potential evapotranspiration (ET) have been taken from BoM's Australia wide interpolation dataset. The potential ET across the area is approximately 2,302 mm/yr according to BoM (2022) (**Figure 3-2**). The definition of potential ET 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. Where the water table nears ground level, ET can also approach the potential ET value.

Table 3-3 Average Monthly Potential Evapotranspiration (PET)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	244	202	206	173	144	120	134	166	206	250	256	263	2,364
Nebo	223	184	186	155	130	110	122	150	185	228	236	243	2,152
SILO Grid Point Data	238	197	201	169	140	117	131	161	199	242	250	257	2,302

AET across the area is approximately 1,156 mm/year according to BoM (2022) (**Table 3-4**). The definition of AET 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 3-4 Average Monthly Actual Evapotranspiration (AET)

AET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	131	119	117	86	56	39	44	65	84	105	117	129	1,092
Nebo	156	138	137	105	73	53	61	86	112	138	149	159	1,368
SILO Grid Point Data	137	124	122	90	60	42	48	70	91	112	125	136	1,156

Figure 3-2 presents a plot of average monthly rainfall vs average monthly PET and AET for nearby stations and from the SILO database. Average monthly PET substantially exceeds average monthly rainfall over the entire year. Average AET also typically exceeds rainfall with the greatest differential occurring through the late dry season and early wet season (Aug to Nov), and April-May.

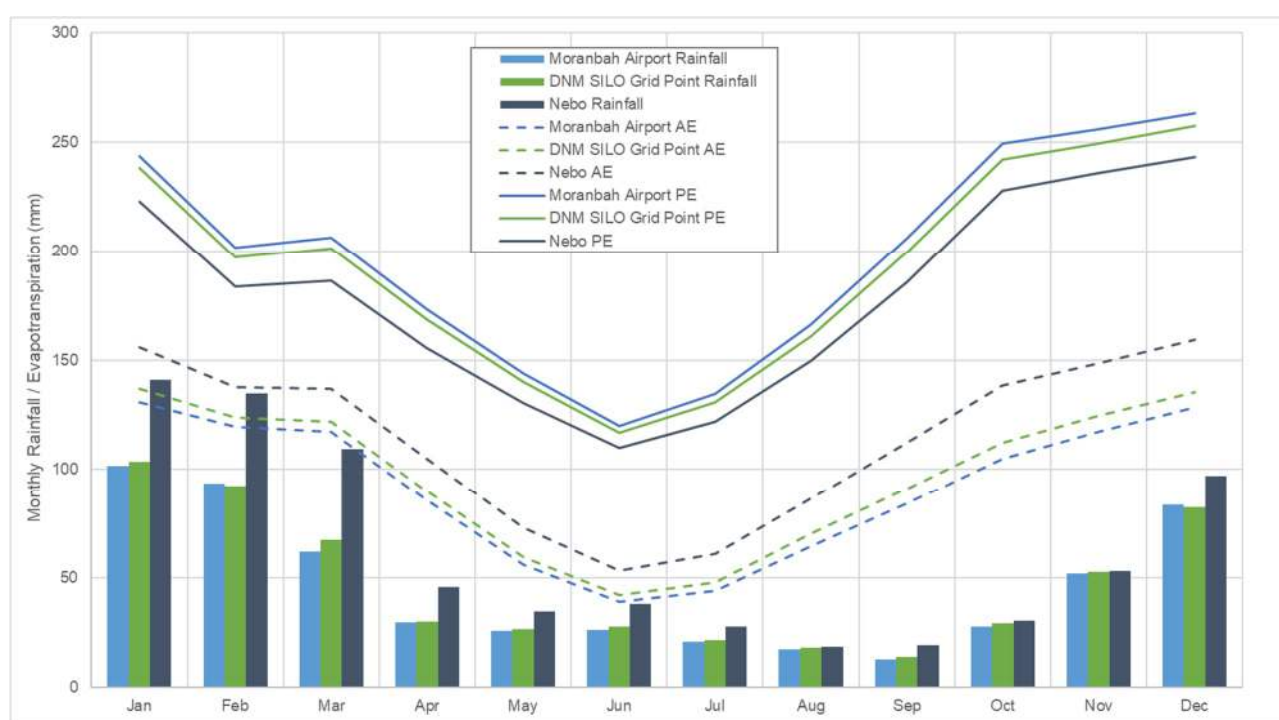


Figure 3-2 Average Monthly Rainfall and Evapotranspiration

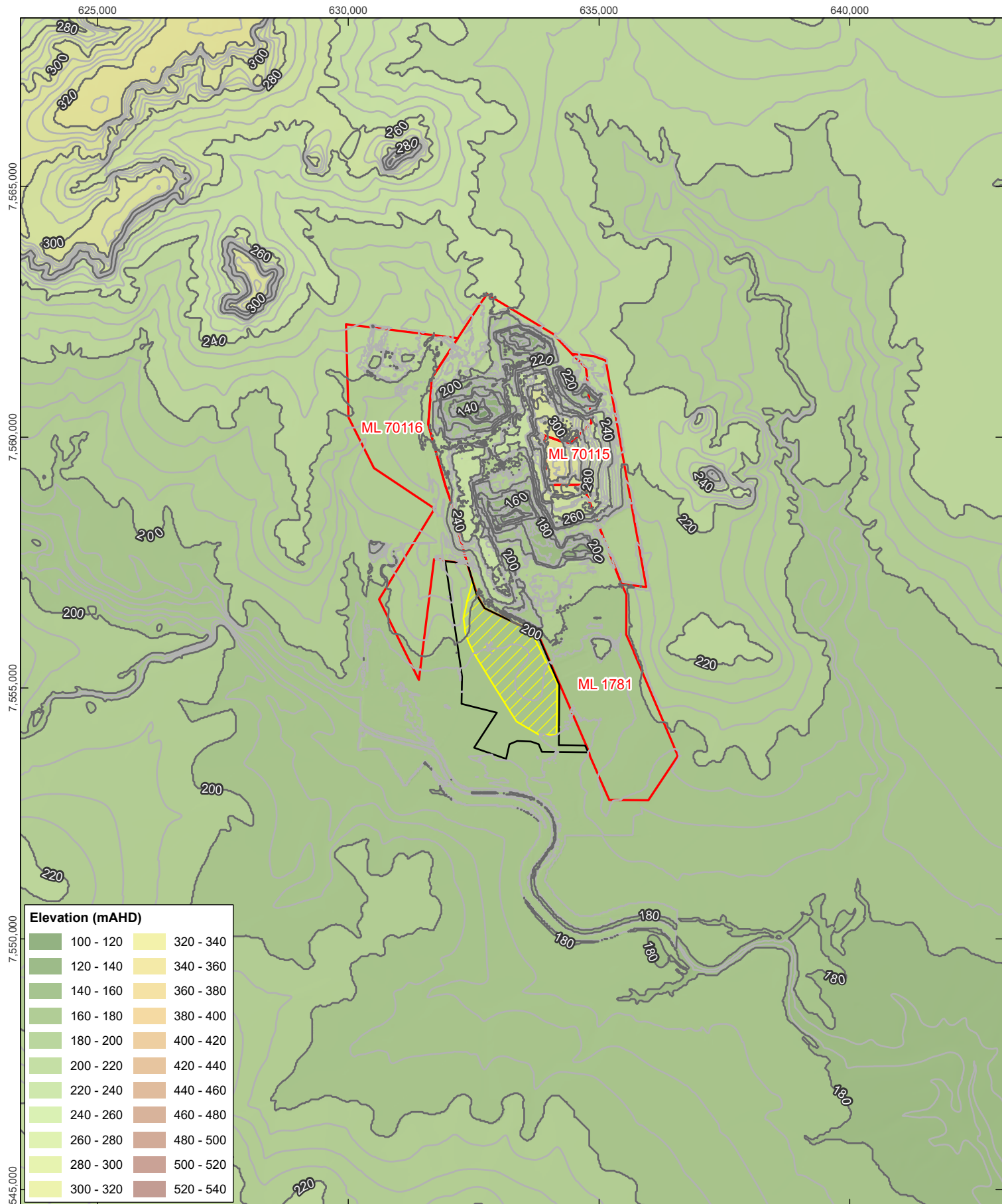
3.2 Topography and Drainage

DNM is located in the Upper Isaac surface water catchment of the Isaac River Sub-Basin. The natural topography of the Project Area is generally inclined to the west towards the Isaac River, with elevations ranging from around 200 mAHD at the northern end of Pandora Pit to 187 mAHD at the Isaac River to the south (riverbank elevation). In the vicinity of Pandora Pit the invert level of the Isaac River channel falls from around 183 to 179.5 mAHD and is typically 10-12 m below the level of the surrounding land.

All watercourses (including the Isaac River), and drainage features and in the vicinity of DNM are ephemeral and only flow in response to rainfall of sufficient intensity / duration to generate runoff. After significant rainfall, perched ponded water may remain in some drainage lines / creeks / water holes that are used as water sources by livestock.

The Isaac River is the major drainage feature of the region and flows from northwest to southeast, to the south-west of DNM (**Figure 3-3**).





 0 1 2 km
 Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:100,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 29-May-2026
 Drawn by: RB

LEGEND

-  Major Topographic Contour (20mAHD)
-  Minor Topographic Contour (5mAHD)
-  Mining Lease
-  Mining Lease Application Area / Project Area
-  Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

TOPOGRAPHY AND HYDROLOGY



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FIGURE 3-3

The Isaac River comes within 1.2km south of the proposed OOPD. New Chum Creek, a minor tributary of the Isaac River, drains southward to join it 1.7km southwest of the OOPD. Another very minor drainage line is located approximately 650m south of the OOPD and drains southward from the western edge of Pandora Pit.

A Queensland Government gauging station is located on the Isaac River approximately 10km south-east (downstream) of DNM (Deverill station - 130410A). The station has a zero gauge elevation of 169.3 mAHD. The gauge has an operational record of good quality data from May 1968 to May 2025. A flow duration curve derived from the 56 years of data for this gauge is presented in **Figure 3-4**. The data indicates that flows greater than 0.001 m³/s have been recorded 25.9% of the time and flows greater than 1 m³/s have been recorded 11.2% of the time. The maximum recorded 24 hr average rate average of 2,251 m³/s for the 3rd March 1988, although the accuracy of flows of this order is not known.

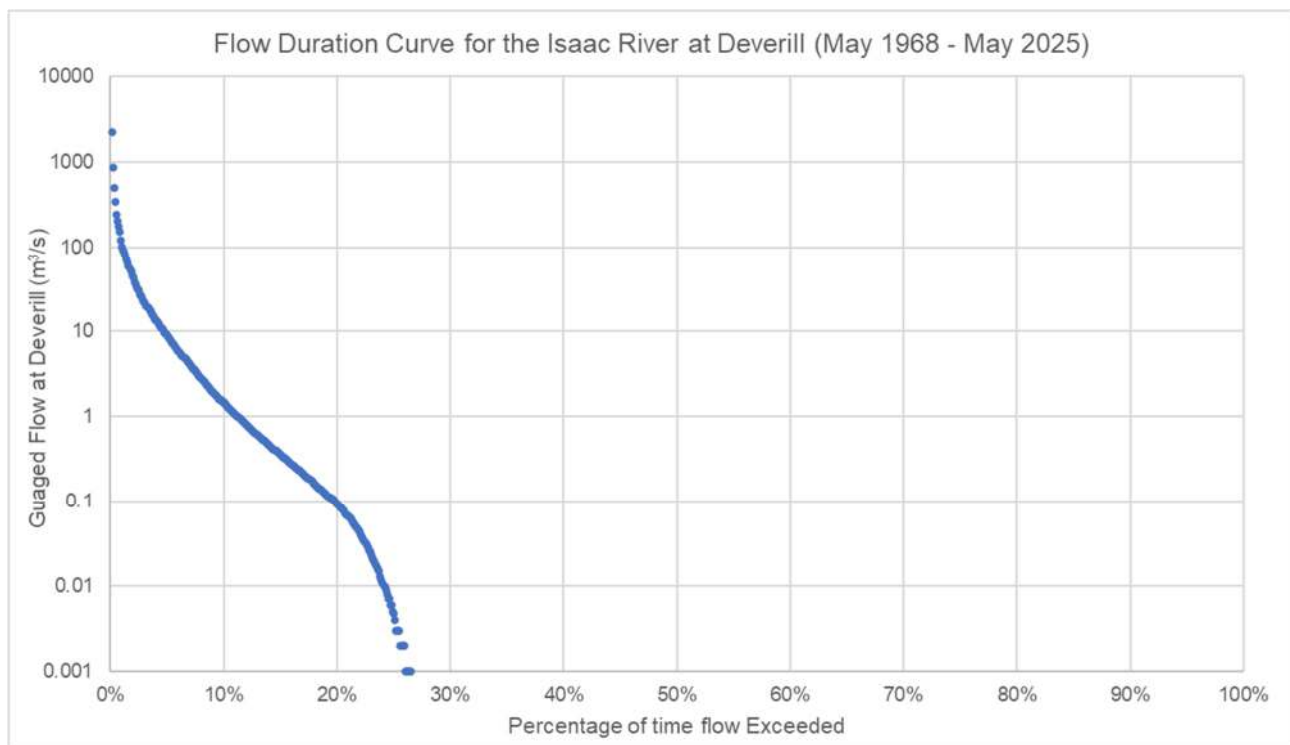
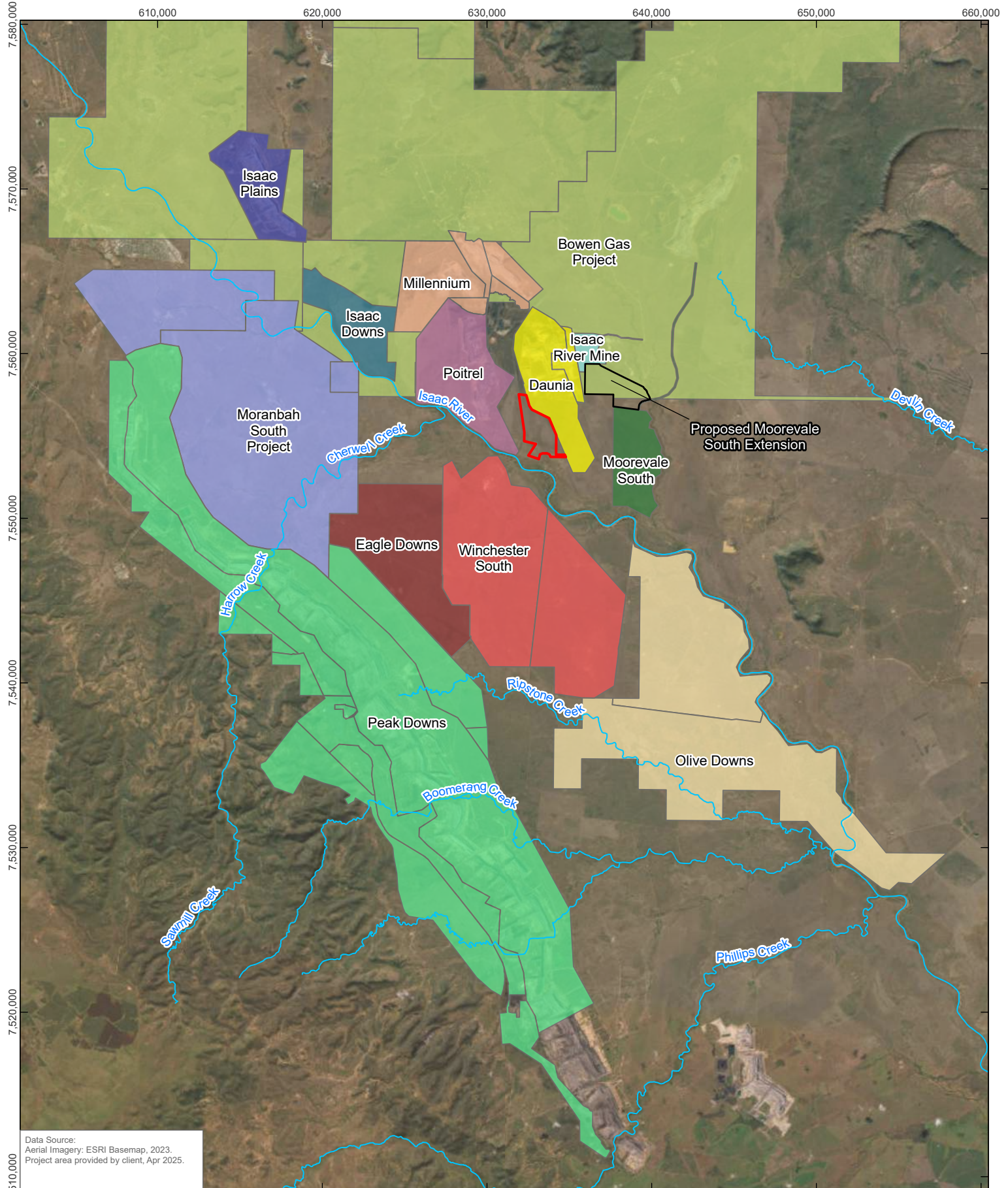


Figure 3-4 Flow Duration Curve for the Isaac River at Deverill (Stn. 130410A)

3.3 Land Use

The mining lease application area is 500 ha adjoining the south-west of existing DNM MLs and within this area the OOPD footprint covers an area of approximately 300 ha. The Project extends across land between the existing DNM operations towards the Isaac River and is largely covered with native pasture used for grazing with remnant and regrowth woodland vegetation present in small patches. There are no nature conservation areas, including National or State parks in or near the Project Area, and no Strategic Cropping Land mapped within the Project Area. The predominant surrounding land uses are mining and agriculture (grazing). There are several proposed and active coal mining operations surrounding DNM (**Figure 3-5**) including Poitrel mine directly to the west and Moorvale South Mine directly to the east including a proposed northwards extension that adjoins the eastern boundary of the existing DNM mining leases.





Data Source:
Aerial Imagery: ESRI Basemap, 2023.
Project area provided by client, Apr 2025.

 0 5 10 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:300,000 at A4

Project Number: 620.042120.00001

Date Drawn: 30-Jul-2025

Drawn by: RB

LEGEND

-  Watercourse
-  Mining Lease Application Area / Project Area
-  Proposed Moorevale South Extension

Mining Operation

-  Bowen Gas Project
-  Daunia
-  Eagle Downs
-  Isaac Downs
-  Isaac Plains
-  Isaac River Mine
-  Millennium
-  Moorevale South
-  Moranbah South Project
-  Olive Downs
-  Peak Downs
-  Poitrel
-  Winchester South

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

NEIGHBOURING MINING OPERATIONS



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FIGURE 3-5

4.0 Geology

4.1 Regional Geology

DNM is located in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km² referred to as the Collinsville Shelf (**Figure 4-1**). 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).

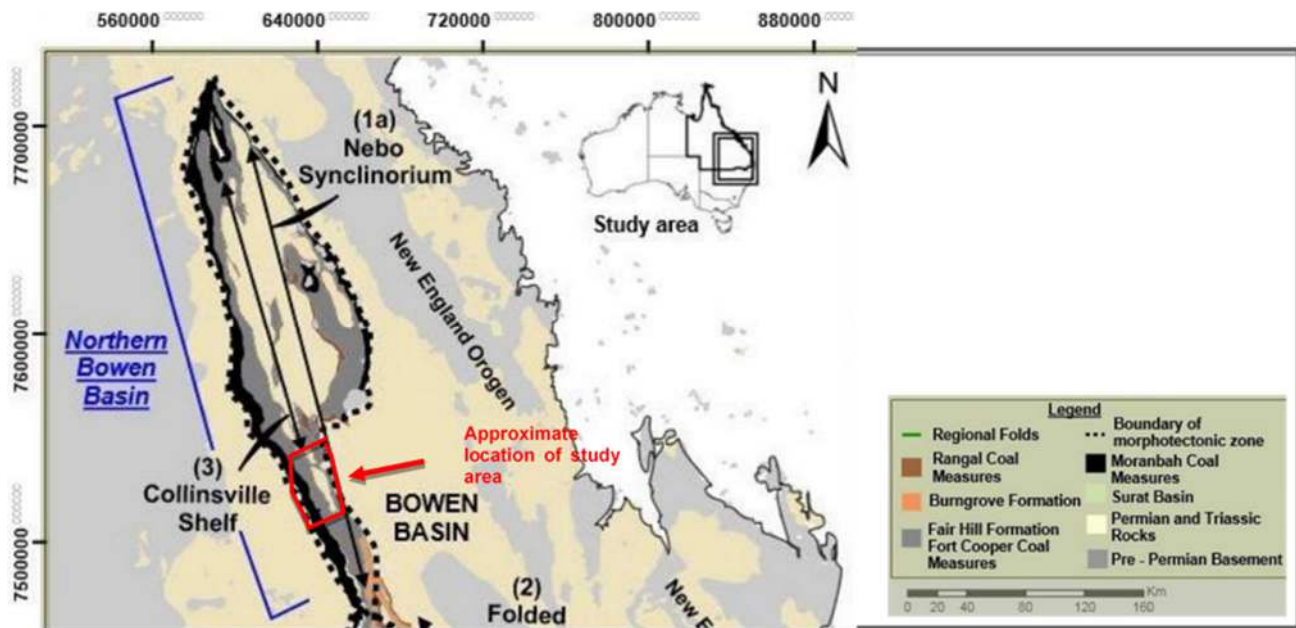


Figure 4-1 Structural Setting of the Bowen Basin (after Dickins and Malone, 1973)

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 and Rangal Coal Measures. The economic seams at DNM are contained in the Late Permian Rangal Coal Measures. 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.

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.

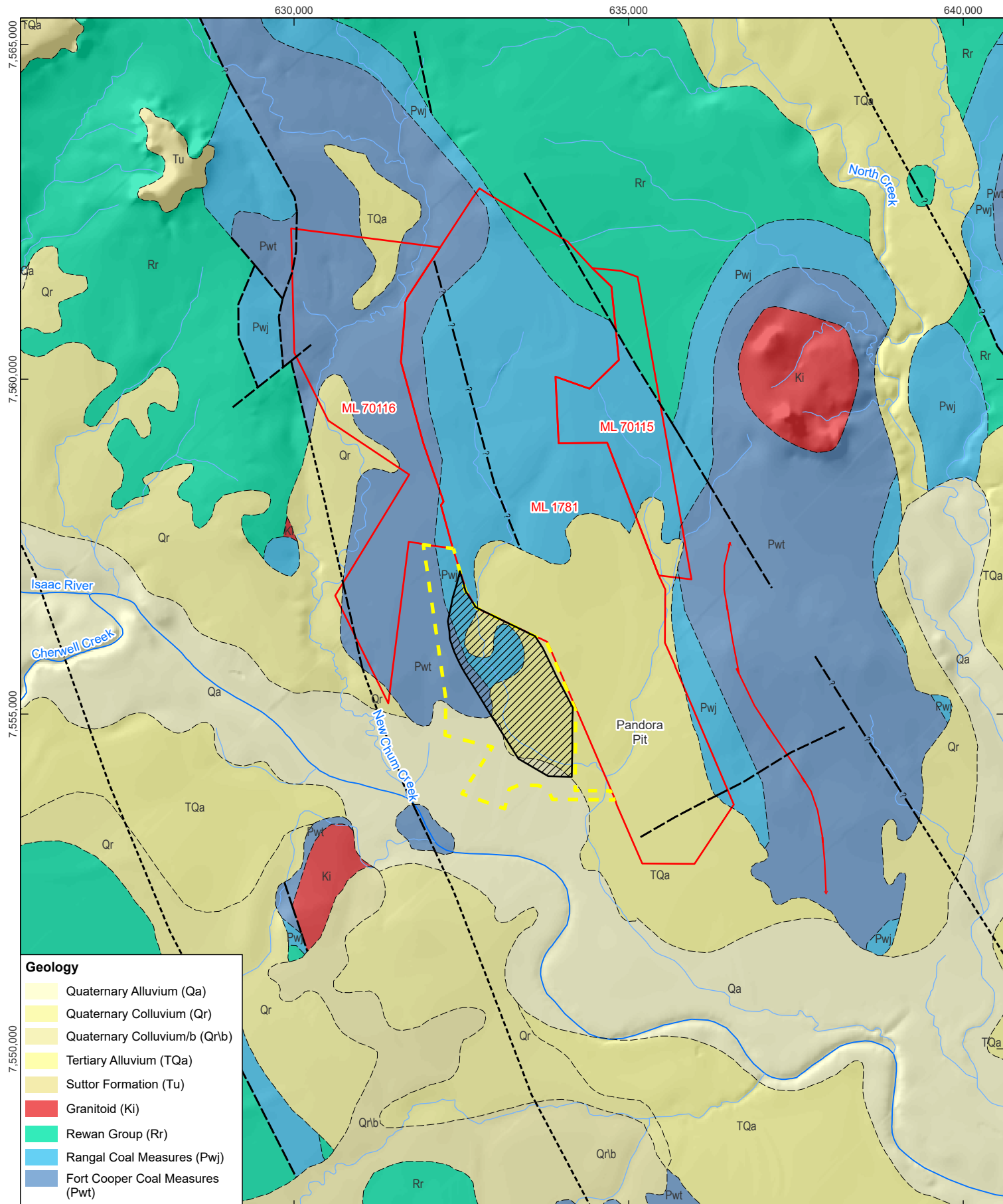
The generalised regional stratigraphy is summarised in **Table 4-1**. The surface geology is shown in **Figure 4-2**, and is based on the Clermont (SF5511) and St Lawrence (SF5512) 1:250k geological maps, as compiled within the Queensland Geology Detailed Surface Mapping (DNRME, 2017). Solid geology based on published geological mapping (1:500k) is presented in **Figure 4-3**.



Table 4-1 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.	~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

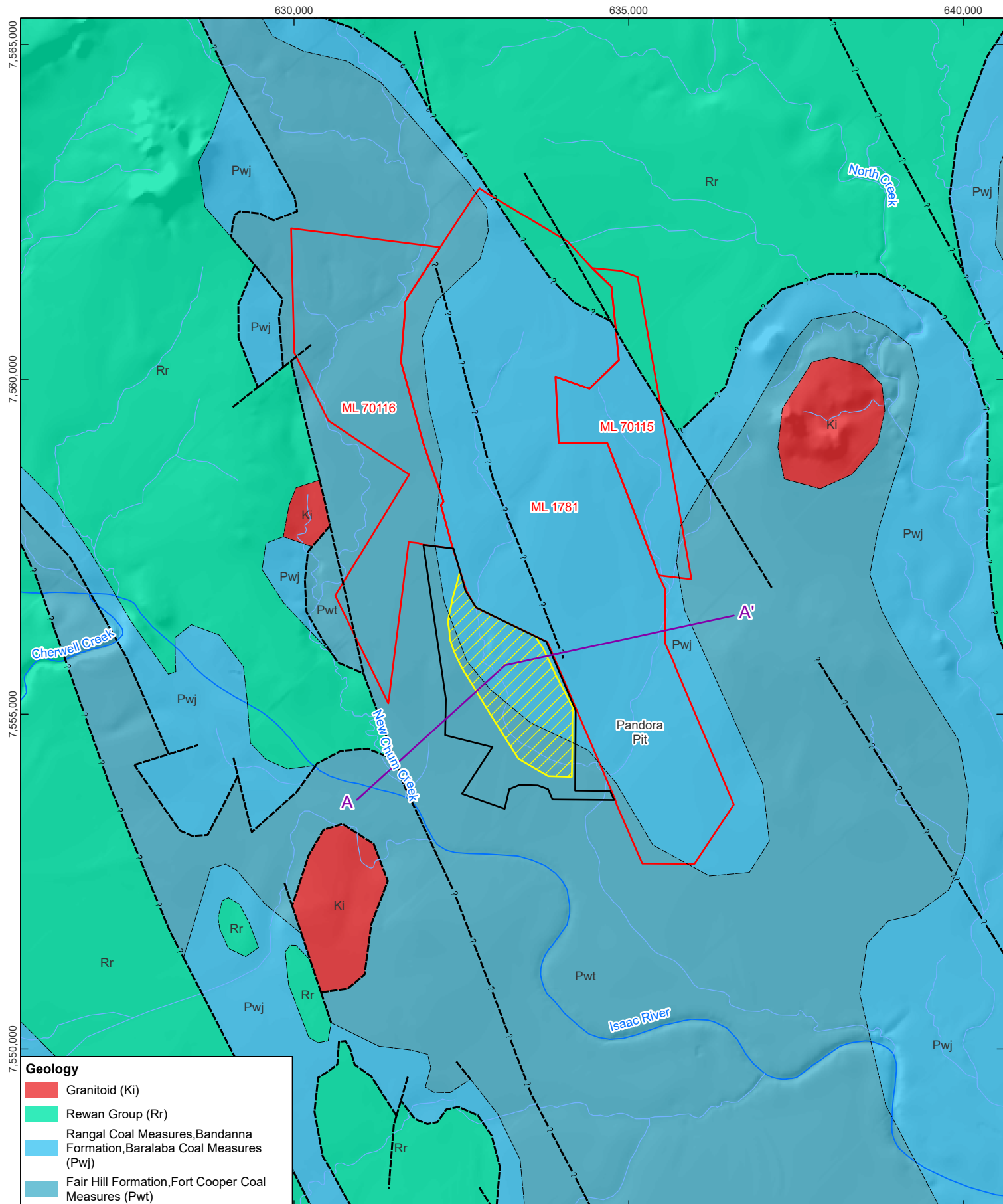




Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:75,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 29-May-2026
 Drawn by: RB



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- Geology**
- Granitoid (Ki)
 - Rewan Group (Rr)
 - Rangal Coal Measures,Bandanna Formation,Baralaba Coal Measures (Pwj)
 - Fair Hill Formation,Fort Cooper Coal Measures (Pwt)

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.042120.00001

Date Drawn: 01-Jun-2026

Drawn by: RB

LEGEND

- Major Watercourse
- Minor Watercourse
- Geological Section
- Fault Approximate
- Fault Inferred
- Geological Boundary Approximate
- Mining Lease
- Mining Lease Application Area / Project Area
- Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

SOLID GEOLOGY



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FIGURE 4-3

4.2 Local Geology

A review of available geological and hydrogeological data has been undertaken including hydrogeological reports, site exploration drill hole data and the DNM site geological model.

4.2.1 Cenozoic Sediments

Surface geology mapping shown in **Figure 4-2**, indicates that Tertiary to Quaternary aged sediments are present across the area of Pandora Pit, the OOPD and along the flood plain of the Isaac River. These deposits typically comprise a heterogeneous distribution of unconsolidated clay, silt, sand, and gravel and are generally less than 20 m thick. The transition from Tertiary to Quaternary sediments is often difficult to define such that the Quaternary and Tertiary units is often taken to form a single unconsolidated sedimentary unit. Detailed information on the nature and thickness of the Tertiary-Quaternary sediments between Pandora Pit, the OOPD and the Isaac River (and the base of weathering) is limited.

4.2.1.1 Isaac River Alluvium (Quaternary)

Quaternary alluvium is present along the course of the Isaac River in a broad tract between 1.5 to 2 km wide to the south-west of DNM, becoming wider downstream. The flood-plain alluvium typically comprises clay, silt, sand and gravel (**Figure 4-2** symbolised as Qa), and is typically less than 20m thick (AGE, 2013).

Figure 4-2 indicates that the mapped extent of the Isaac River Alluvium extends just beneath part of the southwestern margin of the OOPD footprint. There is limited data for monitoring bores within the mapped extent of the Isaac River Alluvium in the vicinity of the Project. Poitrel Mine monitoring bore OBS8 shown in **Figure 5-1**, is located approximately 2 km south-west of the proposed OOPD and directly adjacent to the Isaac River (east bank), recorded 8m of alluvium comprising clay and sandy clay.

The Winchester South drill hole WSN206 log, located within the mapped alluvial extent just south of the Project boundary, records undifferentiated Quaternary-Tertiary sand to a depth of 22m, overlying siltstone. Drill holes intercepting Isaac River Alluvium around the Olive Downs Project site to the south-east of DNM indicate that it comprises a heterogeneous distribution of fine to coarse grained sands interspersed with lenses of clays and gravels (SLR, 2021a). These sediments, while spatially highly variable, generally comprise four layers:

- Upper soil and clay layer (0 m – 13 m thick);
- Sand and sandy clay unit (0 m – 24 m thick);
- Sand and gravel unit (0 m – 8 m thick); and
- Basal clay unit (0 m – 10 m thick).

The heterogeneous distribution of alluvial sediments associated with the Isaac River was also characterised by AGE (2020) for the Isaac Downs project (located 10km upstream from Daunia on the north side of the Isaac River) in the same geological setting. AGE (2020) describe a highly heterogenous alluvial system, with deeper paleochannel systems incised into the bedrock. Towards the edge of the alluvial plain, away from the current main channel the sediments mainly comprise clay and silt associated with floodplain deposits. A conceptual representation of the Isaac River alluvial facies derived from the AGE 2020 study is provided in **Figure 4-4**.



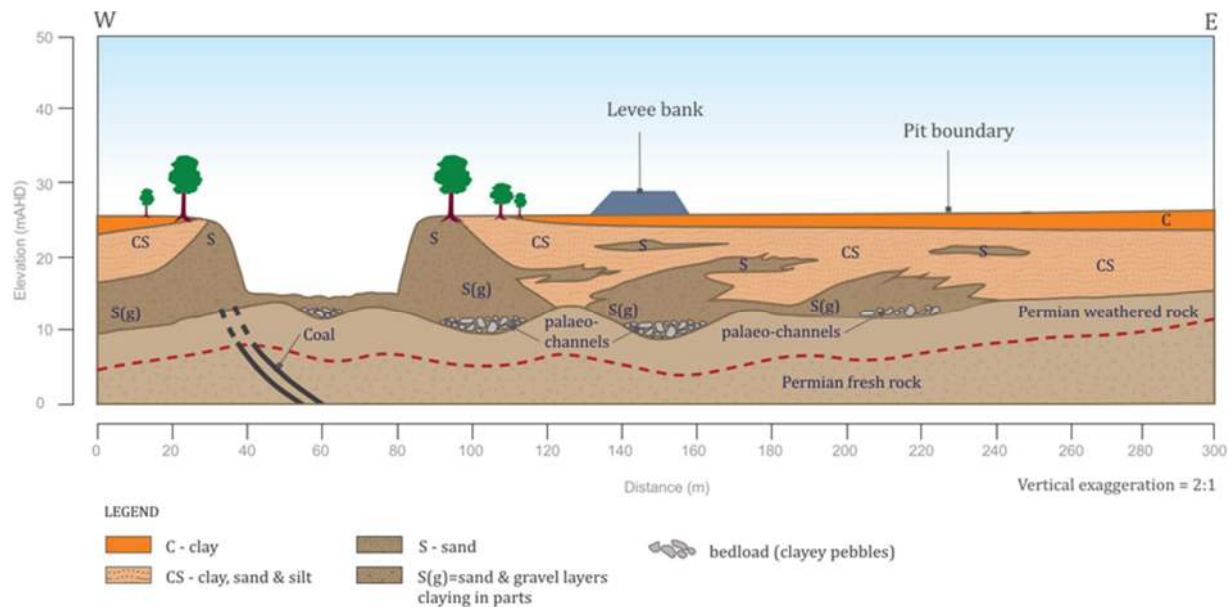


Figure 4-4 Conceptualisation of Isaac River Alluvium Facies (AGE, 2020)

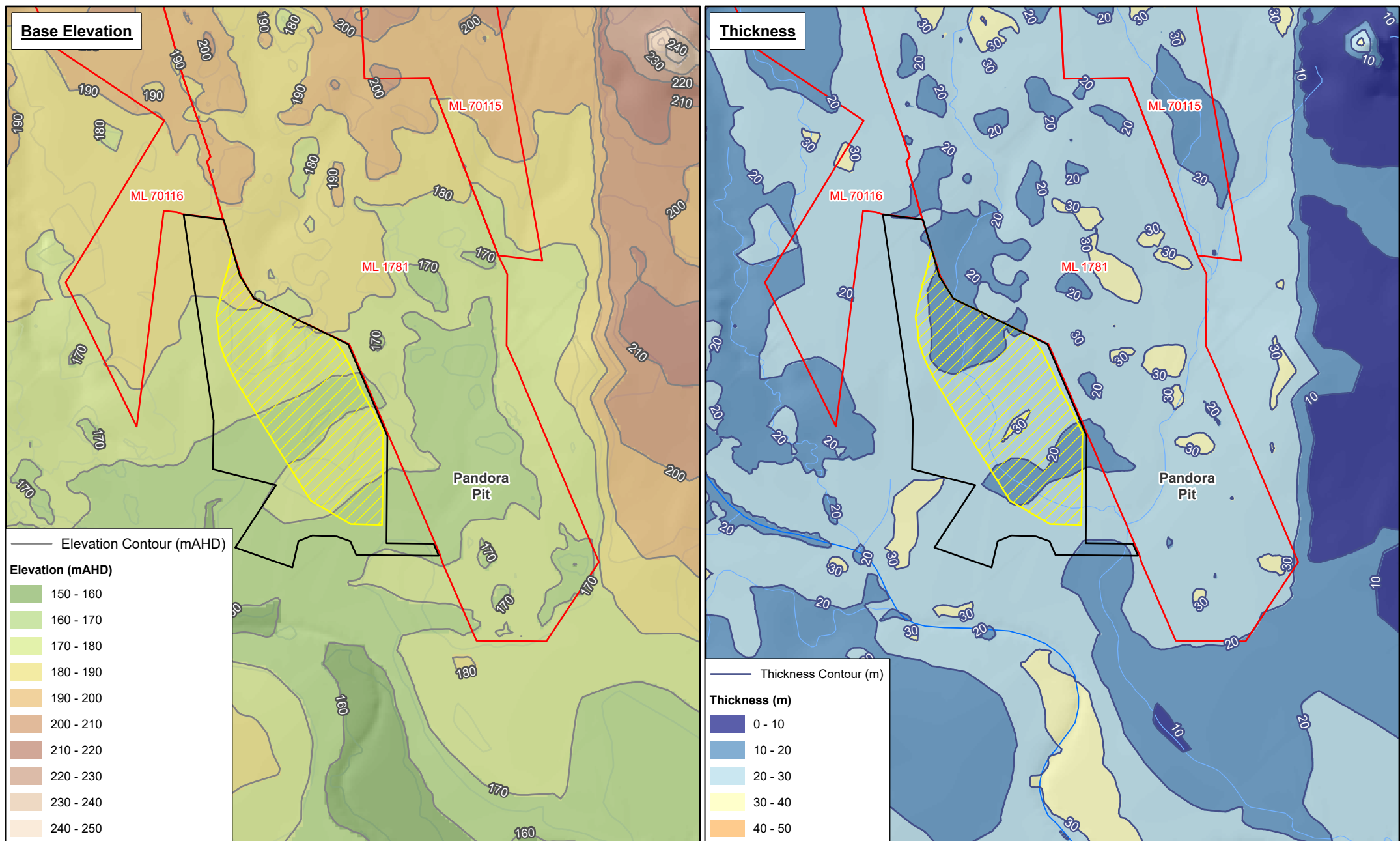
4.2.1.2 Other Quaternary and Tertiary Sediments

Surface geology mapping shown in **Figure 4-2** indicates that the surficial material covering the area of Pandora Pit and the OOPD comprises older higher level Tertiary-Quaternary alluvium (TQa). Review of the bore log for MB20DNM05A in **Figure 5-1**, shows the Tertiary material on the west of the Pandora Pit lease boundary to be approximately 8m thick, directly overlying weathered Permian strata. Beyond the higher level alluvial deposits, areas of Quaternary colluvium and are present.

Beneath the Tertiary-Quaternary alluvial and colluvial deposits weathered Permian strata make up the lower portion of the regolith above unweathered bedrock. In the vicinity of DNM, the Permian units are highly weathered to an average depth of 25 mBGL. In recent groundwater studies (e.g. HydroSimulations 2018, SLR 2019, 2020 & 2021b) the Quaternary sediments are grouped with the unconsolidated Tertiary units and the weathered bedrock and collectively termed “regolith”, as they are essentially regarded as functioning as a single hydrogeological unit, and there is limited data to accurately spatially separate these units into separate layers within the numerical model.

Detailed information on the nature and thickness of the Tertiary-Quaternary sediments and the base of weathering between Pandora Pit, the OOPD and the Isaac River is currently limited but the inferred extent and combined thickness of the alluvial deposits and regolith is presented in **Figure 4-5** based on DNM site geological data and the CSIRO Soil and Landscape Grid of Australia (CSIRO, 2015) data.





4.2.2 Triassic Strata

The Triassic aged strata include the Rewan Group (Rr), which unconformably overlies the Permian coal measures sub cropping on the northeastern boundary of the DNM mining lease. It also subcrops to the west of DNM as a result of faulting and deformation of the Permo-Triassic strata. The Rewan Group comprises Late Permian to Early Triassic strata with pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerates.

The Rewan Group includes two defined formations, the Rewan Formation comprising green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate, and the underlying Sagittarius Sandstone unit that comprises lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material. The transition from the Rewan Group to the underlying Permian coal measures is generally difficult to define. Transition is often based on a change in colour (green-grey to blue-grey) and depth (15 m to 60 m) above the first major coal seam (Leichhardt Seam) of the Rangal Coal Measures (JB Mining Services, 2016).

4.2.3 Permian Coal Measures (Blackwater Group)

Permian coal-bearing sedimentary rocks of the Blackwater Group form the main economic resource of the numerous mines in the Study Area. In order of increasing age (top to bottom), the major coal measures in the area of the Project are:

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

4.2.3.1 Rangal Coal Measures (RCM)

The economic coal resources at DNM (as well as at the adjacent Poitrel Mine, Moorvale South Mine, Olive Downs Mine and Winchester South Project) are contained within the ~100 m thick Rangal Coal Measures (Pwj), which is underlain by the Fort Cooper Coal Measures and overlain to the north-east by the Rewan Group. The Late Permian RCM comprise light grey, cross-bedded, fine to medium grained labile and well cemented sandstones, grey siltstones, mudstones, shale and coal seams.

The Leichhardt and Upper Vermont Seams are the target seams within the RCM at DNM. The Leichhardt Seam (DL1) is typically 5 m thick and the Upper Vermont Seam (DV4) typically 3.5 m thick at DNM. These two seams are separated by approximately 10 m to 35 m of siltstone and sandstone interburden (**Figure 4-6**). In the north of DNM, the Upper Vermont Seam splits into upper and lower plies (DV2 and DV1 respectively).

Across Pandora Pit, directly east of the Project area, the Permian coal measures form a syncline with a north-west south-east axis. Within this syncline the Leichhardt and Vermont seams reach maximum depths of approximately 115m and 140m respectively below natural surface.

Interpolated base elevation and depth contours of the Leichhardt Seam across the southern area of Daunia are presented in **Figure 4-7**. A schematic geological cross section is presented in **Figure 4-8** and the section line is shown on **Figure 4-3**.



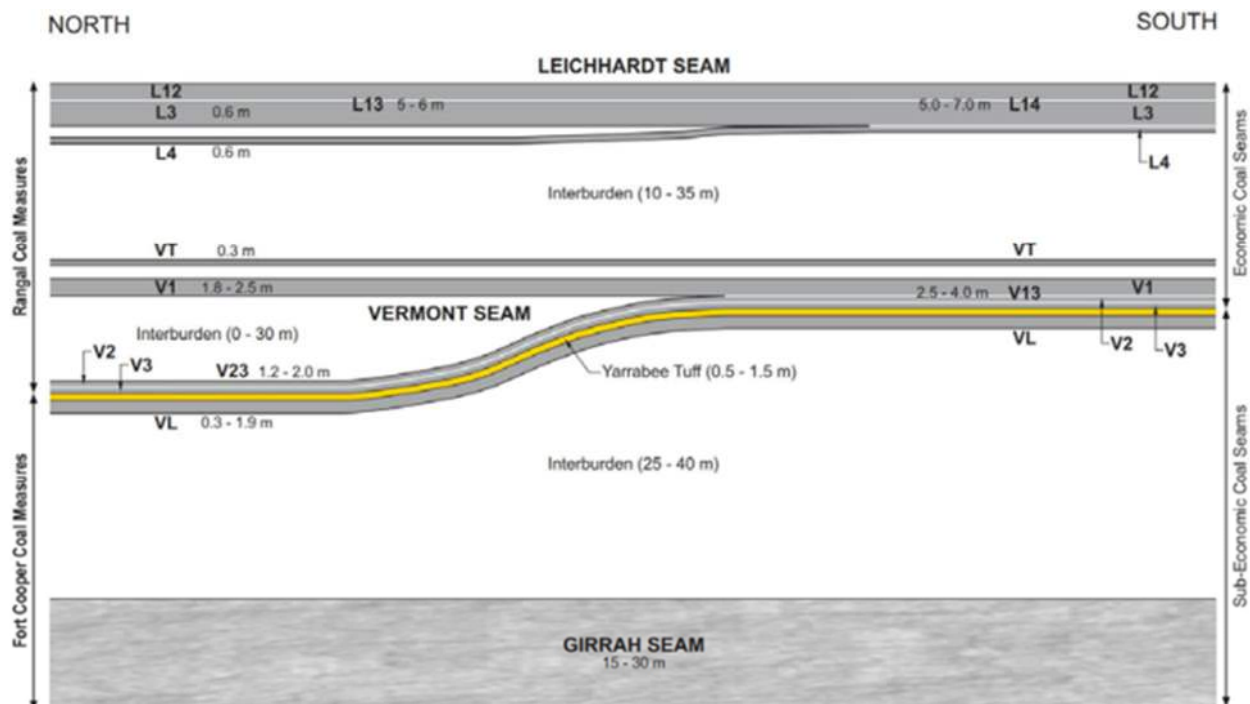
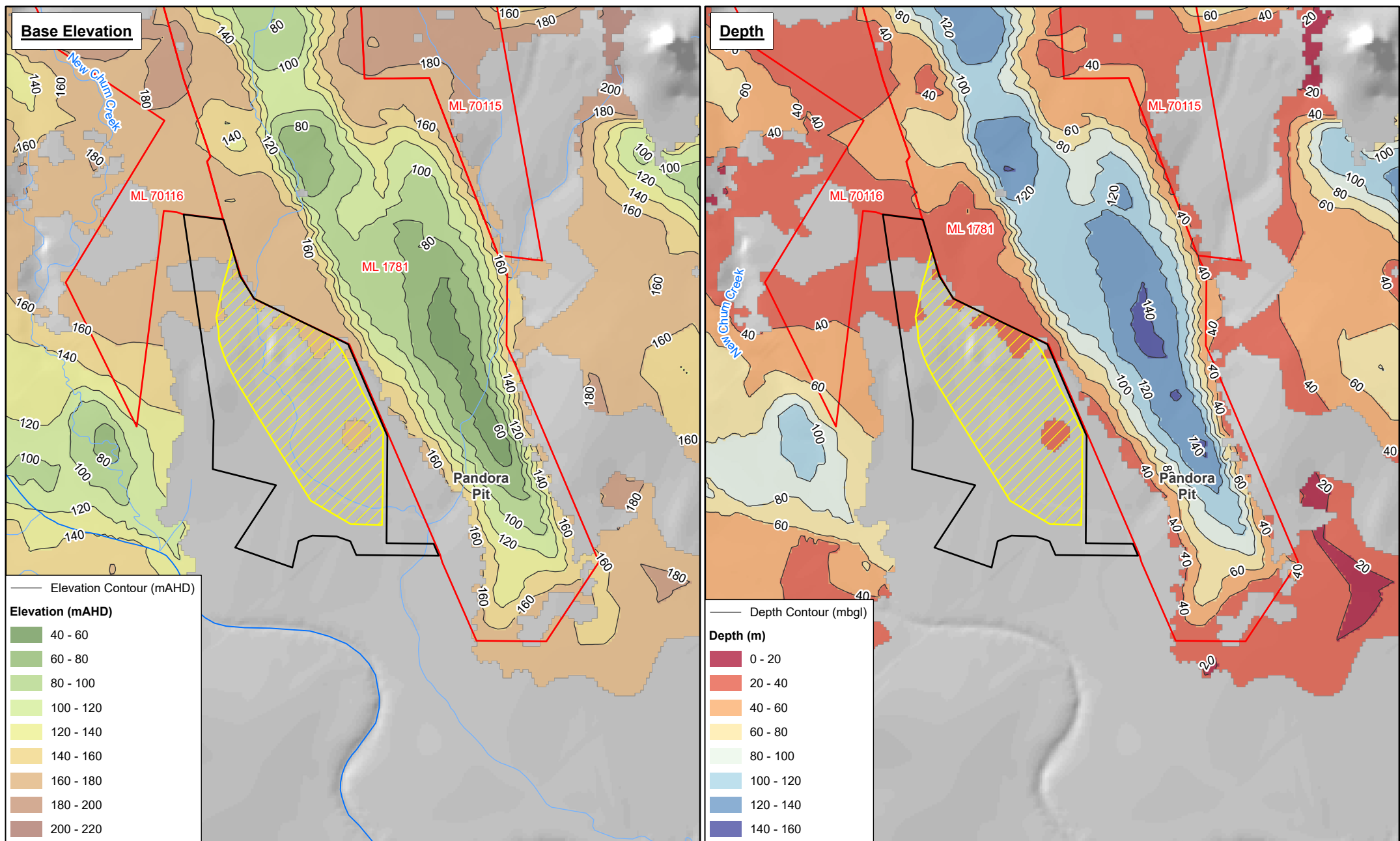


Figure 4-6 Schematic Correlation of Coal Seams at Daunia Mine (BHP, 2019)





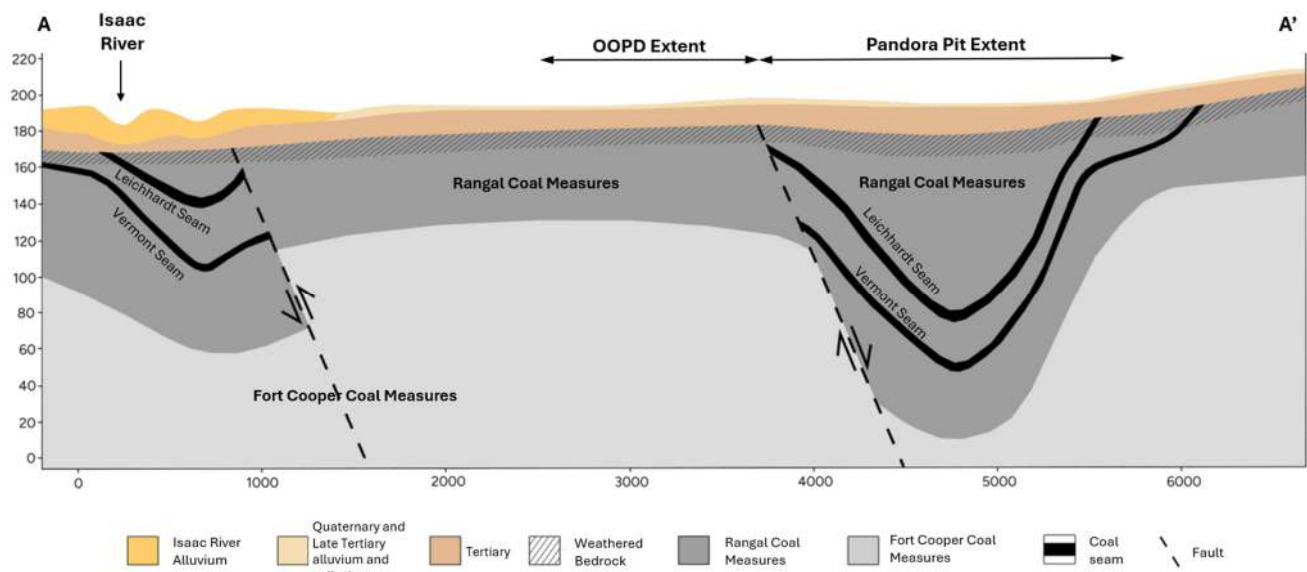


Figure 4-8 Schematic geological cross section through the DNM South

4.2.3.2 Fort Cooper Coal Measures (FCCM)

The FCCM (Pwt) underlie the RCM at DNM, and subcrop along the northwestern boundary of DNM. Regionally, the FCCM have a maximum thickness of approximately 350m. The FCCM comprise lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff and tuffaceous mudstone.

The transition between the RCM and the FCCM is marked by the Yarrabee Tuff, which immediately overlies the Lower Vermont Seam (**Figure 4-6**). The Yarrabee Tuff is a basin-wide marker bed comprised of weak, brown tuffaceous claystone, with a thickness ranging from 0.5 - 1.5 m at DNM. The Girrah Seam is the other major coal seam within the formation and is approximately 10 m to 20 m thick.

4.2.3.3 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 in relation to DNM mining activities means the Moranbah Coal Measures are not relevant to this groundwater assessment.

4.3 Structural Geology

The Bowen Basin was subject to significant tectonic compression from the east at the end of coal deposition in the late Triassic. This compression 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 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 result in the FCCM / RCM /



Rewan sequence repeating at surface (or subsurface), from west to east in the vicinity of DNM. Two main sets of faults at DNM are summarised (BHP, 2019):

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

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 can be traced up to 1.35 km in length.
- 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 Area (refer **Figure 4-3**). Drilling in the DNM Area has also identified intrusive igneous rock present at the southern end of ML 1781, not identified in Queensland Government geological mapping.



5.0 Hydrogeology

5.1 Introduction

The following section outlines the hydrogeology of the study area including an assessment of the available monitoring data, groundwater resources, local groundwater values, and the potential for contaminant migration from the OOPD.

The key hydrogeological units at DNM relevant to the Project are:

- Cainozoic sediments and weathered strata:
 - Quaternary alluvium – unconfined aquifer where saturated (water-bearing strata of permeable unconsolidated sand or gravel with interlayered clays and silts) localised along Isaac River;
 - Quaternary to Tertiary colluvium and weathered Permian coal measures (collectively 'regolith') – unconfined and largely unsaturated unit extending beneath the alluvium (where present) and across the OOPD footprint and Pandora Pit;
- Permian coal measures (unweathered) with:
 - Low permeability interburden (mudstone, siltstone) with aquitard properties; and
 - Coal seams with higher permeability due to secondary porosity (cleats 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 is considered an aquitard.

The coal seams within the RCM can be characterised as confined fractured rock aquifers, with the Leichhardt Seam and combined Vermont Seams being the main 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 significant 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.

5.2 Local Groundwater Monitoring Network

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 5-1** and bore locations are shown in **Figure 5-1**.

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 Area. These bores were monitored for groundwater levels between September 2012 and August 2013 (AGE, 2013) to support the early development of the mine but were not used as long term monitoring bores.

5.2.1 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 6.5**).



Table 5-1 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
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 Dec '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			
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			

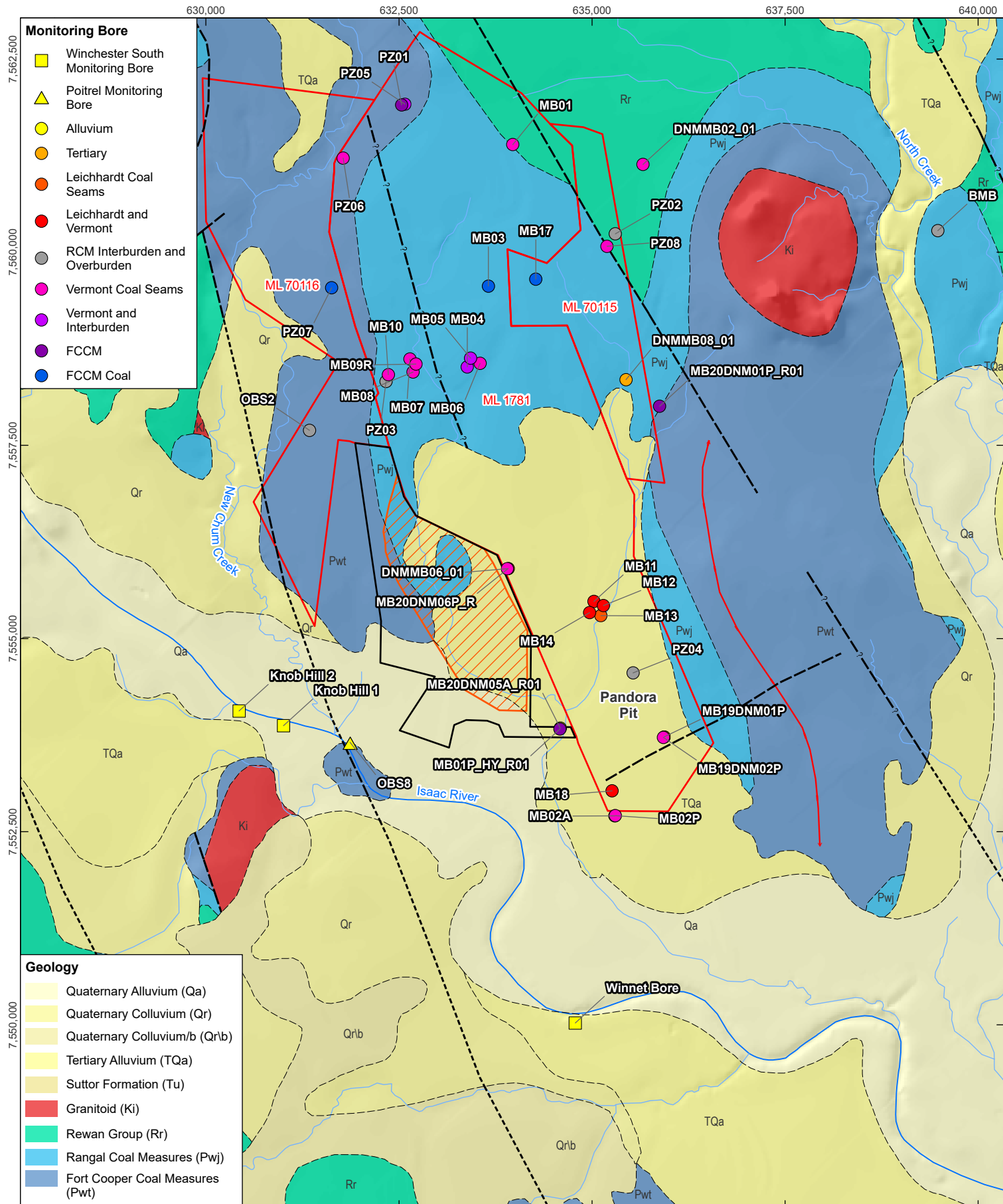


Bore ID	Easting (GDA94)	Northing (GDA94)	Ground Elevation (m AHD)	Screen Elevation (m AHD)	Monitored Unit	Installed	Status	WQ Data	Available WL Data
MB06	633550	7558561	214.6	170.6 - 167.6	Vermont Coal Seams	2012			Sep 2012 to Aug/Mar 2013
MB07	632641	7558617	209.1	114.1 - 105.1	Vermont Coal Seams	2012			
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





Coordinate System: GDA2020 MGA Zone 55

Scale: 1:65,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB



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FIGURE 5-1

5.3 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.

5.3.1 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 5-2**. 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 5-2 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 also found hydraulic conductivity to be at the lower end of this scale, with values ranging from 0.09 m/d to 1.25 m/d. 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 secondary (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/d for the Leichhardt Seam (only one bore tested)
- 0.00076 – 0.25 m/d for the combined Vermont Seams
- 0.0011 – 0.45 m/d where bores are screened across the Leichhardt Seam, Vermont Seams and interburden between seams
- 0.002 – 0.035 m /d 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 5-2** 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 (shown in **Figure 5-2**) includes estimates derived from pumping tests that are more representative of the coal seams at a larger-scale.



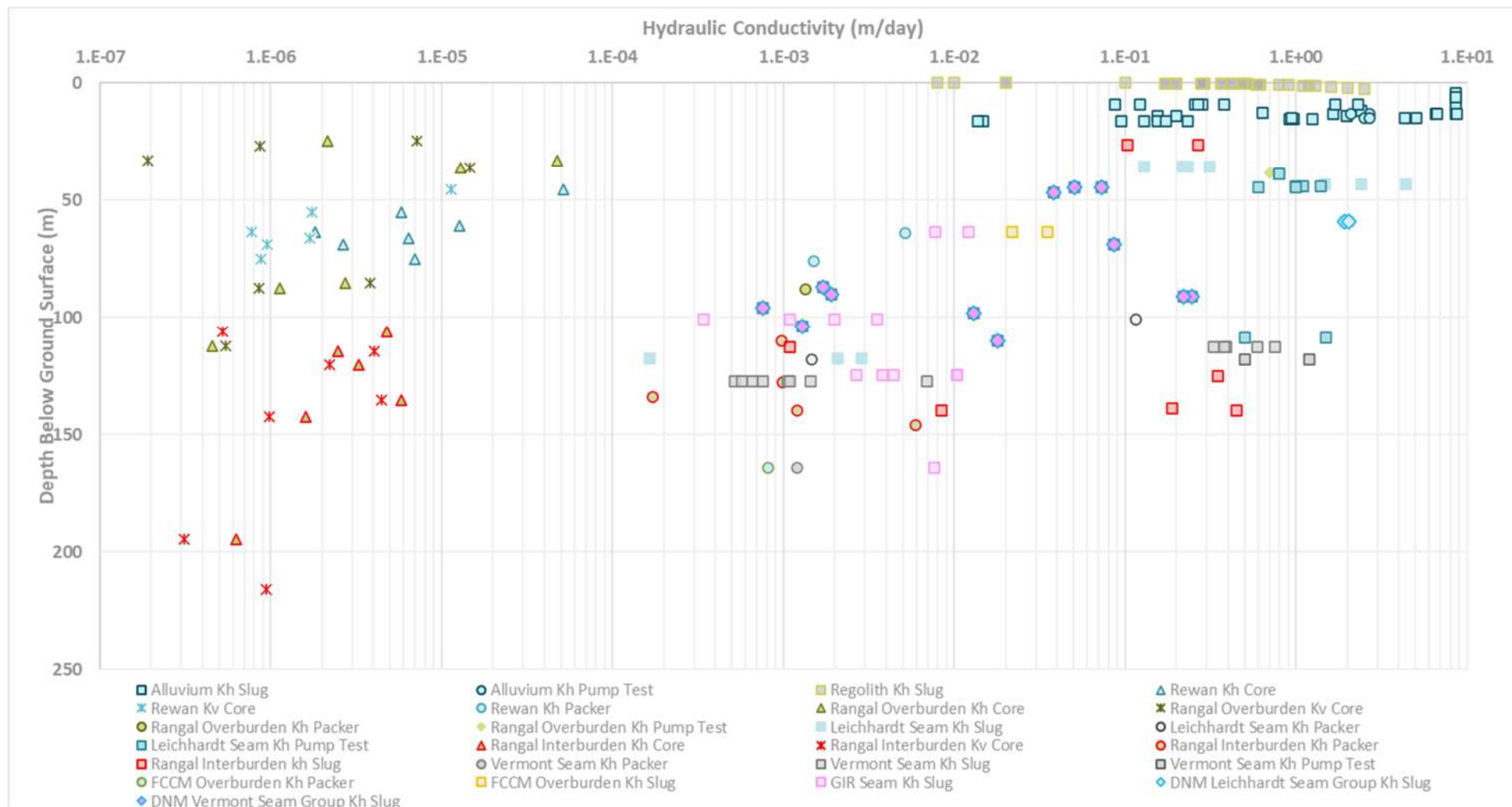


Figure 5-2 Summary of Hydraulic Conductivity Data for Bowen Basin Formations in the Vicinity of DNM



5.3.2 Hydraulic Conductivity Ranges

A histogram of horizontal hydraulic conductivity data (Kh) derived from field testing at DNM, as well as at other nearby Bowen Basin coal mines in the same geological setting, is presented in **Figure 5-3**. The results are compared to the range of values for each unit as presented within a literature review previously completed by HydroSimulations (2018) based on a number of other studies within the Bowen Basin.

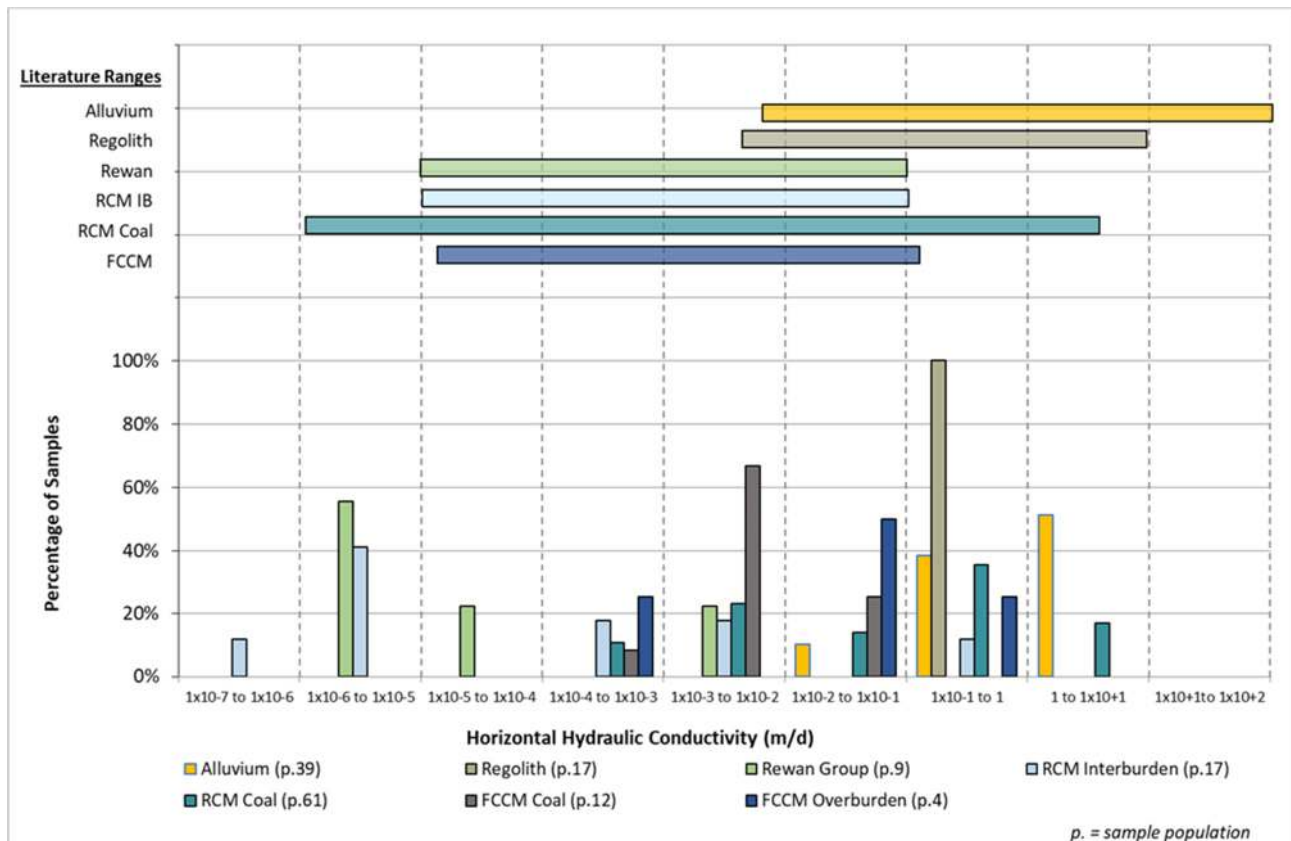


Figure 5-3 Histogram of Horizontal Hydraulic Conductivity Distribution

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

5.3.3 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 Area 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 6.93×10^{-5} to 2.07×10^{-3} m/day, in line with those presented in **Figure 5-4**. 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 (shown in **Figure 5-4**), 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.

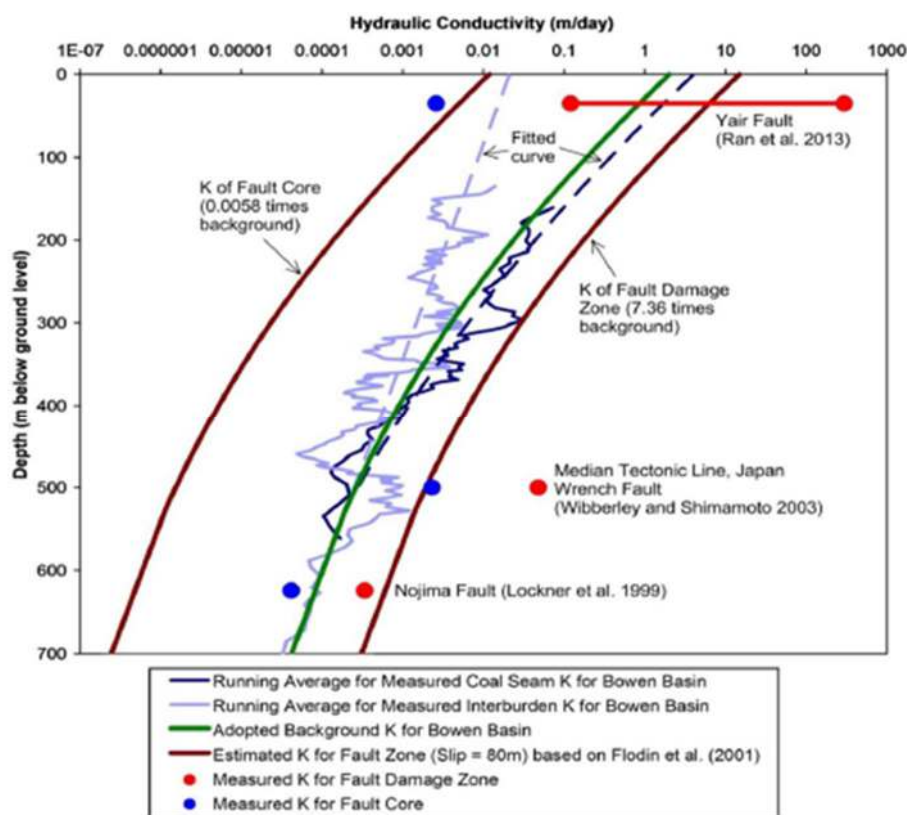


Figure 5-4 Faulting Conceptual Model Developed by Coffey (2014)



5.4 Groundwater Flow, Recharge and Discharge

5.4.1 Quaternary and Tertiary 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 proposed OOPD. Older Quaternary and Late Tertiary sediments extend across the footprint of the OOPD and Pandora Pit.

There are no groundwater monitoring bores within the Isaac River Alluvium to the south-west of the proposed OOPD and Pandora Pit. However, a Poitrel Mine groundwater monitoring bore (OBS8) screened in the alluvium is located approximately 3km west-northwest (i.e. up hydraulic gradient) of the OOPD on the north bank of the Isaac River. This bore proved 8 m of alluvium comprising clay and sandy clay. Groundwater monitoring at OBS8 was limited (due to it 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 suggests 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 5-1**), 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 1m 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.

The DNM alluvial bores MB20DNM05A and MB02A located on the south-west side of Pandora Pit (**Figure 5-1**) have always been recorded as dry and the Poitrel monitoring bore OBS8 is understood to be monitored irregularly after being found to be dry following installation. Therefore, it is possible that the Isaac River Alluvium (and potentially also the underlying older Tertiary sediments) is largely dry in the immediate vicinity of DNM and the Project area. 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.

Recent groundwater modelling for DNM PRCP (SLR, 2025a), indicates that the Isaac River acts as a recharge source generating a low hydraulic gradient away from the river to the east towards the proposed OOPD and Pandora Pit.

5.4.1.1 Recharge and Discharge

Recharge to the alluvium and underlying / adjacent unconsolidated sediments is considered to occur mostly 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 mm/yr
- Isaac River Flood Plain Alluvium – 1.3 mm/yr
- Other alluvium – 1.3 mm/yr
- Tertiary sediments – 0.1 mm/yr

Calibrated recharge values used in the numerical model are generally lower for the alluvium (0.2 – 0.4 mm/yr for the Isaac River Alluvium) and were derived using the AWRA-L climate model's simulated deep drainage values with multipliers.

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 across Pandora Pit and the proposed OOPD footprint 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 than 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.

5.4.2 Permian Coal Measures

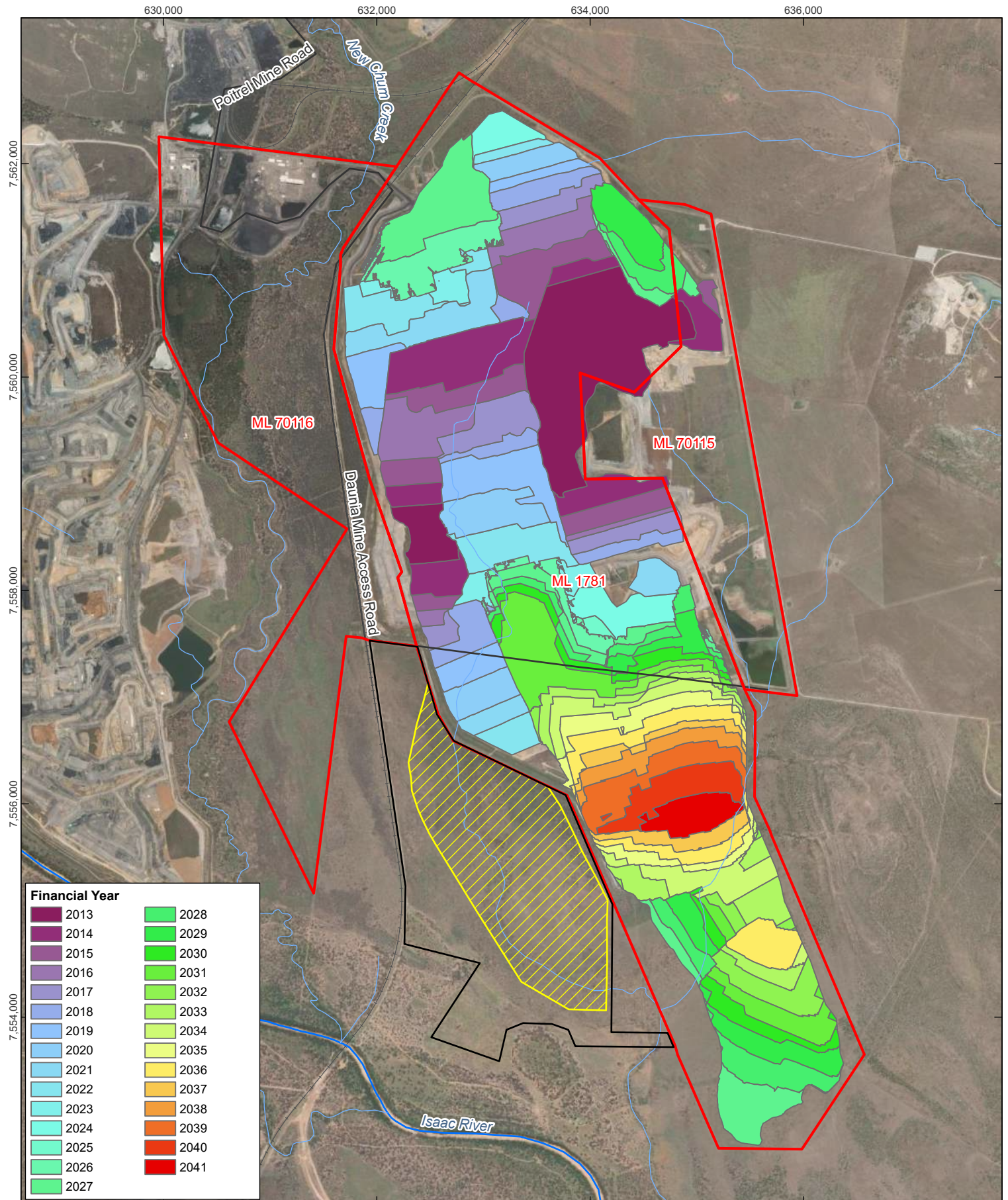
Groundwater within the Permian coal measures is confined and sub-artesian. Groundwater level trends for DNM monitoring bores screened in the Permian Coal Measures are presented in **Figure 5-6** to **Figure 5-8**. For context, the DNM mining progression is presented in **Figure 5-5**.

5.4.2.1 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 5-6**. 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 5-6** 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.





0 0.5 1 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:46,923 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Road
- +— Railway
- Major Watercourse
- Minor Watercourse
- ▭ Mining Lease
- ▭ Mining Lease Application Area / Project Area
- ▨ Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

DAUNIA MINE MINING PROGRESSION



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FIGURE 5-5

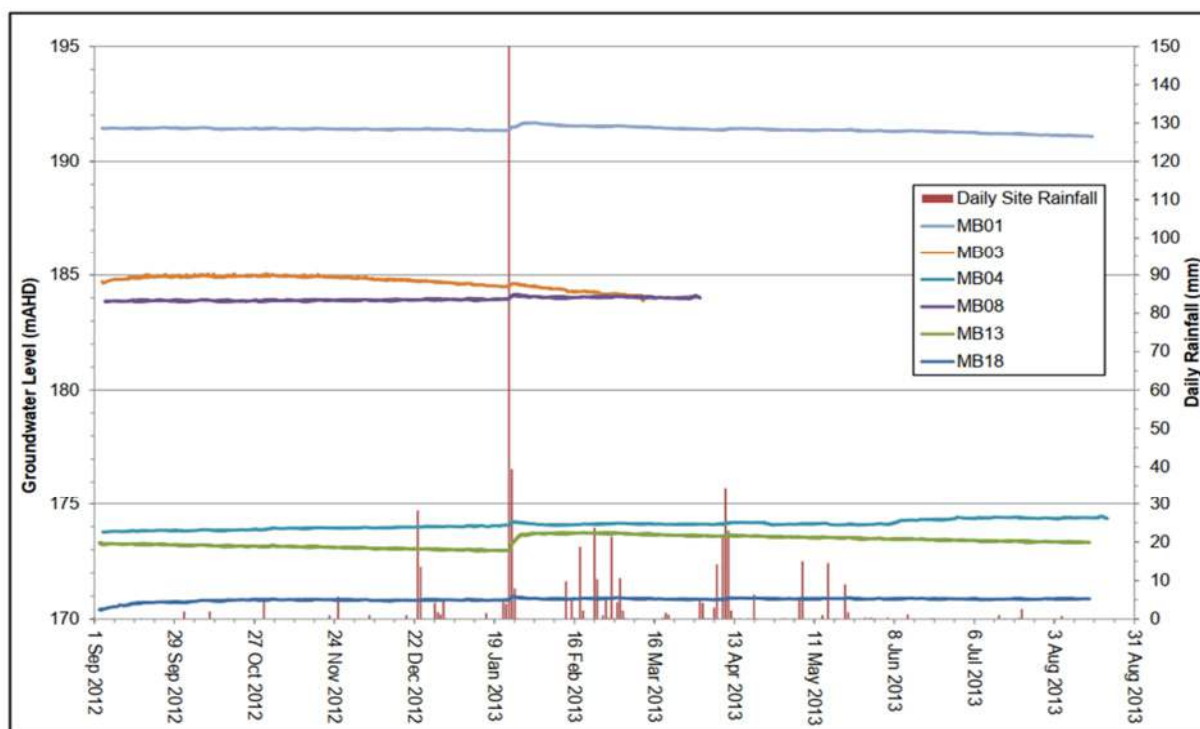


Figure 5-6 Permian Coal measures Monitoring Bore Hydrographs 2012-13 (AGE, 2013)

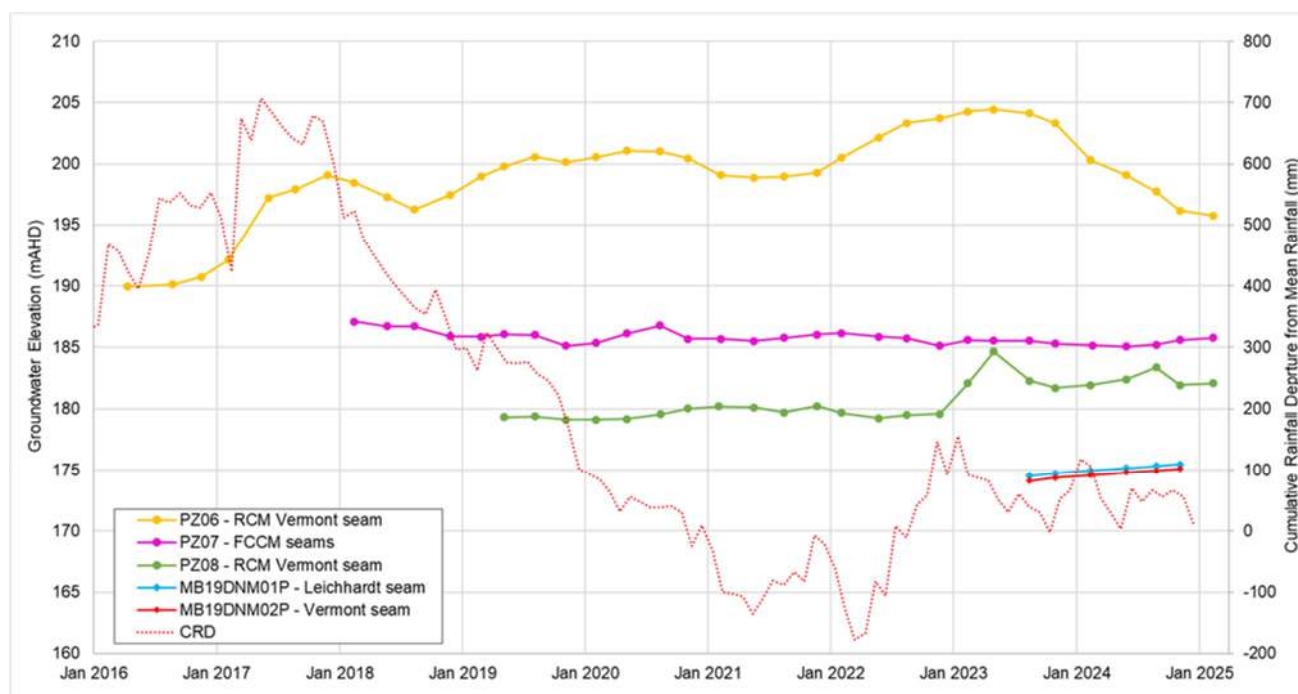


Figure 5-7 Leichhardt and Vermont Seams - Monitoring Bore Hydrographs

Groundwater levels are presented in **Figure 5-7** 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. PZ06 is located in the north-west of DNM approximately 450m west of a water storage dam which could explain the response in this bore if there is significant leakage from this dam and variable storage levels.

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 5m 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.

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 1m over a year, through a period of average rainfall conditions. The reason for the groundwater level increase is not clear although a water storage dam is located approximately 2 km to the north-west with a water level of 180m AHD. MB02P (FCCM interburden below RCM) also located south of the dam, shows a slight increasing trend (**Figure 5-8**). PZ04 (RCM interburden) located further north and approximately 1km from the water storage dam shows a more pronounced increase in levels (**Figure 5-8**) of the same trend seen in MB19DNM01P, MB19DNM02P and MB02P.

5.4.2.2 Permian Interburden

Hydrographs for Permian coal measures interburden/overburden are presented in **Figure 5-8**.

PZ01, PZ05 and MB20DNM01P_R01 are located in the north of the DNM Area, in close or relatively close proximity to the currently active mining voids. PZ05 and MB20DNM01P_R01 show decreasing trends 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 extraction and so it is difficult to draw clear conclusions about groundwater level trends in this bore. However, the maximum recorded levels appear to show 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.



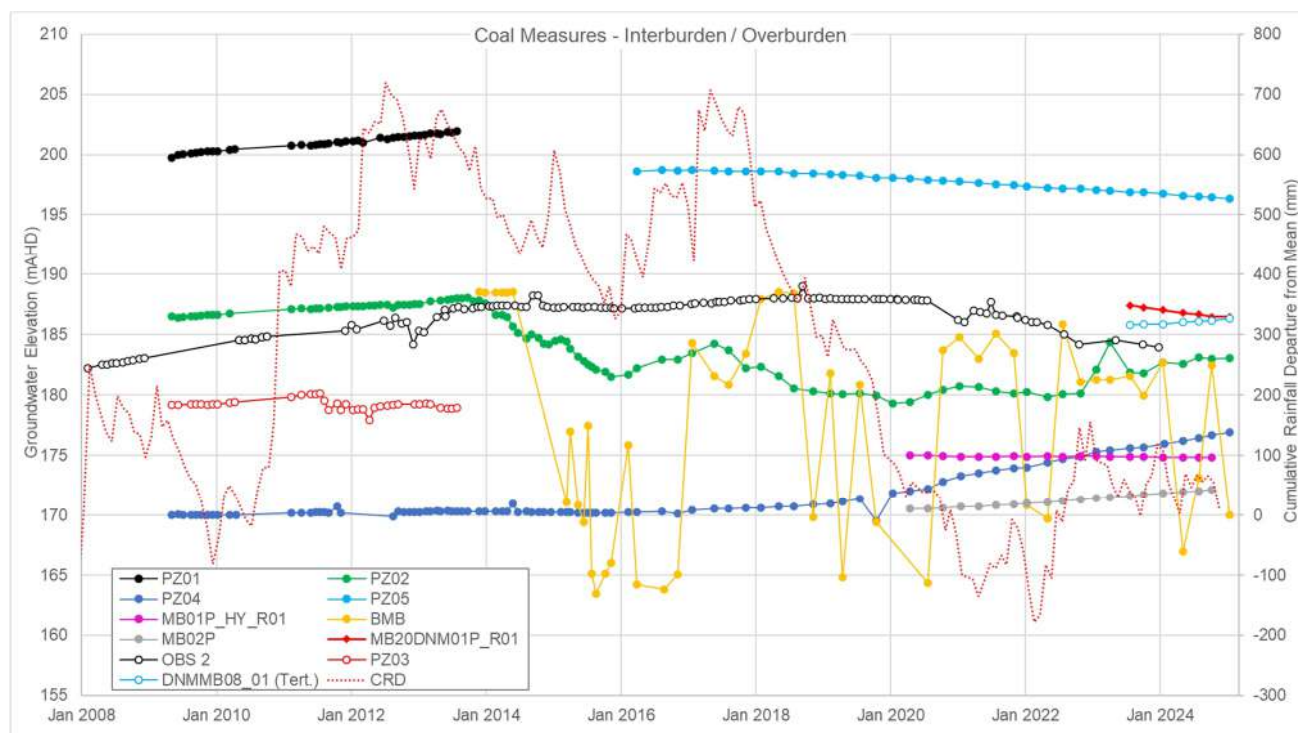


Figure 5-8 Permian Coal Measures (non coal) Monitoring Bore Hydrographs

5.4.2.3 Summary of Permian Coal Measures Groundwater Levels

The general lack of obvious / significant groundwater level drawdown response to mining activity within most 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 5.3.3**). Some indication of groundwater level increases in response to mining surface activity (restoration and waste rock placement) may be evident. Potentially limited mining impacts are observable in PZ06, PZ05, OBS2 and MB20DNM01P_R01.

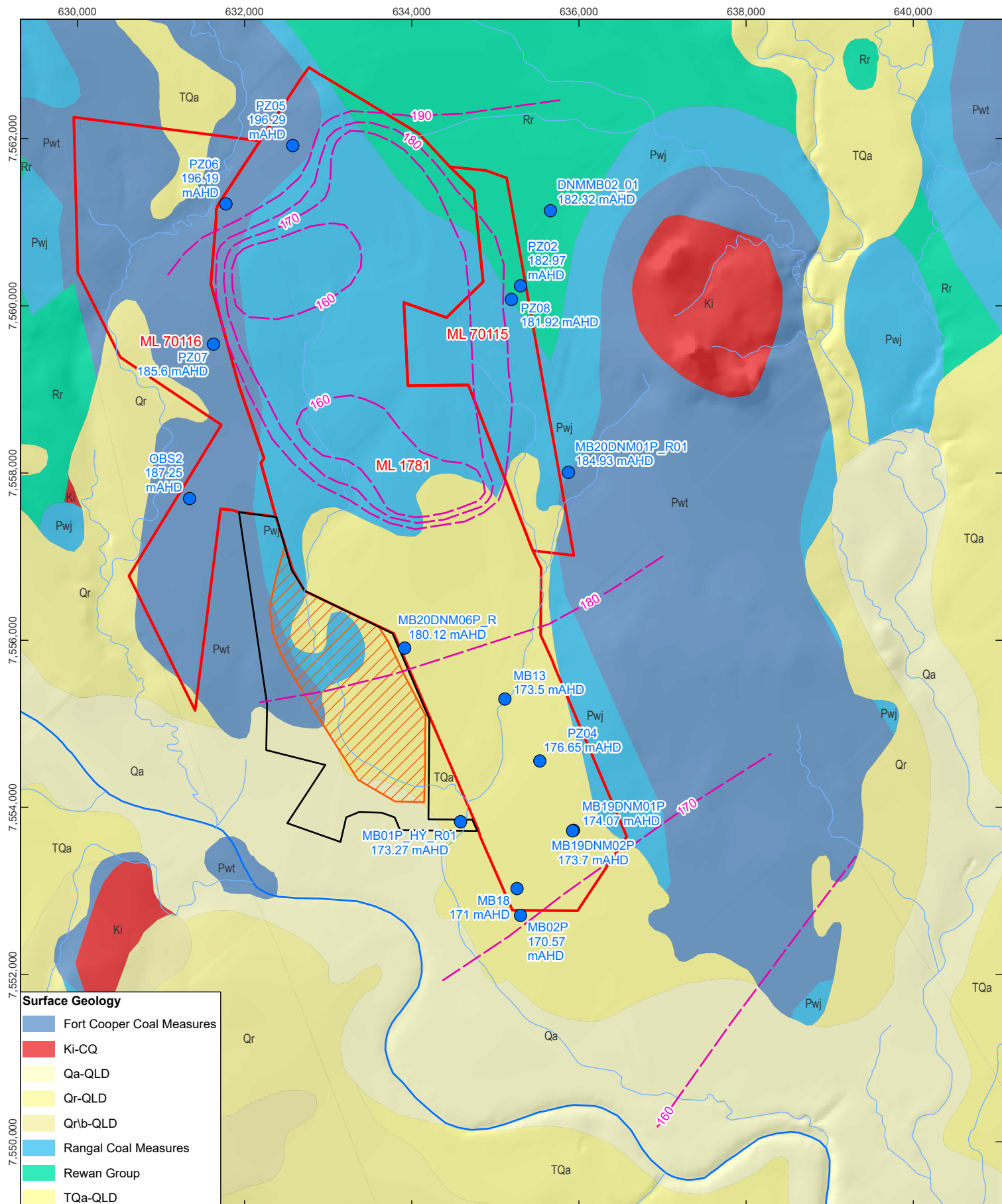
Groundwater levels in the Permian Coal Measures show a general northwest to southeast decline in elevation (**Figure 5-9**), with local drawdown in immediate vicinity of the active mine pit voids as expected. Local groundwater flow is therefore towards the active mine pit voids, whilst regional flow remains towards the southeast.

5.4.2.4 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/Tertiary 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.





Coordinate System: GDA2020 MGA Zone 55

Scale: 1:60,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Monitoring Bore
- Rangal Coal Measures Groundwater Elevation (mAHD)
- Major Watercourse
- Minor Watercourse
- Mining Lease
- Mining Lease Application Area / Project Area
- Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

RANGAL COAL MEASURES GROUNDWATER LEVELS (LATE 2024)



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FIGURE 5-9

5.5 Groundwater Quality

This section summarises groundwater quality data for monitoring bores at DNM against relevant water quality guidelines. Leachability data for samples of coal measures interburden obtained from samples taken from two bores at DNM is presented as an approximate guide to the potential quality of water that may potentially seep from the OOPD to groundwater.

5.5.1 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 in **Figure 5-10**. 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 no alluvium monitoring bores at DNM, however samples from the Isaac River Alluvium collected from Moortvale South mine 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.



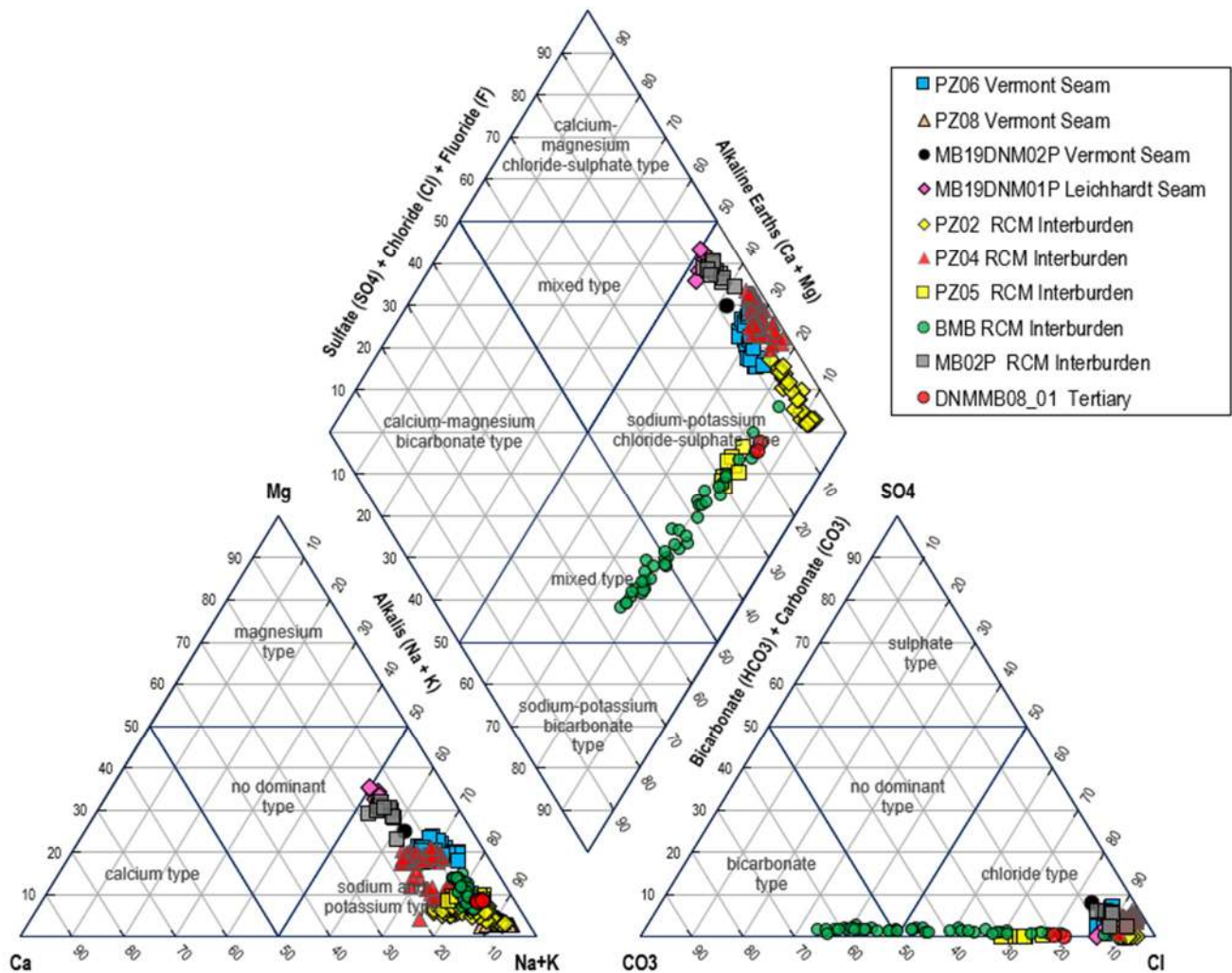


Figure 5-10 Piper Plot of Groundwater Quality at DNM

5.5.2 Groundwater Use (Environmental Values)

Groundwater resources in the DNM area are scheduled under the EPP Water and Wetland Biodiversity as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EVs) for these groundwaters are:

- Biological integrity of aquatic ecosystems;
- Human use EVs:
 - Suitability of water supply for irrigation;
 - Farm water supply/use;
 - Stock watering;
 - Primary recreation;
 - Drinking water supply; 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 have 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.
- **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.
- **Australian Drinking Water Guidelines (NHMRC, NRMCC 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.
- **Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)** – these guidelines, originating from the ANZECC & ARMCANZ (2000) water quality guidelines, provide for the protection of fresh and marine water habitats. The guideline value selected from this guidance is for slightly to moderately disturbed freshwater systems and the 95% species protection value (99% species protection for Se and Hg). 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 5-2**, together with groundwater quality data for the bores currently monitored at DNM (screened within coal seams or coal measures interburden). In addition, **Table 5-2** also includes summary water quality statistics for leachability tests undertaken on coal measures waste rock samples collected from DNM between 2008 and 2022 (Terrenus, 2025), as a very approximate guide to potential water quality within the OOPD. However, it should be noted that spoil leachability tests are a poor proxy for understanding the potential quality of water within the OOPD as these tests are likely to overestimate the leachable concentrations of substances from the waste rock.



Table 5-2 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	20 th	50 th	80 th	No.	<LOD	20 th	50 th	80 th	No.	<LOD	20 th	50 th	80 th
				20 th	50 th	80 th	20 th	50 th	80 th															
pH (units)	-	-	6.5 – 8.5 ^C	7.4	7.8	8.03	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 (As V) ^D	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 (Cr III)	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	0.00006 ^B	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 ^B	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 CaCO ₃	-	-	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 ²				188	330	650	187	536	878	67	0	408	797	974	281	0	349	433	1014	125	1	40.0	81.5	466

All concentrations in mg/l

* 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 For RCM samples HCO₃ derived by multiplying CaCO₃ 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)

B Guidelines recommend use of the concentration for 99 % freshwater species protection

C Aesthetic guideline / Insufficient data to set a guideline value based on health considerations.

D In the absence of speciated arsenic analysis the lower guideline value for As V has been used. There is also a guideline value for As III of 0.024 mg/l for 95% freshwater species protection.

ID - insufficient data



5.5.3 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, data presented in the DNM PRCP (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 5-3 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 than 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 5-3 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	2,000 – 3,000	3,000 – 4,000
Formation	20 th %ile	50 th %ile	80 th %ile
Rangal – coal seams	6,072	9,690	11,760
Rangal - interburden	3,860	6,425	12,000

5.5.4 Comparison to Guideline Values

5.5.4.1 Permian coal measures

The groundwater quality data for the Permian groundwater samples and the leachability test samples presented in **Table 5-2** 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 5-2**).

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 SO₄ 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 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 HCO₃ 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.

5.5.4.2 Leachability Tests (Terrenus, 2025)

Table 5-2 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”.

5.5.4.3 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.

5.6 Groundwater Receptors

5.6.1 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 (**Figure 5-11**), 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 on-site DNM monitoring bores, this landholder bore is not considered to be at risk from drawdown impacts related to mining at DNM.

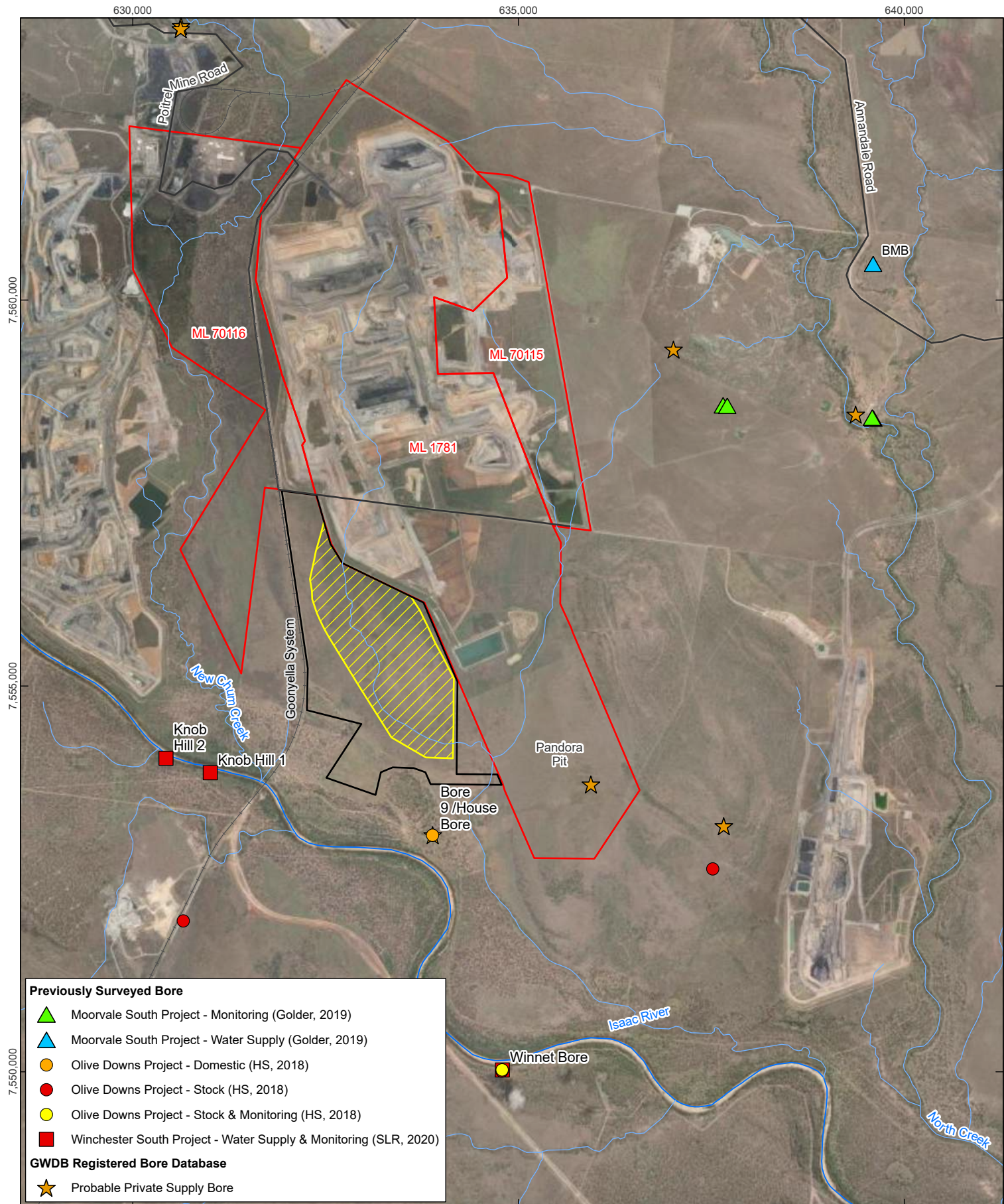
The 2023 PRCP groundwater assessment for DNM (SLR, 2023) included a review of landholder bore surveys for surrounding mining projects (Olive Downs, Moorvale South, and Winchester South). **Figure 5-11** presents a summary of the identified groundwater supply bores from these surveys and the GWBD. Four alluvium / Tertiary bores were identified directly south of the OOPD, 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 OOPD. Available details for the four landholder bores identified to the south of the OOPD are summarised in **Table 5-4**.

Table 5-4 Groundwater Bores South and South-West of the OOPD

RN	Bore Name	Easting ¹	Northing ¹	Depth (m)	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)
162826	Bore 9 / House Bore	633886	7553064	30*	Domestic	Alluvium	Yes	Olive Downs Bore Census 2017

¹ GDA94z55 *Estimated by landowner





0 1 2 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:65,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Road
- +— Railway
- Major Watercourse
- Minor Watercourse
- ▭ Mining Lease
- ▭ Mining Lease Application Area / Project Area
- ▨ Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

GROUNDWATER SUPPLY BORES



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 5-11

5.6.2 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 categorises the potential for 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 5-12**), with moderate to high potential GDEs 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 ($>0.001 \text{ m}^3/\text{s}$) only 26% of the time, i.e. there is no perennial groundwater supported flow (baseflow). The surface expression of groundwater in the creeks and the associated aquatic habitat will 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.



630,000

635,000

640,000

7,560,000

7,555,000

7,550,000

Potter Mine Road

Annandale Road

ML 70116

ML 70115

ML 1781

New Chim Creek

Goonyella System

Pandora Pit

Isaac River

North Creek



0 1 2 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:65,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Road
- +— Railway
- Major Watercourse
- Minor Watercourse
- ▭ Mining Lease
- ▭ Mining Lease Application Area / Project Area
- ▨ Proposed Operational Out-of-Pit Dump (DWIP)

Aquatic GDE

- ▨ High Potential GDE
- ▨ Moderate Potential GDE

Terrestrial GDE

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

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

GDES IN THE VICINITY OF DNM



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FIGURE 5-12

Path: \\au.slr.local\Corporate\Projects\SLR\620-BNE\620-BNE\620.042120.00001 Daunia West Infrastructure Proj\12 SLR Data\01 GIS\GIS\Daunia West Infrastructure Project\Daunia West Infrastructure Project.aprx\620042120_GW_F05-12_DWIP_GDES in the Vicinity of DNM

5.6.3 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.

5.6.4 Watermark Ecohydrology 2025 Study

Watermark Ecohydrology were engaged by WHC to prepare a desktop GDE risk assessment for the Project. The full report is presented in Appendix C of the EA Amendment application and summarised in Chapter 12 of the EA Amendment Supporting Document. A brief summary of the findings of this assessment is presented below.

- Groundwater within and adjacent to the OOPD areas is typically too deep (>10 mbgl) to support most woody vegetation species in the Project area and surrounds, meaning that most woody vegetation is reliant on soil moisture to support transpiration.
- Facultative groundwater dependence for riparian vegetation fringing the Isaac River is likely where deep-rooted vegetation accesses alluvial groundwater resources on a permanent or seasonal basis, depending on its position relative to the channel and distance from the watercourse.

Several factors indicate that the development of the OOPD will not significantly impact the ecohydrological function of groundwater-dependent vegetation within and surrounding the Project.

The higher infiltration rates to the spoil and retention of water within the spoil will result in groundwater mounding below the OOPD and extending out to the south-west towards the Isaac. Shallower groundwater levels will result in an increase in groundwater availability within the tree root zone, as well as an extended period of potential groundwater availability.



6.0 Hydrogeological Conceptual Model

A summary conceptual hydrogeological model (CHM) of the groundwater regime at DNM in the vicinity of Pandora Pit and the OOPD is presented below based on the information in the preceding sections.

6.1 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, and minor southwest-northeast trending faults. Pandora Pit in the south of DNM will target the Leichhardt and Upper Vermont seams of the Rangel Coal Measures, whilst the Project's OOPD will overlie Quaternary to Tertiary unconsolidated deposits including a small area of Isaac River alluvium, older alluvium and colluvium as well as weathered Permian strata. The main hydrogeological units of significance to the Project include:

- Cainozoic sediments:
 - Quaternary alluvium – unconfined aquifer (sporadically water-bearing strata of permeable unconsolidated sand or gravel) localised in close proximity to the south-west of Pandora Pit and the OOPD and regionally along the Isaac River, and to the east along North Creek.
 - Quaternary to Tertiary older alluvium, colluvium and weathered bedrock (regolith) – unconfined and largely unsaturated unit at DNM and in the Pandora Pit 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).

Along the ephemeral Isaac River immediately adjacent to the south-west of the Project, the alluvium comprises a heterogeneous distribution of fine to coarse sand, silt clay and gravel with correspondingly variable hydraulic properties.

Based on the 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.

6.2 Groundwater Flow, Recharge and Discharge

6.2.1 Shallow Groundwater System

Shallow groundwater is variably present in Quaternary alluvium and/or older unconsolidated Tertiary sediments and weathered Permian bedrock (regolith). From a hydrogeological standpoint, 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 proposed OOPD, 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 where it has been monitored in the vicinity of DNM.

Recharge to the alluvium is considered to be primarily from river flow loss 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 lines 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, and leakage 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 on the saturated water table away from the river to adjacent areas (including the area of Pandora Pit) 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.

6.2.2 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 very limited extraction of groundwater where salinity is sufficiently low for uses such as stock watering.

In the vicinity of DNM groundwater flow within the Permian coal measures is to the south-east.

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.

A limited number of hydrographs for the Permian coal measures monitoring bores at DNM show impacts from mining (generally limited), where they are in close proximity to active mining. This reflects the very low permeability of the coal measures interburden and/or structural compartmentalisation of groundwater within the Permian strata. The RCM coal seams will be entirely mined 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 than interburden.

6.3 Groundwater Quality

There are 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 WQOs for aquatic ecosystem protection in Isaac Groundwaters (Zone 34) 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).

6.4 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 the OOPD, the nearest being an “active” domestic supply bore adjacent to the Isaac River approximately 1 km south of the proposed OOPD.

6.5 Summary Conceptual Hydrogeological Model

A conceptual hydrogeological cross-section orientated north-east south-west through Pandora Pit and the proposed OOPD is presented in **Figure 6-1** showing an interpreted pre-mining and post-mining groundwater profile across Pandora Pit, the OOPD and the Isaac River floodplain. The pre-mining water table shows a local hydraulic gradient away from the Isaac River due to higher recharge across the alluvium and additional recharge from occasional flow events via river leakage. Across DNM, groundwater flows south turning south-east at the southern end of the site aligning with the drainage direction of the Isaac River (**Figure 5-9**).

When mining below the water table commences at the southern end of Pandora Pit, there will be a local reversal of the hydraulic gradient south of Pandora Pit with groundwater flowing back towards the mine void. The active Pandora Pit mine void will form a local groundwater sink during mining operations. When mining has ceased and groundwater levels partially recover, a lake will form in the residual void as a result of both surface water and groundwater inflow. A low lake level will be maintained by higher rates of evaporation from the void lake compared to the rate of surface and groundwater inflow, which will result in the void continuing to act as a groundwater sink.

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 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. The Project's numerical groundwater model (**Section 7.0**) uses a range of recharge for spoil of 1-5.5% total rainfall based on a widely accepted study (Mackie, 2009). Placement and compaction of out of pit spoil to form a designed landform with profiling to promote runoff, together with spoil consolidation over time and increasing EVT as vegetation becomes established and matures is considered likely to result in infiltration rates towards the lower end of the range used for spoil within the numerical model.

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) with the exception of a slight exceedance for pH. Consequently, the potential risk posed by off-site migration of seepage from the OOPD is considered low.

Given the low risk posed by the proposed OOPD a detailed ecohydrological model or assessment using impact pathway diagrams (IPDs) is not considered necessary for the Project.

The effect of increased rainfall infiltration through the OOPD and the potential to impact groundwater was evaluated using numerical groundwater modelling and the results are presented in **Section 7.0. Section 8.0** presents the findings of the groundwater impact assessment in the form of a risk assessment drawing on the quantitative output from the numerical modelling.



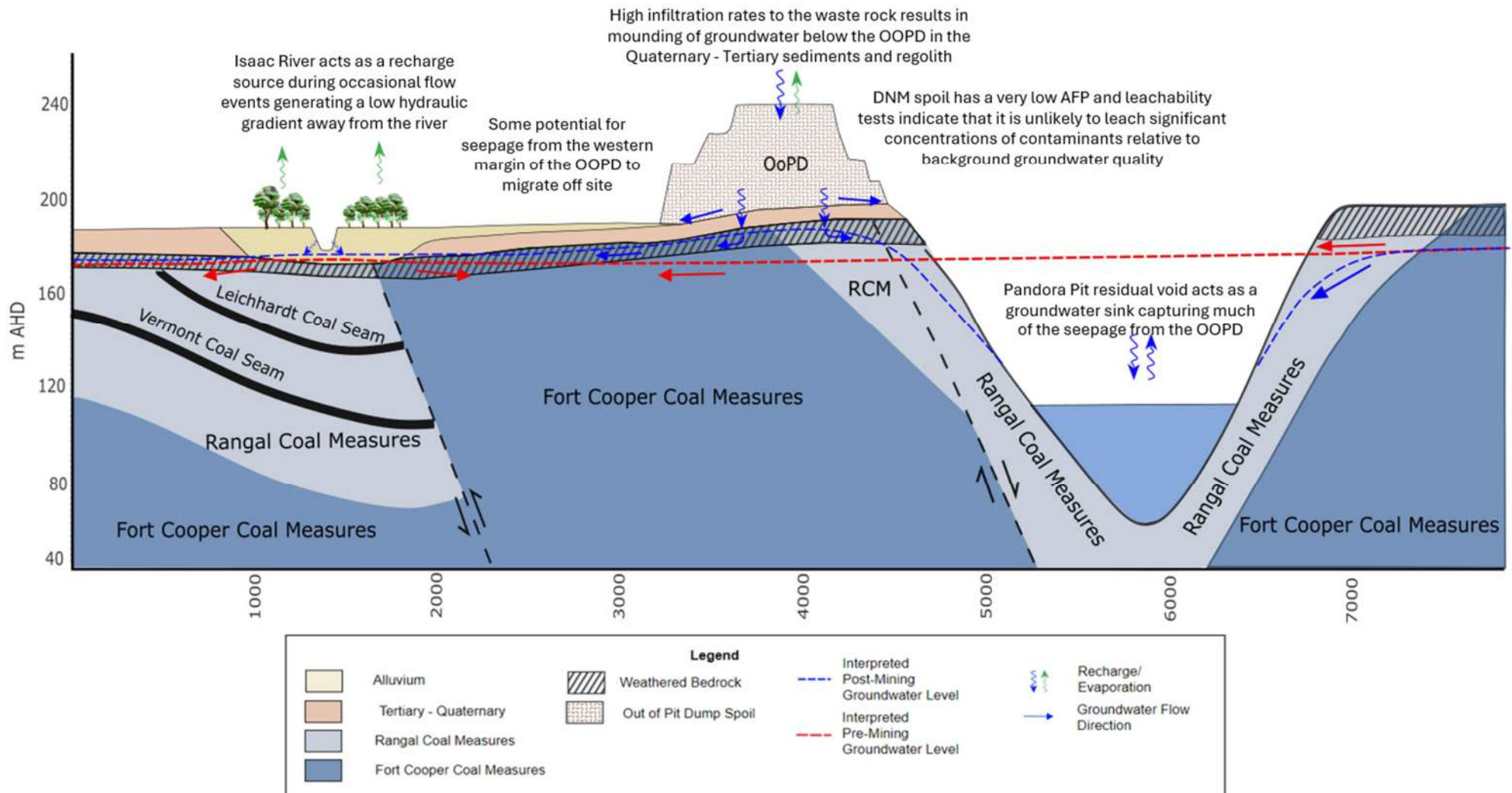


Figure 6-1 Conceptual Hydrogeological Cross Section



7.0 Numerical Modelling

This section outlines the numerical groundwater modelling that has been undertaken to evaluate the impact of the proposed OOPD. Details of the model build, calibration and predictive model setup are presented in the technical groundwater modelling report that accompanies this groundwater assessment (SLR, 2025c). Key modelling outputs are presented in this section together with a discussion of the potential impacts on groundwater.

7.1 Modelling Objectives

The objective of the numerical groundwater modelling exercise is to simulate the presence of the OOPD and its effect on the groundwater regime against the base case of there being no OOPD. The Project does not involve any changes to proposed mining, either in terms of extent or the timing of mining progression previously modelled for the DNM PRCP (SLR, 2025a). The key change to the SLR (2025a) predictive model is the increased recharge over the area of the OOPD. Considering this, and the location of the OOPD on the north-east margin of the Isaac River floodplain, the key quantities of interest in terms of model predictions are:

- Shallow groundwater levels and hydraulic gradients in the vicinity of the OOPD: The increased recharge over the OOPD footprint will result in local increases in the elevation of the water table which will locally change hydraulic gradients and the direction of groundwater flow
- Groundwater flux to the Isaac River Alluvium / baseflow: The increased groundwater levels in the vicinity of the OOPD have the potential to change the groundwater levels in the Isaac River Alluvium and baseflows to the Isaac River on the isolated occasions where, immediately following significant rainfall / runoff events, simulated groundwater levels in the alluvium may be sufficiently high to generate very short-term periods of baseflow to the Isaac River.
- Pandora Pit residual void lake levels: The increased recharge to the OOPD and locally increased groundwater levels in the vicinity of the OOPD will increase the hydraulic gradient into the adjacent Pandora Pit final void and likely increase the post-mining equilibrium void lake level through an increase in groundwater inflow.
- Potential contaminant concentrations in groundwater: Particle tracking and simple solute transport modelling has been undertaken to determine the migration pathways, and potential concentrations of selected contaminants in groundwater arising from seepage from the OOPD to groundwater.

7.2 Numerical Model

DNM sits within the Central Bowen Basin regional groundwater model domain, a regional scale model using MODFLOW-USG code developed by SLR. The model has been developed under data share agreements between some mining operators within the model domain and represents 20 existing and proposed mining operations. The model is therefore based upon information owned by different operators, supplied to SLR for use in the model development, calibration, and prediction. The model is regularly updated with new data as it becomes available, and on a project by project basis for individual mining operations. The model is designed primarily to predict the hydrogeological effects of mining on a regional scale in a cumulative impact framework. This model has been adopted for the groundwater assessment of the proposed OOPD at DNM for the following reasons:

- The model incorporates the DNM geological model in that the numerical model layer representation consistent with the geological model;



- The stochastic model is calibrated using an extensive regional dataset, including data from DNM and neighbouring mines. Calibration of the ensemble incorporates optimisations to the regional dataset and localised subsets at individual mine sites. The ensemble of model realisations with the best fit to the DNM dataset was selected for assessment of the Project;
- The model incorporates neighbouring mining operations that may interact with the groundwater system (and model predictions) at DNM, given their proximity;
- The model has previously been used to support Water License compliance reporting to the State and the PRCP for DNM; and
- The version of the model used for the Project 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.

Details of the model build, calibration and predictive setup are presented in the technical groundwater modelling report that accompanies this groundwater assessment (SLR, 2025c) and the report prepared for the recent rebuild of this model (SLR, 2025d). For reference the numerical model layering is presented in **Table 7-1** as relevant model layers are referred to in the following report sections.

Table 7-1 Model Layering

Model Layer	Formation	Hydrostratigraphic Unit	Present at 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
13		Interburden	Yes
14		P Seam	Yes
15		Interburden	Yes
16		H Seam	Yes
17		Interburden	Yes
18		D Seam	Yes
19		Interburden	Yes



7.3 Model Setup and Prediction

Mining activities are simulated in the predictive model as an extension of the calibration period. A detailed description of the calibration setup is provided in SLR (2025d). There are no changes to the DNM mining extent or progression for this assessment compared to the recent PRCP groundwater assessment for approved mining at DNM (SLR, 2025a).

The simulation of mines adjacent to DNM, 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 predictive simulation of mining activities at DNM. The simulation of Moorvale South Millennium and Poitrel is consistent with the current PRCP for these sites, i.e. incorporating a final landform including residual voids.

Excluding the addition of the OOPD, the final landform used in the post-mining recovery simulation at DNM is exactly the same as that used in the current DNM PRCP groundwater assessment (SLR, 2025a), including its three residual voids.

During the post-mining recovery period climate conditions (i.e. recharge and EVT) are set constant for the duration of the recovery model, using long term average values. Recharge and ET are not applied to the DNM final voids themselves in the groundwater model as the WRM (2025) water balance model (which is used iteratively with the groundwater model to derive final void lake levels), accounts for these inputs.

The cells representing residual mine voids are 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 $5.0 \times 10^{-6} \text{ m}^{-1}$), to simulate free water movement within the residual void.

7.4 Predictive Scenarios and Representation of the OOPD

7.4.1 Overview

Two predictive scenarios were setup to assess the effect of the OOPD on the local hydrogeological regime:

- **Approved case:** This model setup uses the currently approved DNM mine extent and progression and includes all approved mining at neighbouring mining operations. It uses the currently proposed final landform for DNM as per the recently prepared DNM PRCP (SLR, 2025a) and available final landforms for neighbouring mines.
- **Proposed case:** This model setup includes a representation of the OOPD as the only difference compared to the approved case model setup.

The OOPD has been represented in the proposed case model as follows:

- The OOPD is represented in layer 1 of the model. The top elevation of layer 1 was changed (increased) to match the landform design provided for the OOPD.
- The hydraulic properties of layer 1 were changed to “spoil” over the footprint of the OOPD.
- Evapotranspiration was modified to adopt calibrated value for spoil over the OOPD footprint (EVT rate and EVT extinction depth). The EVT surface was also adjusted for the modified top elevation of layer 1 where it represents the OOPD.
- The recharge rate over the OOPD was increased to represent potential spoil infiltration rates (see below).



7.4.2 Recharge Rate Applied to the OOPD

The calibrated model for the Project, i.e. the model realisation that best matches the observed groundwater levels around DNM, includes a spoil recharge rate of 3.7%. However, as there are no observation bores in the spoil at DNM the calibration will not be sensitive to this recharge rate. As such the spoil recharge rate is not considered to be a calibrated value. However, the recharge rate applied to the spoil of the OOPD in the predictive modelling will report directly to the highest saturated layer of the model resulting in mounding of the simulated water table below the OOPD. That is, there is a conservative assumption applied in the modelling that all recharge applied over the OOPD arrives at the saturated water table beneath the OOPD and becomes part of the groundwater system. It is likely however that recharge to the underlying groundwater table will be lower than the spoil infiltration rate to the reasons stated below. The recharge rate applied to the OOPD is therefore important as it will partly determine the simulated destination of seepage from the OOPD. The higher the recharge rate, the greater the groundwater mounding beneath the OOPD and the more likely it is that seepage from the OOPD will migrate off-site.

As there are no spoil monitoring bores to allow accurate calibration of spoil recharge rates and appropriate value based on literature has been used. The selected spoil recharge rate of 3.7% total rainfall sits approximately in the middle of the widely accepted range of 1% to 5.5% proposed by Mackie (2009). However it is considered likely that rainwater infiltration to the OOPD, and more importantly recharge to the underlying natural ground, will be lower than this value for a number of reasons:

- Placement / compaction of spoil to form a designed landform with profiling which will promote runoff.
- Spoil consolidation and compaction under loading will decrease the permeability of the spoil in the OOPD over time.
- Increasing EVT intercepting soil moisture as vegetation becomes established and matures.
- Possible 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 by perimeter toe drains.

Consequently, the spoil recharge rate of 3.7% total rainfall is considered highly conservative and will generate greater mounding beneath the OOPD and outward migration of groundwater within the model simulations than is likely.

7.5 Model Timing

The model has been set up to simulate mining at DNM as per the historic mine progression, and the future progression sequence provided through to the end of 2041 (**Figure 5-5**), after which the post mining period starts. The post-mining recovery period runs for approximately 1,000 years from the end of mining at DNM and incorporates recovery at neighbouring mine sites. This long post mining period allows for full stabilisation of residual void lake levels and allows a long run time for particle tracking and contaminant transport modelling.

Construction of the OOPD would start in FY2028 and enhanced recharge over the area of the OOPD has been applied from this time.

7.6 Post Mining Recovery

Recovering groundwater levels, rainfall, runoff and drainage of rainfall infiltration through the spoil can result in the accumulation of water in the residual voids and the formation of void water bodies. Final void equilibrium water body levels were derived through an iterative process using both the groundwater model and a surface water model (WRM, 2025). The surface water balance model simulates the processes of direct rainfall, rainfall runoff from the void catchment and evaporative



loss from the void water body to estimate void water body levels and uses estimates of groundwater inflow to the final voids from the SLR groundwater model.

The iterative process involves taking the initial void water body recovery levels from the surface water balance model and applying them as time variant fixed heads in the groundwater model to represent the increasing void water levels over the recovery period. The time variant fixed heads constrain the rate of groundwater flux to/from the final voids over time within the groundwater model. The void groundwater fluxes generated using the time variant fixed heads are then used as input in the next iteration of the surface water balance model. The surface water balance model then generates a modified set of void water body recovery levels, which are used in the groundwater model to generate a new set of groundwater fluxes to the voids. As this process continues the difference between successive iterations of the groundwater model void fluxes and the surface water model void water body recovery levels becomes smaller, until the change is not significant and the models are considered to be in alignment.

This iterative process was completed for the DNM PRCP groundwater assessment using the approved case version of the groundwater model and is documented in the associated report (SLR, 2025a), including void water body recovery curves and details of the recovery model setup. For this assessment, two further iterations were undertaken using the groundwater inflows to the voids generated by the proposed case model for the Project i.e. including the OOPD. As anticipated the higher recharge applied to the OOPD (3.7% total rainfall) resulted in slightly higher predicted groundwater inflows to the Pandora Pit void and a slightly higher equilibrium void lake level, although it is still far below the crest level of the void and the elevation of Quaternary and Tertiary sediments. Details of the equilibrium conditions for the DNM residual voids (both with and without the OOPD) are presented in **Table 7-2**.

Table 7-2 Approximate Equilibrium Conditions for Residual Voids at DNM With and Without the OOPD

Component	Residual Void					
	Titan North		Titan East		Pandora	
	Without OOPD	With OOPD	Without OOPD	With OOPD	Without OOPD	With OOPD
Fill Time to Equilibrium Level (years)	100		150		200	
Equilibrium Void Water Level (mAHD)	140	140	120	121	92	95
Spill Elevation (mAHD)	210		220		190	
Freeboard ¹ (m)	70	70	100	99	98	95
Approximate Pre-mining Groundwater Level (mAHD)	198		192		180	
Net groundwater inflow at equilibrium (ML/d)	-0.08	-0.08	0.20	0.20	0.83	0.93

¹ Freeboard is the remaining depth of void between the predicted equilibrium water body level and the void spill level

7.7 Predicted Effect of the OOPD on Shallow Groundwater Levels

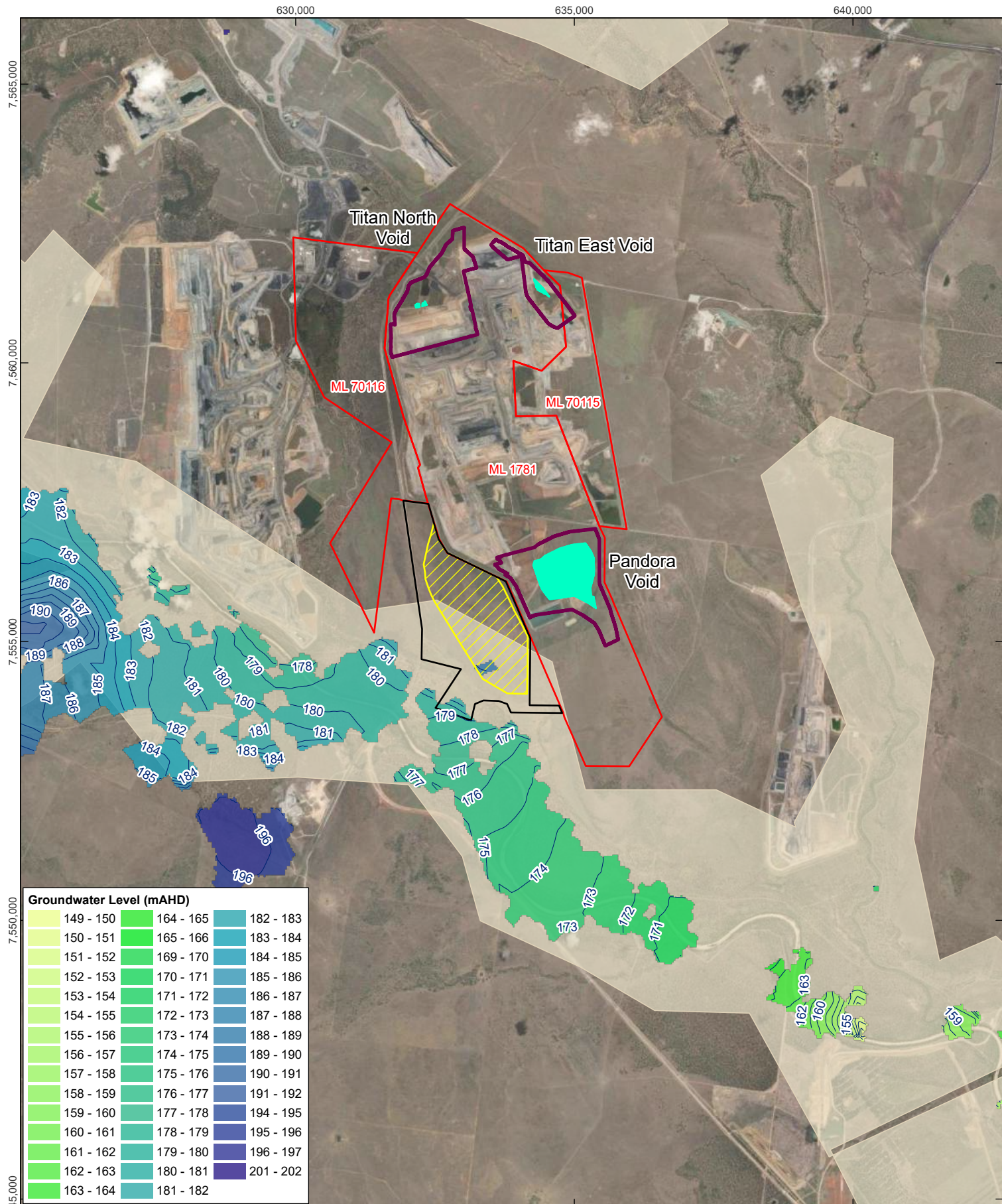
The key change to the hydrogeological regime arising from the presence of the OOPD is the significantly increased recharge over the area of this feature, together with the conservative assumption that all the additional infiltration to the spoil reaches the water table. The predicted effect on shallow groundwater in the vicinity of DNM and the OOPD in the form of outputs from the numerical modelling for the 3.7% spoil recharge rate is presented and discussed below.



7.7.1 Quaternary Alluvium (Layer 1)

Figure 7-1 presents groundwater levels in the Quaternary Alluvium (model Layer 1) for the proposed case i.e. including the OOPD. **Figure 7-2** presents the increase in groundwater levels within the Quaternary Alluvium (model Layer 1) as a result of the OOPD, as compared to the approved case simulation without the OOPD, at post mining equilibrium. Layer 1 is either not present or unsaturated immediately south west of the OOPD. **Figure 7-1** shows a water table within the Quaternary Alluvium along much of the course of the Isaac River although the depth to the water table below the Isaac channel elevation is >2m adjacent to DNM at the end of recovery, which aligns with the long term average climate conditions used for the long post-mining stress periods which do not include occasional simulated flows in the Isaac River. Between the Isaac River and the OOPD the Quaternary alluvium becomes thinner and elevated well above the saturated water table (or is not present) and so no mounding of groundwater is predicted in this area in Layer 1. South-west of the OOPD in the area of saturated Quaternary Alluvium groundwater levels are predicted to increase by as much as 5 m in isolated areas, with the effect of the increased recharge through the OOPD extending up to 6 km downstream and 4 km upstream.





 0 1 2 km
 Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:90,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 29-May-2026
 Drawn by: RB

LEGEND

-  Groundwater Contour (mAHd)
-  Major Watercourse
-  Minor Watercourse
-  Mining Lease
-  Mining Lease Application Area / Project Area
-  Proposed Operational Out-of-Pit Dump (DWIP)

-  Void Extent
-  Void Lake
-  Quaternary Alluvium Extent

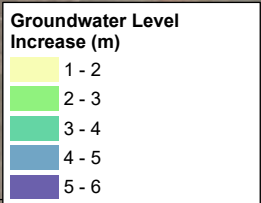
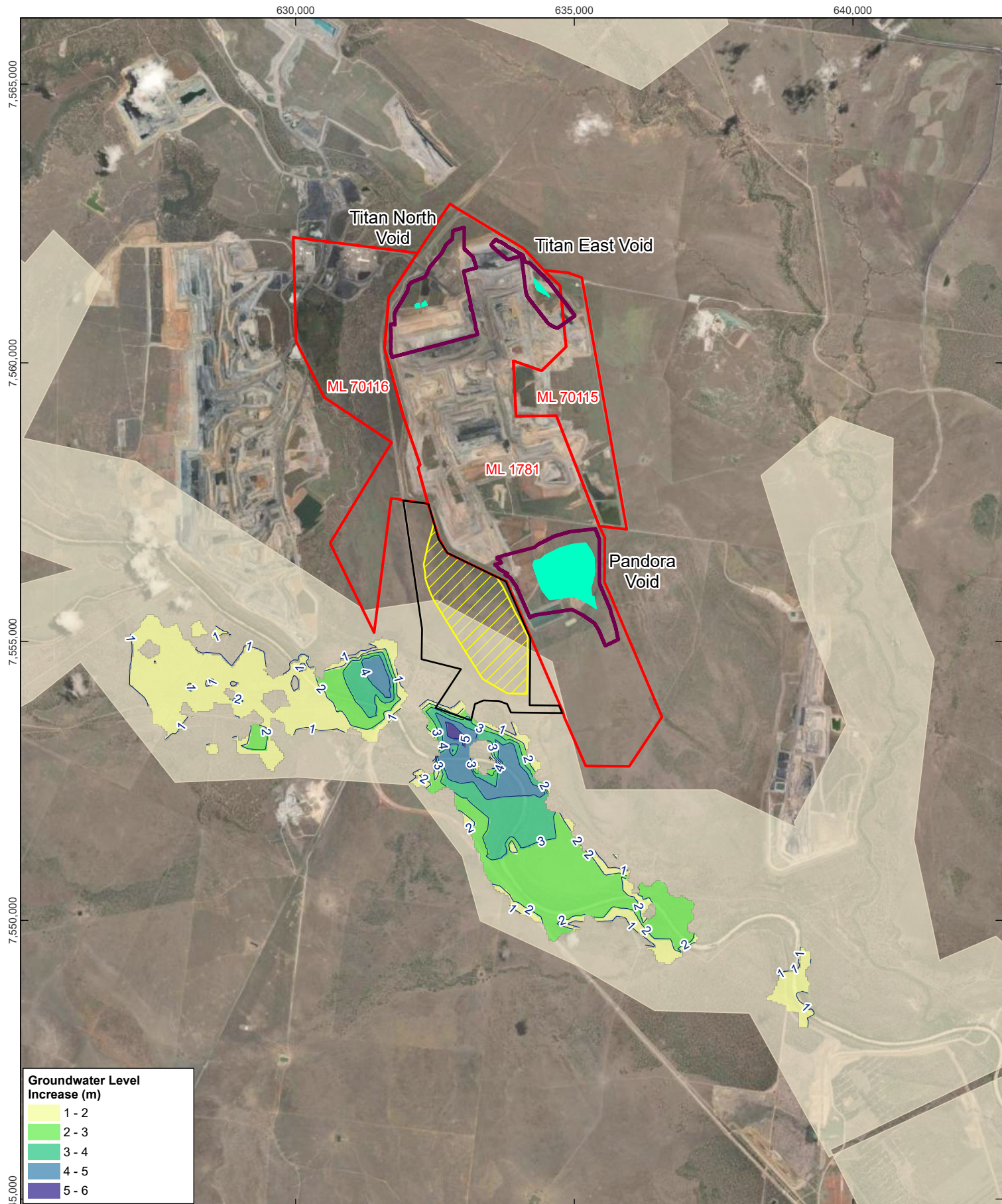
DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

GROUNDWATER LEVELS IN LAYER 1 (QUATERNARY ALLUVIUM), POST MINING EQUILIBRIUM



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FIGURE 7-1



 0 1 2 km
 Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:90,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 29-May-2026
 Drawn by: RB

- LEGEND**
-  Groundwater Contour (mAHD)
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 -  Void Extent
 -  Void Lake
 -  Quaternary Alluvium Extent

**DAUNIA WEST
 INFRASTRUCTURE PROJECT
 GROUNDWATER IMPACT
 ASSESSMENT**

**GROUNDWATER LEVEL INCREASE
 DUE TO THE OOPD IN LAYER 1
 (QUATERNARY ALLUVIUM),
 POST MINING EQUILIBRIUM**



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FIGURE 7-2

7.7.2 Post Mining Water Table and Groundwater Mounding

The predicted groundwater elevation in Layer 2 (Tertiary-Quaternary alluvium, regolith) at post mining equilibrium is presented in **Figure 7-3**. This is the shallowest layer beneath the OOPD containing groundwater. The increased recharge applied across the area of the OOPD results in mounding of groundwater in the underlying layer 2, extending out into the surrounding area. The position of the groundwater divide through the western margin of the OOPD is clear with the mounded water table in Layer 2 below the OOPD inclined mostly toward the east and the deep residual void in Pandora Pit.

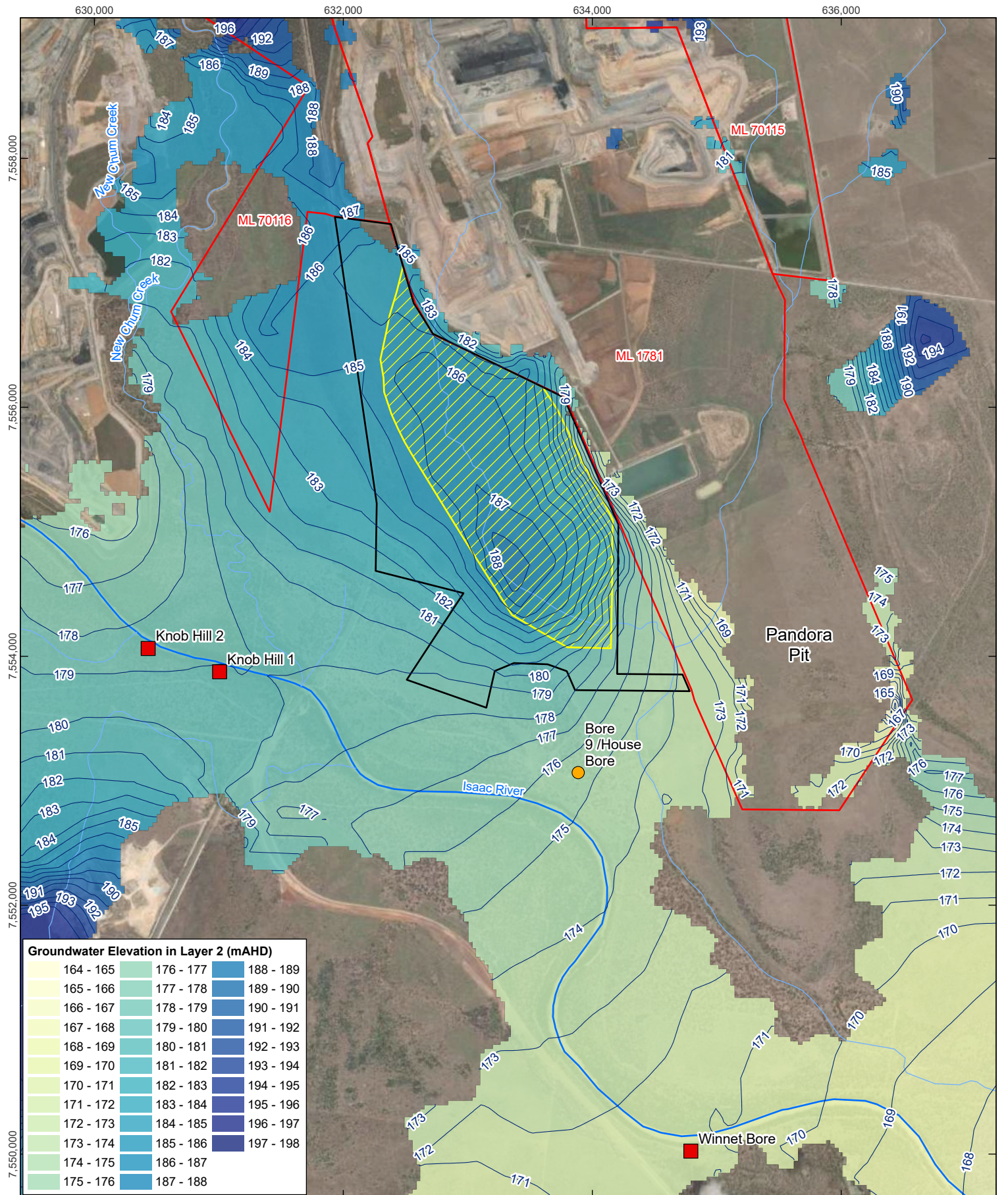
The groundwater mounding in layer 2 beneath the OOPD is up to 16m greater than predicted by the same simulation with no OOPD. Mounding of 1m or more in layer 2 extends up to 7.5 km down the Isaac River floodplain from the OOPD and approximately 5 km west of the OOPD. Mounding in the vicinity of the Isaac River immediately southwest of the is below 5 m.

Despite this mounding of groundwater in layer 1 and layer 2, groundwater levels along the Isaac River are >2 m below the channel elevation in the vicinity of DNM at post-mining equilibrium reflecting the long term average climate condition resulting in no baseflow from the alluvium to the Isaac.

The predicted groundwater elevation in Layer 9 (Fort Cooper overburden) at post mining equilibrium is presented on **Figure 7-4**. This layer immediately underlies Layer 2 (Tertiary-Quaternary alluvium, regolith) below the OOPD and the area to the west and south, and is confined by the overlying Rangal Coal Measures (Vermont Seam Underburden) exposed in Pandora Pit to the east.

Across the area of the OOPD groundwater levels in Layer 9 are significantly lower than the overlying Layer 2 (by up to 10m) indicating a strong downward vertical gradient. The flow direction is to the east or southeast with a southerly flow direction only beneath the very western edge of the OOPD.





Coordinate System: GDA2020 MGA Zone 55

Scale: 1:40,000 at A4

Project Number: 620.042120.00001

Date Drawn: 29-May-2026

Drawn by: RB

LEGEND

- Winchester South Project - Water Supply & Monitoring (SLR, 2020)
- Olive Downs Project - Domestic (HS, 2018)
- Groundwater Contour (mAH)
- Mining Lease
- Mining Lease Application Area / Project Area
- Proposed Operational Out-of-Pit Dump (DWIP)

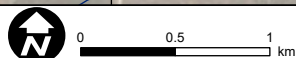
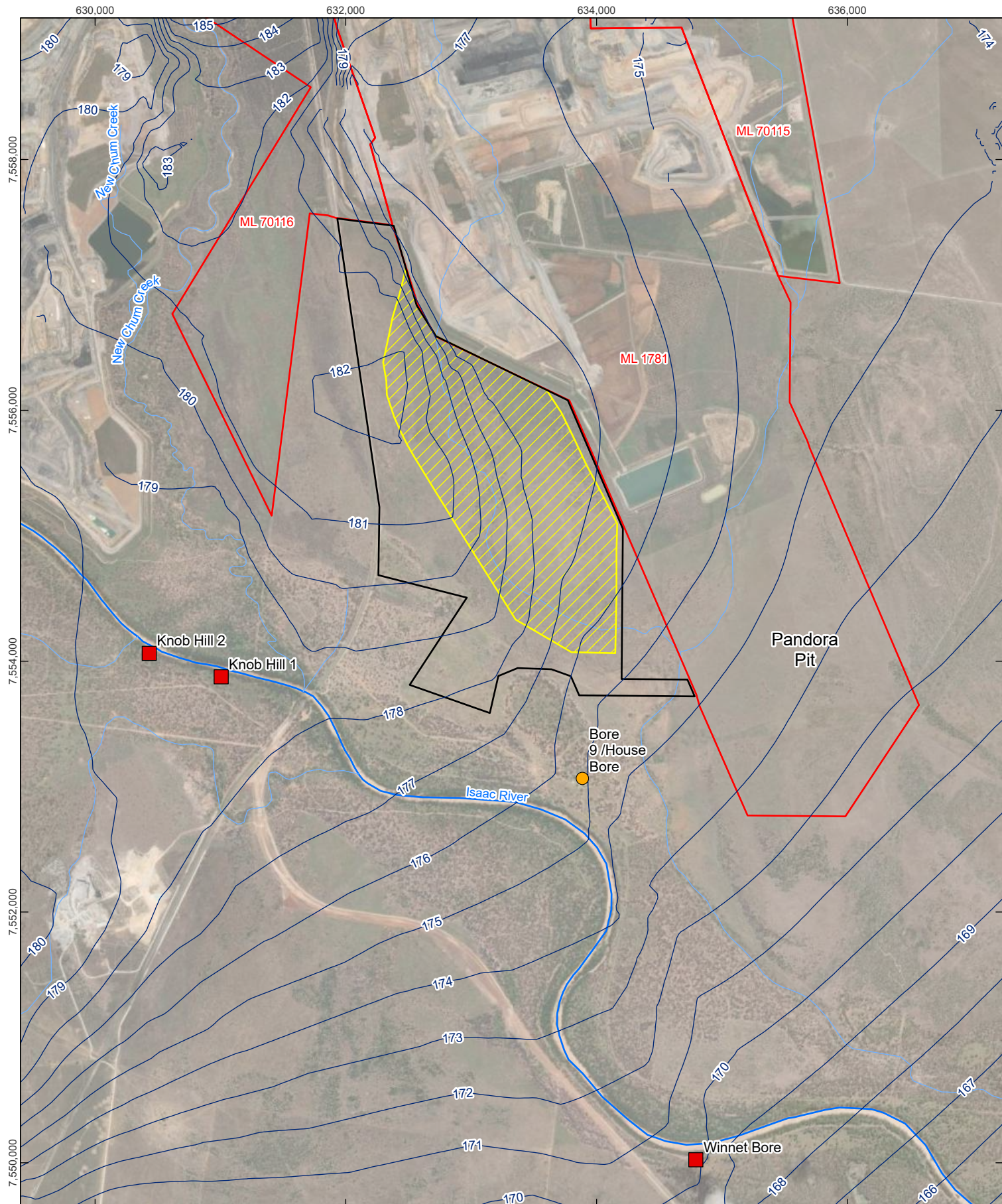
DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

PREDICTED GROUNDWATER ELEVATION IN LAYER 2 (TERTIARY- QUATERNARY ALLUVIUM, REGOLITH) AT POST MINING EQUILIBRIUM



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FIGURE 7-3



Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:40,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 29-May-2026
 Drawn by: RB

LEGEND

- Winchester South Project - Water Supply & Monitoring (SLR, 2020)
- Olive Downs Project - Domestic (HS, 2018)
- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- Mining Lease
- Mining Lease Application Area / Project Area
- Proposed Operational Out-of-Pit Dump (DWIP)

DAUNIA WEST INFRASTRUCTURE PROJECT GROUNDWATER IMPACT ASSESSMENT

PREDICTED GROUNDWATER ELEVATION IN LAYER 9 (FORT COOPER OVERBURDEN) AT POST MINING EQUILIBRIUM



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FIGURE 7-4

7.8 Predicted Change in Fluxes to the Isaac River Alluvium

Change in fluxes have been assessed for the Isaac River and Isaac River Alluvium along a “potential impact zone” extending 8 km upstream and 10 km downstream of the OOPD that may be affected by the presence of the OOPD and associated increased infiltration.

7.8.1 Isaac River Alluvium

Fluxes to the Isaac River Alluvium includes direct recharge to alluvium plus any lateral and vertical groundwater flow into this layer. **Figure 7-2** and **Figure 7-4** show increased groundwater levels in the alluvium and regolith adjacent to the Isaac River arising from the high model infiltration/recharge rate across the OOPD. As a result of groundwater mounding below the OOPD the lateral groundwater flux westward into the Isaac River Alluvium is predicted to increase by around 0.09 ML per day (~1 L/s) at post mining equilibrium due to the presence of the OOPD (**Figure 7-5**).

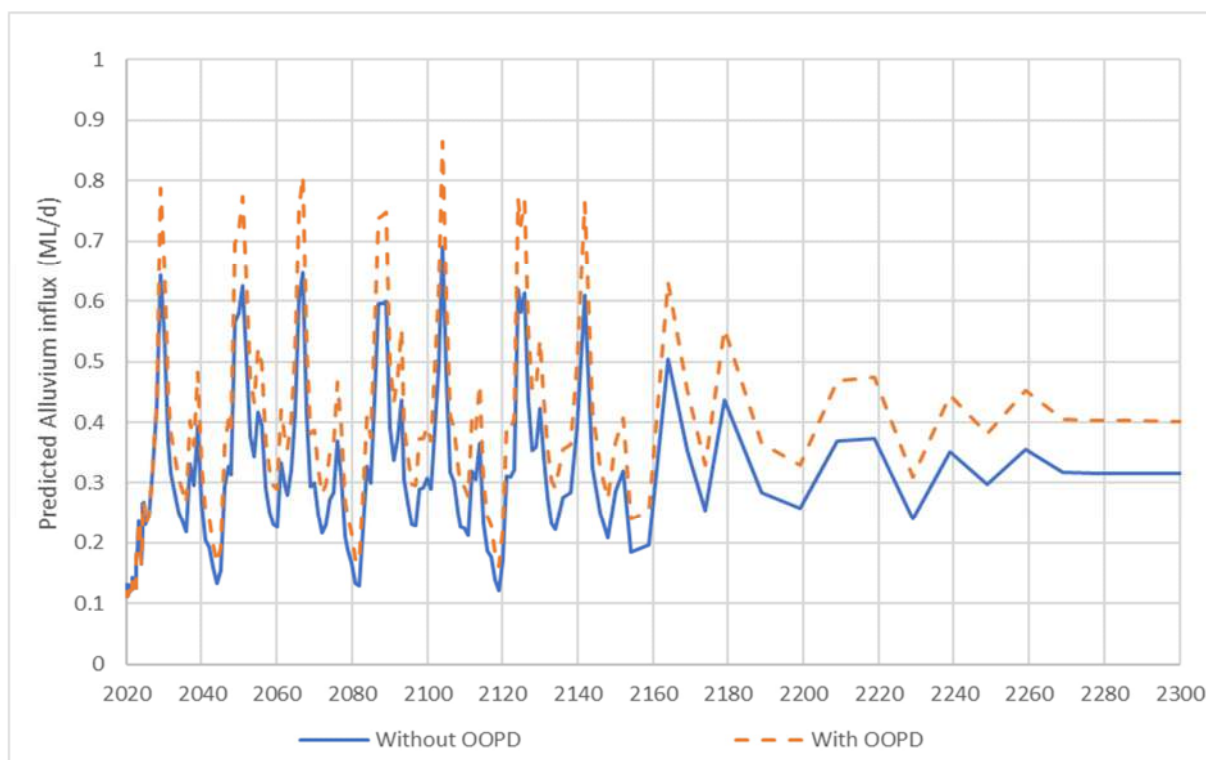


Figure 7-5 Predicted Inflows to the Isaac River Alluvium Inflow

7.8.2 Isaac River

Predicted changes in the groundwater flux to the Isaac River have been assessed by looking at the groundwater outflow from the model to river cells representing the Isaac River along the potential impact zone. The model simulates the Isaac River as an ephemeral watercourse with a river stage above zero provided for short durations through the calibration to match observed river flow events. Through the predictive mining period (for all mining within the model, which ends in 2113) synthetic episodic flows are simulated in the Isaac River to match the historic flow record with the last flow period occurring in 2104. For the recovery period from 2113 onwards, the stress period lengths increases up to 50-years and reflects long term average conditions. Episodic Isaac River flows cannot be not simulated through the very long post-mining stress periods. However, the simulation of occasional flows in the Isaac through the long post-mining period is considered unlikely to significantly affect the migration of seepage from the OOPD into groundwater which is driven by the higher recharge rate over the area of the OOPD and the resulting mounding of groundwater beneath the OOPD. Occasional additional recharge to the Isaac River Alluvium from the simulated



Isaac flow events might locally increase groundwater levels in the alluvium close to the river channel and possibly slightly inhibit the westward migration of any spoil affected groundwater arising from the OOPD.

Due to the higher groundwater levels in the surficial geology as a result of higher recharge over the OOPD there is a predicted increase in the occasional groundwater discharges to the Isaac River. Following periods of simulated Isaac River flow (i.e. river cell stage > 0), there is an increase in groundwater levels in the Quaternary Alluvium along the course of the Isaac River due to leakage from the river. In the following stress periods, a small amount of water (up to 7 ML per year or 0.2 L per second) is simulated leaving the model via the river (baseflow) from layer 1 where the water level in layer 1 is predicted to be greater than the riverbed elevation. **Figure 7-6** shows that the short term baseflow following periods of simulated river flow along the Isaac is slightly higher for the simulation including the OOPD, by up to 0.03 L/s at peak baseflow.

Post recovery, the stage in the river is always zero reflecting the average condition of the longer stress periods. As such the alluvium is no longer intermittently recharged by the river and groundwater levels in layer 1 never exceed the riverbed elevation and there is no short term discharge from the alluvium to the river.

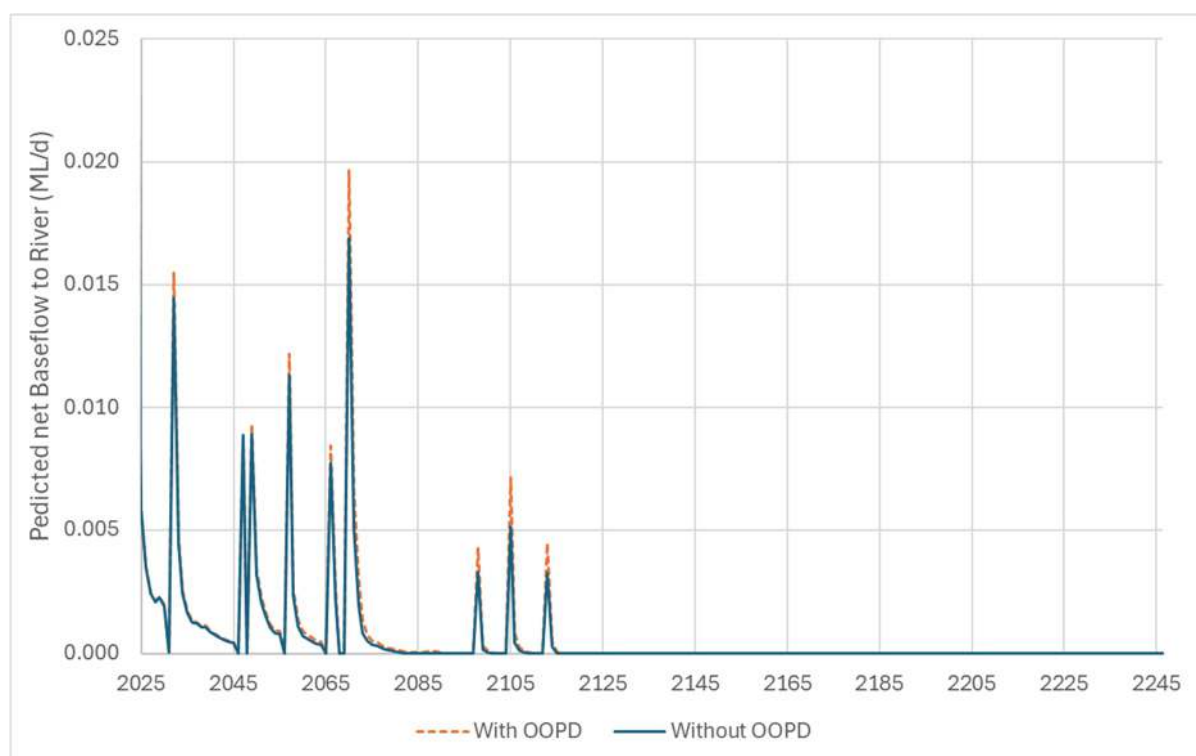


Figure 7-6 Predicted Groundwater Outflow to the Isaac River with and without the OOPD

7.9 Post Mining Groundwater Flow Path Simulation (Particle Tracking)

Particle tracking was undertaken as a first pass assessment of the movement and fate of water particles from the area of the OOPD through the surrounding groundwater system. Particle tracking can be considered as simulating the advection component of solute transport and is therefore indicative of potential groundwater flow paths. A number of particles were placed across the OOPD and released at the end of mining / start of groundwater recovery to understand the groundwater flow pathways away from the OOPD under the altered hydrogeological conditions generated by its presence.



The mod-PATH3DU code (S.S.Papadopoulos & Associates, Inc., 2018) was used to simulate particle pathways through the groundwater flow field from the end of mining / start of recovery, with a model run time of 977 years from release at the end of mining at DNM in 2042 to the end of the model simulation in 3019. The transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flowpaths.

The recharge rate applied to the OOPD is 3.7% of total rainfall which sits approximately in the middle of the widely accepted range of 1% to 5.5% proposed by Mackie (2009). The recharge rate across the OOPD of 3.7% total rainfall is the same as that applied to the in-pit spoil across the rest of the model.

A key parameter affecting the distance travelled by the particles is the effective porosity allocated to the formations through which the particles travel. Fluid velocity is inversely proportional to effective porosity, therefore lower effective porosity will tend to result in greater velocity and in turn increase the distance travelled within a given time frame i.e. lower porosity increases the potential area affected by solute migration.

The following effective porosity values were used in the model for the particle tracking simulation:

- Layer 1 – Isaac River Alluvium: 10% effective porosity was used for what will be a mixed sequence of fine to coarse material. The effective porosity of sand layers within this layer could be significantly higher
- Layer 2 – Older Quaternary to Tertiary alluvium and regolith: 10% effective porosity was also used to for the older more extensive alluvium and regolith which is considered likely to have a more open permeable texture
- Layer 9 – Fort Cooper Overburden: this is the geology which underlies Layer 2 in the vicinity of the OOPD and the area to the west and south. An effective porosity of 1% was applied to this layer which is considered a low value for mixed fine sandstone, siltstone and mudstone.
- All other layers: 1% effective porosity was applied to all other consolidated formations – mostly coal measures formations and the Rewan Formation, although these do not affect the area of interest to the west and south of the OOPD.

Figure 7-7 shows the pathlines for the particle tracking after 977 years, as well as the starting location of particles placed across the OOPD. The pathlines are colour coded according to the model layer they are moving through. The mod-PATH3DU code automatically moves the particle to the shallowest saturated layer at the commencement of the simulation (2042). The shallowest saturated layer beneath the OOPD is layer 2 (Quaternary-Tertiary alluvium and regolith), and this is the layer in which all particles released over the OOPD start.

The movement of particles within Layer 2 aligns with the flow directions illustrated by the groundwater level contours for Layer 2 (**Figure 7-3**). The particle movements clearly demonstrate the presence of the groundwater divide beneath the OOPD with approximately 65% of the particles moving eastward into the Pandora Pit void. Below the western margin of the OOPD there is some outward movement of particles away from the OOPD to the north, west and south, through Layer 2. Beneath the OOPD groundwater levels are significantly higher in Layer 2 than in the underlying Fort Cooper overburden (Layer 9) which drives a downward vertical hydraulic gradient. The particles enter the underlying Fort Cooper overburden (Layer 9) and there is a sharp change in direction for many of the particles in line with the groundwater flow direction in this layer (**Figure 7-4**). Some of the particles on the western part of the OOPD that migrate west through Layer 2 turn back to the east towards the Pandora Pit void as they enter Layer 9, and particles on the western edge of the OOPD footprint take a sharp turn to the south on entering Layer 9.

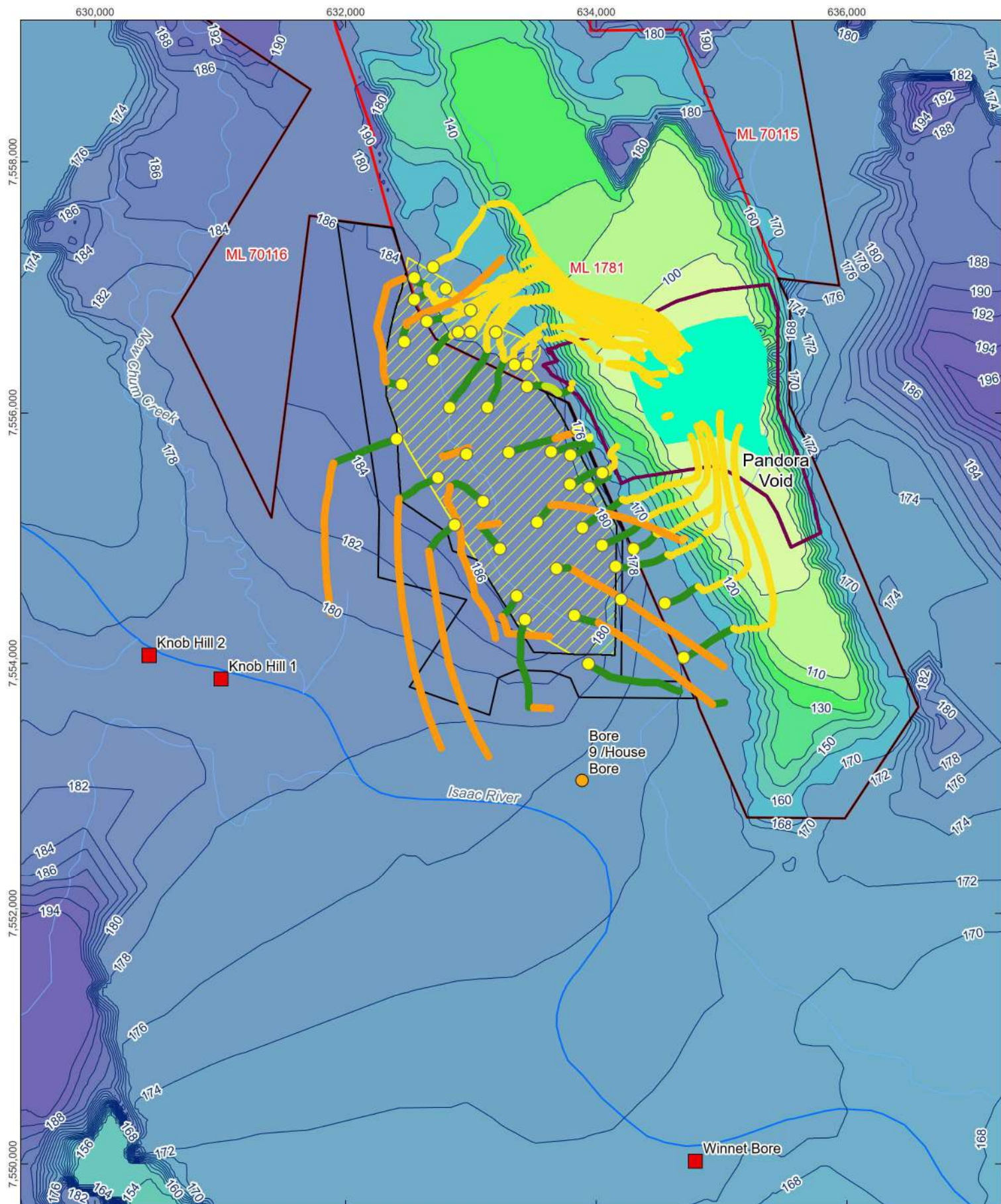
Only 3 particles on the very western margin of the OOPD continue to move south to south-east away from DNM and along the general direction of deeper groundwater flow in this area. These particles remain in the Fort Cooper Coal Measures overburden (Layer 9) and travel for the full



simulation, i.e. they remain within the deeper Permian groundwater system and do not migrate to shallow depths as they move towards the Isaac River.

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. 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.





 0 0.5 1 km
 Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:40,000 at A4
 Project Number: 620.042120.00001
 Date Drawn: 19-May-2026
 Drawn by: RB

LEGEND

-  Olive Downs Project - Domestic (HS, 2018)
-  Winchester South Project - Water Supply & Monitoring (SLR, 2020)
-  Starting Location of Particle
-  Groundwater Contour (mAHD)
-  Major Watercourse
-  Minor Watercourse
-  Mining Lease
-  Mining Lease Application Area / Project Area

 Proposed Operational Out-of-Pit Dump (DWIP)

 Void Extent

 Void Lake

Model Layer Traversed

-  2
-  7
-  5
-  8
-  6
-  9

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PREDICTED MOVEMENT OF PARTICLES RELEASED AT THE END OF MINING (3.7% RECHARGE TO THE OOPD)

FIGURE 7-7

7.10 Groundwater Solute Transport Modelling

Particle tracking provides a high level assessment of groundwater movement and migration pathways. Given that this has indicated the potential for off site migration of seepage from the OOPD a groundwater solute transport assessment was completed.

7.10.1 Solute model setup

Full details of the set up of this simulation are presented in the Modelling Technical Report (SLR, 2026) and key elements of the model are described here:

- The contaminant transport simulation was preformed using MODLOW USG - Transport V2.0.3.
- Two packages are used to simulate mass contaminant transport: The Block Centred Transport (BCT) package, which defines the transport parameters for the model (e.g., dispersion and porosity) and the RCH package, which defines the location (i.e. node), mass concentration and flux of the contaminant infiltration
- The transport model packages are added to the numerical flow model simulation from which the other modelling output presented in this report has been derived.
- The solute is released via the recharge (RCH) package over the entire footprint of the OOPD. A constant nominal concentration of 1 mg/L was applied and the reduction of this nominal concentration with distance from the source provides a “dilution factor” that can be applied to actual source concentrations for any substances of interest.
- The model uses advection and dispersion transport only. No retardation parameters have been applied making this approach very conservative.

7.10.2 Solute migration from the OOPD and dilution

The output from the solute transport modelling is presented in Figure 6-1 to Figure 6-3 of the groundwater modelling report (Appendix E) which show the extent of seepage migration from the OOPD within each of the model layers to the west and south (Layer1, 2 and 9). The figures show concentration contours after 977 years for a solute seeping from the OOPD which has a nominal starting concentration of 1 mg/l at the source (the recharge applied to the OOPD).

Figure 6-1 of Appendix E presents the extent and concentration contours for Layer 1 (Isaac River Alluvium). This layer is only present / partly saturated close to the Isaac River. Whilst there is a constant downward vertical hydraulic gradient between the OOPD and the Isaac River, with particle tracking indicating that seepage from the OOPD migrates downward from Layer 2 into Layer 9, the solute transport modelling indicates migration and dispersion through Layer 2 and into Layer 1 where it contains groundwater close to the Isaac River. After 977 years solute concentrations at the House Bore (likely screened in Layer1 / Layer 2) would be diluted by 100 times i.e. a solute concentration of 1 mg/l seeping from the OOPD would be 0.01 mg/l in Layer 1 at the location of the House bore. Over this timescale (and with no retardation), solutes seeping from the OOPD and entering groundwater would not reach any other private bores at measurable concentrations. At the Isaac River over a short reach southwest of the House Bore seepage from the OOPD has been diluted by a factor of approximately 650. However, the Isaac River receives minimal sporadic baseflow discharge and any small volumes of baseflow from the alluvium would be further diluted in the river under flowing conditions.

Figure 6-2 of Appendix E presents the solute concentration contours for Layer 2 (Tertiary-Quaternary alluvium and regolith). After 977 years solute concentrations at the House Bore would be diluted by a factor of approximately 33 i.e. a solute concentration of 1 mg/l seeping from the OOPD would be 0.03 mg/l in Layer 2 at the location of the House bore. At the Isaac River over a short reach southwest of the House Bore the dilution factor in Layer 1 increases to 200 reducing a



source concentration of 1 mg/l to 0.005 mg/l. Over this timescale (and with no retardation), solutes seeping from the OOPD migrating through Layer 2 would not reach any other private bores at measurable concentrations.

Figure 6-3 of Appendix E presents the solute concentration contours for Layer 9 (Fort Cooper overburden), the formation which directly underlies the alluvium / regolith across the OOPD and the area to the south and southwest. It is unlikely that this is the source aquifer for the House Bore, however after 977 years solute concentrations in Layer 9 at the location of this bore would be diluted by a factor of approximately 50 i.e. a solute concentration of 1 mg/l seeping from the OOPD would be 0.02 mg/l. At the Isaac River west of the House Bore the minimum dilution factor is 10 with OOPD seepage concentrations in Layer 9 reducing to 0.1 mg/l from a source concentration 1 mg/l. However, the Fort Cooper overburden would not be providing baseflow to the Isaac River at this location.

7.10.3 Potential impacts of OOPD seepage on groundwater quality

To understand the potential concentrations of solutes that may seep from the OOPD and reach receptors, the dilution factors from the solute transport modelling have been applied to the DNM waste rock leachate concentrations presented in **Table 5-2**. As described in **Section 5.5** the waste rock leachability data is a very conservative proxy for the likely quality of seepage from the OOPD. This is because the testing method results in higher concentrations of dissolved solids that would naturally seep from the spoil. However, several substances in the spoil leachate were detected at concentrations exceeding relevant water quality guidelines. Using the dilution factors from the solute transport modelling the concentrations of substances in the spoil leachate data can be reduced to their potential concentration at a receptor (e.g. House Bore and the Isaac River). This diluted leachate concentration is added to the background concentration in groundwater to derive a conservative total concentration at the point of interest.

Table 7-3 presents the substances and concentrations in the spoil leachate data that exceed one or more relevant guideline values at either the 80th or 50th percentile concentration. The table also presents background groundwater quality for the RCM derived from the DNM groundwater monitoring network. There are no DNM groundwater monitoring bores located to the west or south of the OOPD and consequently there is limited background groundwater quality data for the Isaac River Alluvium, the older Tertiary-Quaternary alluvium. However, as part of the Winchester South Project (SLR, 2020) groundwater samples were collected from private bores including the Knob Hill bores and the Winnet bore located close to the Isaac River upstream and downstream of the OOPD (no groundwater quality data is available for the House Bore). These bores are considered to be installed in the shallow Quaternary and Tertiary deposits and the groundwater quality data for these bores is presented in **Error! Reference source not found.** as background water quality data for the alluvium and superficial deposits adjacent to DNM.

Using the dilution factors for the OOPD seepage quality for relevant model layers at the receptor locations, and background concentrations for the substances of interest, total concentrations have been calculated at the location of the House Bore and the Isaac River. These are the total concentrations predicted 977 years after mining at DNM ceases with no depletion of the OOPD source concentration. The results are presented in **Table 7-4** (L1 – Isaac River Alluvium), **Table 7-5** (Tertiary-Quaternary alluvium / regolith) and **Table 7-6** (Fort Cooper overburden).

The predicted total concentrations in Layer 1 and 2 at the House Bore are all below the guideline values for drinking water quality and stock watering, with most total concentrations falling below detection limits. The predicted total concentrations in Layer 1 and 2 (alluvium) at the Isaac River are also generally below detection limits with the exception of zinc which exceeds the freshwater guideline for 95% species protection at the 80th percentile. However, this exceedance is due to the background concentration and not the diluted concentration in seepage from the OOPD which is below detection limits.



Predicted total concentrations in Layer 9 (Fort Cooper overburden) are less relevant as this is not considered to be the source formation for the House Bore and this formation will not discharge baseflow to the Isaac River at this location. However, the predicted total concentration of arsenic at the 80th percentile slightly exceeds the freshwater guideline for 95% species protection.

The solute transport modelling indicates that even with conservative assumptions (constant source concentration and no retardation), and after approximately 1000 years, seepage from the OOPD is unlikely to pose a significant risk to private water supplies or alluvial groundwater at the Isaac River.



Table 7-3 Spoil Leachate Exceedances of Relevant Guideline Values and Background Groundwater Quality

Analyte	95% Aquatic species protection for freshwater ¹	Livestock (ANZECC)	ADWG ^A	Daunia leachability Data* (1:5 solid : water)			Shallow Private Bores in the vicinity of the OOPD **			RCM Interburden at PTM		
				20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile
Aluminium	0.055	5	0.2 ^C	<0.01	0.04	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Arsenic	0.013	0.5	0.01	<0.001	0.016	0.183	<0.001	<0.001	0.0014	<0.001	<0.001	0.005
Molybdenum	0.034	0.15	0.05	<0.001	0.011	0.056	<0.001	<0.001	<0.001	<0.001	0.002	0.011
Selenium	0.005	0.02	0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.008	20	3	<0.005	<0.005	0.01	<0.005	0.005	0.0094	-	-	-

All concentrations in mg/l

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

** Data from three sampling events in 2019 at the Knob Hill bores (1 and 2), and the Winnet Bore, collected as part of the Winchester South Project (SLR, 2020). These bores are located close to the Isaac River upstream and downstream of DNM and believed to be screened in the alluvium / tertiary

Metals concentrations presented for groundwater are dissolved concentrations

greyed out values indicate concentrations below 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. For selenium the guideline value for 99% species protection is recommended and has been used here.

A ADWG are recommended guidelines for human consumption of water (i.e. post-treatment), NHMRC (2011)

C Aesthetic guideline / Insufficient data to set a guideline value based on health considerations.



Table 7-4 Predicted Groundwater Concentrations in Isaac River Alluvium (Layer 1) at Receptors

Analyte	95% Aquatic species protection for freshwater	Livestock (ANZECC)	ADWG	Diluted OOPD leachate Concentration at Receptor			Adopted Background Groundwater Quality for Alluvium / Tertiary			Predicted Total Concentration at Receptor (977 years post-mining)		
				20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile
Predicted Concentrations at House Bore: dilution factor of 100												
Aluminium		5	0.2	<0.01	0.0004	0.0010	<0.01	<0.01	<0.01	<0.01	0.0004	0.0010
Arsenic		0.5	0.01	<0.001	0.0002	0.0018	<0.001	<0.001	0.0014	<0.001	0.0002	0.0032
Molybdenum		0.15	0.05	<0.001	0.0001	0.0006	<0.001	<0.001	<0.001	<0.001	0.0001	0.0006
Selenium		0.02	0.01	<0.01	<0.01	0.0002	<0.01	<0.01	<0.01	<0.01	<0.01	0.0002
Zinc		20	3	<0.005	<0.005	0.0001	<0.005	0.005	0.0094	<0.005	0.005	0.0095
Predicted Concentrations in L1 at the location of the Isaac River: dilution factor of 650												
Aluminium	0.055			<0.01	0.0001	0.0002	<0.01	<0.01	<0.01	<0.01	0.0001	0.0002
Arsenic	0.013			<0.001	0.0000	0.0003	<0.001	<0.001	0.0014	<0.001	0.0000	0.0017
Molybdenum	0.034			<0.001	0.0000	0.0001	<0.001	<0.001	<0.001	<0.001	0.0000	0.0001
Selenium	0.005			<0.01	<0.01	0.0000	<0.01	<0.01	<0.01	<0.01	<0.01	0.0000
Zinc	0.008			<0.005	<0.005	0.0000	<0.005	0.005	0.0094	<0.005	0.005	0.0094

All concentrations in mg/l



Table 7-5 Predicted Groundwater Concentrations in Quaternary-Tertiary Alluvium / Regolith (Layer 2) at Receptors

Analyte	95% Aquatic species protection for freshwater	Livestock (ANZECC)	ADWG	Diluted OOPD leachate Concentration at Receptor			Adopted Background Groundwater Quality for Alluvium / Tertiary			Predicted Total Concentration at Receptor (977 years post-mining)		
				20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile
Predicted Concentrations at House Bore: dilution factor of 33												
Aluminium		5	0.2	<0.01	0.0012	0.0030	<0.01	<0.01	<0.01	<0.01	0.0012	0.0030
Arsenic		0.5	0.01	<0.001	0.0005	0.0055	<0.001	<0.001	0.0014	<0.001	0.0005	0.0069
Molybdenum		0.15	0.05	<0.001	0.0003	0.0017	<0.001	<0.001	<0.001	<0.001	0.0003	0.0017
Selenium		0.02	0.01	<0.01	<0.01	0.0006	<0.01	<0.01	<0.01	<0.01	<0.01	0.0006
Zinc		20	3	<0.005	<0.005	0.0003	<0.005	0.005	0.0094	<0.005	0.005	0.0097
Predicted Concentrations in L2 at the location of the Isaac River: dilution factor of 200												
Aluminium	0.055			<0.01	0.0002	0.0005	<0.01	<0.01	<0.01	<0.01	0.0002	0.005
Arsenic	0.013			<0.001	0.0001	0.0009	<0.001	<0.001	0.0014	<0.001	0.0001	0.0023
Molybdenum	0.034			<0.001	0.0001	0.0003	<0.001	<0.001	<0.001	<0.001	0.0001	0.0003
Selenium	0.005			<0.01	<0.01	0.0001	<0.01	<0.01	<0.01	<0.01	<0.01	0.0001
Zinc	0.008			<0.005	<0.005	0.0001	<0.005	0.005	0.0094	<0.005	0.005	0.0095

All concentrations in mg/l



Table 7-6 Predicted Groundwater Concentrations in Fort Cooper Overburden (Layer 9) at Receptors

Analyte	95% Aquatic species protection for freshwater	Livestock (ANZECC)	ADWG	Diluted OOPD leachate Concentration at Receptor			Adopted Background Groundwater Quality for Alluvium / Tertiary			Predicted Total Concentration at Receptor (977 years post-mining)		
				20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile	20 th %ile	50 th %ile	80 th %ile
Predicted Concentrations at House Bore: dilution factor of 50												
Aluminium		5	0.2	<0.01	0.0008	0.0020	<0.01	<0.01	0.02	<0.01	0.0008	0.022
Arsenic		0.5	0.01	<0.001	0.0003	0.0037	<0.001	<0.001	0.005	<0.001	0.0003	0.0087
Molybdenum		0.15	0.05	<0.001	0.0002	0.0011	<0.001	0.002	0.011	<0.001	0.0022	0.0121
Selenium		0.02	0.01	<0.01	<0.01	0.0004	<0.01	<0.01	<0.01	<0.01	<0.01	0.0004
Zinc		20	3	<0.005	<0.005	0.0002	-	-	-	<0.005	<0.005	0.0002
Predicted Concentrations in L9 at the location of the Isaac River: dilution factor of 10												
Aluminium	0.055			<0.01	0.0040	0.0100	<0.01	<0.01	0.02	<0.01	0.0040	0.030
Arsenic	0.013			<0.001	0.0016	0.0183	<0.001	<0.001	0.005	<0.001	0.0016	0.0233
Molybdenum	0.034			<0.001	0.0011	0.0056	<0.001	0.002	0.011	<0.001	0.0001	0.0166
Selenium	0.005			<0.01	<0.01	0.0020	<0.01	<0.01	<0.01	<0.01	<0.01	0.0020
Zinc	0.008			<0.005	<0.005	0.0010	-	-	-	<0.005	<0.005	0.0010

All concentrations in mg/l



8.0 Potential Impacts on Groundwater Resources

8.1 Influence on Shallow Groundwater

It is anticipated that the proposed OOPD will increase recharge to the underlying Quaternary-Tertiary deposits and regolith. Increased recharge over the area of the OOPD (3.7% of total rainfall) could result in groundwater mounding in the order of 16m below the OOPD, and up to 5m to the south-west within the nearby Isaac River Alluvium. Increased groundwater levels in the alluvium and regolith of up to 1m could extend up to 6 km downstream and 4 km upstream along the Isaac River floodplain from the OOPD.

The change (increase) in flux to the alluvium along the affected reach of the Isaac River has been estimated at approximately 0.09 ML/day (~1 L/s) as a consequence of the OOPD.

8.2 Potential Impacts on Groundwater Users

8.2.1 Private Water Supply Bores

Previous bore census' in the vicinity of DNM have identified a number of potentially active private water supply bores to the south and south and south-west of the proposed OOPD (**Figure 5-11** and **Table 8-1**). These bores are in the zone of predicted groundwater level increases resulting from the OOPD. Predicted increases in the standing water levels at the location of these bores as a result of the OOPD are presented in **Table 8-1**.

Table 8-1 Predicted Increase in Standing Water Levels at Local Water Supply Bores

RN	Bore Name	Easting ¹	Northing ¹	Depth (m)	Purpose	Geology	In use?	Predicted change in water table at location
Unregistered	Knob Hill 1	631005	7553874	-	Unknown	Tertiary	Yes	+2.8m
Unregistered	Knob Hill 2	630431	7554061	-	Unknown	Tertiary	Back-up	+2.0m
Unregistered	Winnet Bore	634791	7550023	-	Unknown	Alluvium	-	+2.2m
162826	Bore 9 / House Bore	633886	7553064	-	Domestic	Alluvium	Yes	+4.2m

¹ GDA94z55

The current status of these bores is uncertain and the information regarding their use and status is based on previous studies. The predicted increases in standing water levels at the location of these bores assumes that 100% of the recharge rate applied across the area of the OOPD reaches the water table. This is a conservative assumption and consequently increases in shallow groundwater levels may be lower.

8.2.2 Ecological Sites

A desk-based GDE risk assessment for the Project (Watermark, 2025) identified that:

- Groundwater within and adjacent to the OOPD areas is typically too deep (>10 mbgl) to support most woody vegetation species, meaning that it will be reliant on soil moisture to support transpiration.
- Facultative groundwater dependence for riparian vegetation fringing the Isaac River is likely where deep-rooted vegetation can access alluvial groundwater resources on a permanent or seasonal basis, depending on its position relative to the channel and distance from the watercourse.

These findings are supported by other nearby GDE ground-truthing studies.



The Watermark study concludes that several factors indicate that the development of the OOPD will not significantly impact the ecohydrological function of groundwater-dependent vegetation within and surrounding the Project.

The higher infiltration rates to the spoil and retention of water within the spoil will result in groundwater mounding below the OOPD extending out to the south-west towards the Isaac. Shallower groundwater levels will result in an increase in groundwater availability within the tree root zone, as well as an extended period of potential groundwater availability.

8.3 Potential Impacts on Surface Water

The Isaac River is simulated as an ephemeral watercourse with occasional short duration flows to match observed river flow events and simulates these events through the predictive mining period for all mining operations in the model. For the recovery period, where stress periods increase in length to 50 years, episodic flow events cannot be simulated. However, the simulation of occasional flows in the Isaac through the long post-mining period is considered unlikely to significantly affect the migration of seepage from the OOPD into groundwater which is driven by the higher recharge rate over the area of the OOPD and the resulting mounding of groundwater beneath the OOPD.

Following periods of simulated Isaac River flow there is an increase in groundwater level in the Quaternary Alluvium due to leakage from the river. In the following stress periods, a small amount of water (up to 7 ML per year or 0.2 L/s) is simulated leaving the model via the river (baseflow) where the water table is greater than the riverbed elevation. The short term periods of baseflow following simulated river flow along the Isaac is slightly higher for the simulation including the OOPD, by up to 0.03 L/s (16% higher) for the maximum simulated short term period of baseflow.

8.4 Potential Impacts on Groundwater Quality

Modelling conducted for this assessment 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.

A geochemical assessment (Terrenus, 2025) including leachability data for coal measures waste rock samples from DNM that will form the OOPD presents a number of key findings:

- 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 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” acid and metalliferous drainage (AMD) source hazard, with carbonaceous spoil and coal posing a “Low-Moderate” AMD source hazard.
- Taking into account material proportions and expected proportion of potentially acid forming materials reporting to the proposed OOPD it is expected to pose a “Low” AMD hazard, with AMD generation rated as “Highly Unlikely”.

The data from the coal measures leachability tests has been reviewed as a very approximate guide to understanding water quality of seepage from the OOPD. However, it should be noted that these water extract tests use fine pulped materials (very high surface area) enabling a high level of reaction and dissolution and therefore may overestimate concentrations of substances leaching from the OOPD. Regardless of this, many analytes were below detection limits for the majority of leachate samples.



With regard to the WQOs for aquatic ecosystem projection in Isaac Groundwaters (Zone 34), the leachate test samples exceed pH at the 20th, 50th and 80th percentiles, for shallow (<30 m) and deep (>30 m) aquifers, but did not exceed any other parameters.

The RCM leachate quality is also significantly below livestock drinking water guideline values with the exception of selenium which matched the guideline of 0.02 mg/L at the 80th percentile.

The RCM leachate samples exceed the following Australian Drinking Water Guidelines guideline values:

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

The leachate quality exceeded the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) – 95% species protection for the following analytes:

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

Compared to the available Permian groundwater quality data, the leachate quality exceeded concentrations in the Permian groundwater samples for the following analytes (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.

Whilst the leachate data exceeds groundwater quality in the RCM for some parameters it is well below the WQOs for aquatic ecosystem protection in Isaac Groundwaters (Zone 34). In addition it is considered likely that the actual quality of water seeping from the OOPD will contain leached substances at concentrations well below the leachate test results due to the nature of the test methodology vs actual water – waste rock interactions in the OOPD.

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. Only seepage from the very western margin of the OOPD is likely to migrate away from DNM and the Pandora Pit void, to the west and south.

Solute transport modelling was undertaken which considered advection and dispersion of seepage entering groundwater beneath the OOPD and migrating to the west and south. The modelling provided dilution factors at the location of receptors for the alluvium and underlying Fort Cooper coal measures which were applied to the concentration of those substances in the waste rock leachate above guideline values. The modelling indicated that over a 977 year post mining timescale the extent of leachate seepage from the OOPD within groundwater had only reached the House Bore (~1 km south of the OOPD), and a short section of the Isaac River to the southwest of the House Bore. The diluted concentrations of the substances identified in the waste rock leachate above guideline values (Al, As, Mo, Se, Zn), at receptors, were combined with background concentrations in groundwater to give a prediction of the total concentration of these substances at the receptors.

The predicted total concentrations in Layer 1 and 2 at the House Bore are all below the guideline values for drinking water quality and stock watering, with most total concentrations falling below detection limits. The predicted total concentrations in Layer 1 and 2 at the Isaac River are also generally below detection limits with the exception of zinc which exceeds the freshwater guideline for 95% species protection at the 80th percentile. However, this exceedance is due to the background concentration and not the diluted concentration of seepage from the OOPD which is below detection limits.



Predicted total concentrations in Layer 9 (Fort Cooper overburden) are less relevant as this is not considered to be the source formation for the House Bore and it will not discharge baseflow to the Isaac River. However, the predicted total concentration of arsenic at the 80th percentile exceeds the freshwater guideline for 95% species protection

The solute transport modelling indicates that even with conservative assumptions (constant source concentration and no retardation), and after approximately 1000 years, seepage from the OOPD is unlikely to pose a significant risk to private water supplies or the Isaac River.

8.5 Potential Impacts on Final Void Lakes

The higher recharge applied to the OOPD is predicted to result in slightly higher predicted groundwater inflows to the adjacent Pandora Pit void and a slightly higher equilibrium void lake level. However, predicted void lake levels remain far below the crest level of the void, and the elevation of Quaternary and Tertiary sediments. The predicted equilibrium void lake level with and without the OOPD is 98 mAHD and 95 mAHD respectively (**Table 7-2**), indicating only a relatively minor increase as a result of the OOPD.

8.6 Risk Assessment

A risk assessment informed by the numerical modelling outcomes has been used to summarise the potential impacts on groundwater related receptors arising from the proposed OOPD based on the source > pathway > receptor approach and consideration of likelihood and consequence of potential risks being realised. For the two primary potential risks (impacts on groundwater levels and groundwater quality) the following were considered and recorded as part of the risk assessment:

- Brief description of the potential issue in terms of source > pathway > receptor.
- Description of the potential impact.
- Potential likelihood of the risk being realised.
- Potential consequence of the impact.
- Risk rating derived from likelihood vs consequence.

Descriptions of the categories that were used to rank the likelihood and consequence of potential risks being realised are provided in **Table 8-2** and **Table 8-3** respectively. The risk category is based a matrix of the combined consequence and likelihood of a risk being realised (**Table 8-4**), and the risk assessment is presented in **Table 8-5**.

Table 8-2 Likelihood Categories

Likelihood	Basis of Rating
Highly Likely	Expected to occur
Likely	More likely to occur than not to occur
Possible	As likely to occur as not to occur
Unlikely	More likely to not occur than to occur
Highly Unlikely	Very unlikely to occur even in the long term

Table 8-3 Consequence Categories

Rating	Environmental	Reputational / Legal & Compliance
5 Severe	Serious widespread environmental damage or harm that is permanent or irreversible and cannot be adequately remediated • Permanent loss of declared environmental values	• Formal expression of significant dissatisfaction by government • Sustained campaign by one or more international NGOs resulting in physical



Rating		Environmental	Reputational / Legal & Compliance
		- Irreversible contamination groundwater, or surface water - Long-term failure to meet environmental objectives or environmental protection policies - Likely to constitute serious environmental harm under the EP Act - Prohibitive remediation cost or technically unfeasible	- impact on the assets or loss of ability to operate - Major litigation / prosecution at corporate level
4	High	- Material environmental harm with long-term or widespread effects. Recovery possible only through significant intervention over extended timeframe. - Significant degradation of environmental values beyond the site boundary - Long-term contamination requiring active remediation - Measurable impacts on groundwater-dependent ecosystems or beneficial uses - Likely enforcement, regulatory intervention, or EA non-compliance - Recovery timeframe typically years to decades	- Broad societal concern and criticism - Negative media coverage at international level resulting in a Corporate statement within 24 hours - Investigation from government and/ or international (or high-profile) NGOs - Negative impact on share price - Major litigation / prosecution at Department level
3	Moderate	- Impact causes measurable but localised harm to environmental values. Temporary to medium-term and largely reversible through mitigation and management. - Short- to medium-term exceedance of environmental quality objectives - Localised impacts confined to the site or immediate surrounds - Temporary impacts to ecosystems or environmental values with recovery expected - Generally below the threshold of environmental harm, but operationally relevant	- Negative media coverage at national level over more than one day - Local Stakeholder action resulting in national societal scrutiny - Major litigation / prosecution at Operation level
2	Low	- Impact results in minor, short-term disturbance to environmental values. Natural short term recovery and no lasting or measurable effect on environmental objectives. - Minimal harm or low-level contamination - Natural recovery or routine low cost remediation sufficient - No breach of statutory criteria or environmental protection policies	- Negative local/ regional media coverage - Complaint received from an internal or external stakeholder - Regulation breaches resulting in fine or litigation
1	Negligible	- No change to environmental values and no environmental harm. - Impacts within licensed limits and EA conditions - No interaction with sensitive receptors or environmental values - No management or mitigation required beyond standard procedures	- No media interest - Regulation breaches without fine or litigation

The risk rating for each potential impact was determined by combining the likelihood and consequence of a risk being realised. The numerical modelling predictions allows quantification of the likelihood of a particular drawdown impact occurring. The likelihood vs consequence risk assessment matrix is presented in **Table 8-5**.

Table 8-4 Risk Ranking Matrix

		Likelihood				
		Highly Unlikely	Unlikely	Possible	Likely	Highly Likely
Consequence	5	Moderate	Moderate	High	High	High
	4	Low	Moderate	Moderate	High	High
	3	Low	Low	Moderate	Moderate	High
	2	Negligible	Low	Low	Moderate	Moderate
	1	Negligible	Negligible	Low	Low	Low



Table 8-5 Risk Assessment for the Proposed DNM OOPD

Source	Pathway	Receptor	Potential Impact	Likelihood	Consequence	Risk
Increased recharge through the OOPD resulting in locally elevated shallow groundwater levels	Outward migration of shallow groundwater mounding beneath the OOPD into Quaternary and Tertiary sediments to the west and south	Isaac River Alluvium and Isaac River	Increased groundwater levels in the alluvium and increased episodic baseflow to the Isaac River	Possible: The relatively high recharge rate applied to the OOPD, and the assumption that all recharge applied to the OOPD will reach the water table is conservative. Even with these conservative assumptions the change (increase) in episodic baseflow to the Isaac River is very small.	Negligible: The predicted increase in episodic baseflow is very low and probably undetectable. Slightly increased baseflow following episodic flows would not impact environmental values.	Low
		Landholder bores	Increased standing water levels in a number of local private bores (current status of bores unverified)	Possible: The relatively high recharge rate applied to the OOPD, and the assumption that all recharge applied to the OOPD will reach the water table is conservative, and it is considered unlikely that the predicted increases in standing water levels at these bores would be fully realised. Small increases may not be easily observable in active bores with large fluctuations in water levels. Water level increases may not occur within the operational life of the potentially affected bores.	Negligible: standing water level increases at these bores (if still in use) may be considered a benefit. Small increases may not be easily observable in active bores with large fluctuations in water levels.	Low
		Terrestrial GDEs along Isaac River	Groundwater availability	Highly Unlikely: Groundwater levels in the vicinity of the OOPD are predicted to increase as a result of increased infiltration to the waste rock compared to the natural in-situ ground.	Negligible: No negative consequence to TGDEs resulting from slightly elevated groundwater levels in the alluvium occurring over a long period.	Negligible
		DNM final voids	Increased final void lake levels.	Likely: The relatively high recharge rate applied to the OOPD, and the assumption that all recharge applied to the OOPD will reach the water table is conservative, but it is likely that there will be some increased inflow from the OOPD to the adjacent Pandora Pit void that will influence the final void lake level to some degree.	Negligible: The predicted increase in the Pandora Pit equilibrium lake level is 3m, but this is still far below the spill level of the void and the base of superficial sediments.	Low



Source	Pathway	Receptor	Potential Impact	Likelihood	Consequence	Risk
Seepage from the OOPD potentially containing elevated concentrations of contaminants.	Seepage to shallow groundwater below the OOPD and down hydraulic gradient migration to the west and south.	Isaac River Alluvium and Isaac River	Changes in groundwater quality in the alluvium and the episodic baseflow to the Isaac River	Possible: Particle tracking and conservative solute transport modelling indicates that substances seeping from the OOPD could reach the Isaac River Alluvium and a short section of the Isaac River over the very long term. However, this assessment involved conservative assumptions including: • The higher recharge applied to the OOPD all reaches the water table beneath the OOPD • The source term used for seepage from the OOPD is based on leachability tests that are likely to overestimate actual solute concentrations in seepage, certainly over the long term. • The solute transport modelling assumes a constant source and no retardation (advection and dispersion only)	Negligible: The predicted water quality impacts in the alluvium along a short reach of the Isaac River due to seepage from the OOPD are below detection limits.	Low
		Landholder bores	Changes in groundwater quality at private bores located down hydraulic gradient of the OOPD (status of bores unverified)	Possible: Particle tracking and conservative solute transport modelling indicates that substances seeping from the OOPD could reach one private bore (House Bore) located 1 km south of the OOPD over the long term (likely well beyond the operation life of the bore). The solute transport assessment included several conservative assumptions (outlined above) such that it is uncertain whether solutes in seepage from the OOPD could reach this bore even in the long term.	Low: The predicted water quality impacts at the House Bore due to seepage from the OOPD are generally below detection limits and do not result in exceedances of drinking water or stock water guidelines.	Low
		Terrestrial GDEs along Isaac River	Changes in groundwater quality.	Possible: The likely seepage quality from the OOPD will be below WQOs. Conservative solute transport modelling indicates that substances seeping from the OOPD could reach the Isaac River Alluvium and a short section of the Isaac River hosting TGDEs over the very long term. However, this assessment involved several conservative assumptions (outlined above). TGDEs along the Isaac River may access shallow groundwater in the Quaternary and Tertiary sediments facultatively.	Negligible: The predicted water quality impacts occurring over the very long term in the alluvium at the Isaac River are below detection limits.	Low
		DNM final voids	Changes to Pandora final void water quality.	Possible: Seepage from the OOPD is likely to enter the Pandora Pit void and may have some effect on water quality.	Negligible: The void water quality will reduce over time regardless of the OOPD due to evapo-concentration of dissolved substances. Changes to void water quality resulting from the presence of the OOPD are considered unlikely to be detectable,	Low



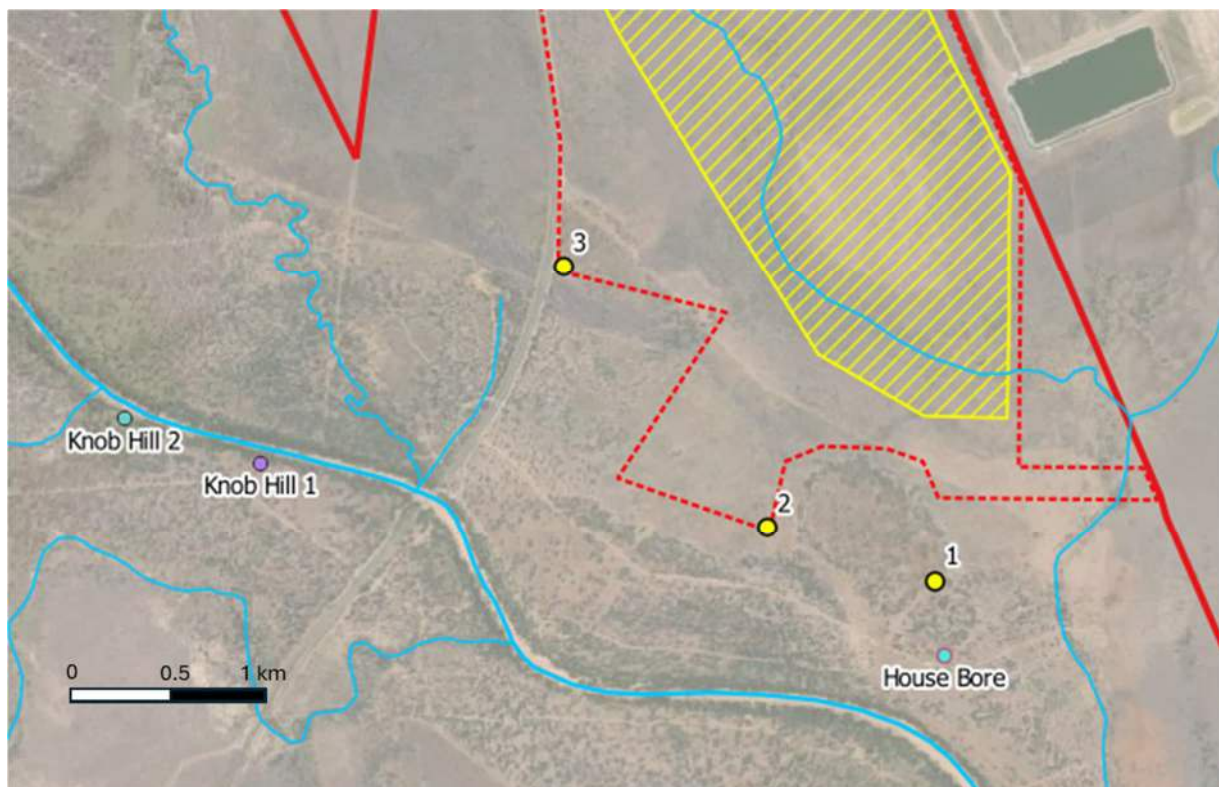
9.0 Recommendations

Whilst the groundwater impact assessment indicates that the risk of significant contamination of groundwater as a result of the OOPD is low, it is recognised that there is the potential for seepage from the OOPD to enter groundwater and migrate to the west and south. There is currently no groundwater monitoring between the OOPD and the Isaac River to the southwest of the OOPD. Given the potential for migration of seepage affected groundwater to the west and south of the OOPD, and to inform the general hydrogeological understanding of the alluvium / Tertiary / regolith to the southwest of DNM we propose the installation of three monitoring bores at the provisional locations in **Figure 9-1**.

The three locations proposed have been selected based on the solute transport modelling and the location of groundwater receptors (private bores and the Isaac River), and the Mining Lease extent. Locations 2 and 3 have been positioned inside the mining lease in order to facilitate installing them more quickly (i.e. without the need for land access negotiations), and so that they remain under the control of DNM. Location 1 positioned between the OOPD and the House Bore is outside the Mining Lease the final position will be subject to negotiation with the landholder.

The bores would target the saturated water table either in the alluvium or the regolith if the alluvium was found to be thin and dry (or absent). As the geological and hydrogeological conditions are uncertain at these locations bore depths and screened intervals would be confirmed during the drilling process. It is also recommended that allowance be made for installing two bores at one or more of these locations in the event that the alluvium is dry at the time of drilling, with a shallower bore installed to the base of the alluvium and a deeper bore screened across the saturated water table.

Figure 9-1 Proposed location of Groundwater Monitoring Bores to the South and West of the OOPD



It is also recommended that bore assessments are undertaken for the three private bores in closest proximity to the proposed OOPD (Knob Hill Bores 1 and 2, House Bore). This would involve assessing the current condition of the bore with landowner interviews to obtain any available details about the bore and how it's used, including:

- Depth and construction details, age of bore, condition, servicing
- Rest water level
- Bore yield (seasonal variations, reduced yield over time)
- Water use (livestock watering, potable supply etc)
- Water consumption (how many livestock it supports, seasonal variation in use etc)
- Water quality issues
- Collection of a sample for laboratory analysis

This information can be used as a baseline for future reference against which potential impacts from mining activity can be assessed. A more detailed understanding of the construction of these bores may also be used to inform the construction / screen depths of the proposed monitoring bores.

There are a number of ways in which it might be possible to reduce seepage from the OOPD to groundwater, reduce infiltration into the OOPD and promote the drainage or removal of water from the OOPD that may help reduce the potential for impacts on groundwater:

- Compaction of the natural ground across the footprint of the OOPD towards Pandora Pit to reduce infiltration to the natural ground promote drainage of water from the base of the waste rock.
- Water seeping from the toe of OOPD could be collected by a perimeter toe drain, with sumps where water can be removed to an appropriate storage dam or for treatment.
- To facilitate the flow of water from the base of the OOPD to a perimeter toe drain, the following could be considered:
 - The selection of coarser material for the base layer of the OOPD
 - The placement of an engineered drainage layer across the base of the OOPD
 - The installation of drains across the OOPD footprint beneath the waste rock.
- Compaction of the waste rock as each lift is placed. This would reduce the permeability of the waste rock material and therefore, reduce infiltration to the OOPD.
- Appropriate selection of the topsoil layer and profiling of the OOPD may also promote runoff rather than infiltration to the waste rock.

It is acknowledged that there will be overriding engineering, geotechnical and stability considerations that take precedence in the design of the OOPD.



10.0 Conclusions

The groundwater impact assessment for the proposed DWIP OOPD concludes that the potential risk to local groundwater environmental values is low.

Due to the more permeable and unstructured nature of waste rock that will form the OOPD the anticipated higher infiltration rate, may result in greater recharge to the underlying strata. Numerical modelling of higher recharge over the OOPD results in groundwater mounding beneath the OOPD. Whilst much of the additional recharge to the OOPD will be captured by the adjacent Pandora Pit residual void, which acts as a strong groundwater sink, particle tracking and solute transport modelling indicates the potential for some off-site migration of seepage from the OOPD to the west and south through the shallow unconsolidated sediments and the underlying Fort Cooper coal measures.

An assessment of the potential extent and concentration of solutes in groundwater arising from the OOPD determined that over the long term (977 years) seepage from the OOPD may reach one private bore (House Bore), and a short reach of the Isaac River. However, the diluted concentrations of solutes in seepage from the OOPD at these locations would not be significant nor would it exceed the relevant water quality guidelines for these receptors.

In addition, this assessment of seepage migration from the OOPD includes several conservative assumptions:

- The assessment assumes that the high recharge rate applied to the OOPD will all reach the water table below the OOPD. In reality, whilst recharge to the sediments below the OOPD may be increased it is likely that some or a significant portion of the infiltration to the spoil may seep from the toe of the OOPD where it can be captured in drains.
- Waste rock leachability data for DNM (Terrenus, 2025) was adopted as the quality of water seeping from the OOPD to groundwater. However, the spoil leachability test method provides a poor proxy for water rock interactions within the OOPD and is considered to overestimate the concentrations of substances that may be present within seepage from the OOPD, certainly over the long term.
- The solute transport model assumes that the “source term” is constant i.e. that the concentrations of solutes seeping from the OOPD do not decline, even over the very long term but remain at the concentrations adopted from the waste rock leachability tests.
- The solute transport model considers advection and dispersion only, no retardation of contaminants was considered that might reduce concentrations or retard their rate of migration.

Even with these conservative assumptions, after 977 years the extent of seepage migration to the west and south of the OOPD was limited with dilution of solutes generally reducing concentrations below detection limits at groundwater receptors.

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 the north of DNM the Titan East final void also acts as a sink for groundwater with a predicted final void lake level of 121 mAHD, approximately 70m below the pre-mining groundwater level.



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Appendix A

A.1 IESC Groundwater Resources Information Checklist



Relevant Items	Report section
Context and conceptualisation	
Describe and map geology at an appropriate level of horizontal and vertical resolution including: – definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data. – geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	Section 4 - Geology
Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Geological maps and sections are included in Section 4 . Groundwater hydrographs and contours for the RCM are presented in Section 5 .
Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. – Site-specific studies (e.g. geophysical, coring/ wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). – Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Section 4.3 provides a discussion on structural geology. The hydrogeological effects of faulting are discussed in Section 5.3.3.
Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 5.5 provides a general discussion groundwater quality. Environmental tracer studies have not been completed for this assessment.
Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 5.3 presents site specific hydraulic properties as well as a larger data set of hydraulic conductivity values for the same lithologies gathered from across the Bowen Basin.
Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Section 5.4
Provide time series level and water quality data representative of seasonal and climatic cycles.	Hydrographs are presented in Section 5.4 , Section 5.5 summarises the available groundwater quality data
Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Discussion of alluvial groundwater and potential GW-SW interaction is provided in Section 5.4.1 and Section 6.2.1
Analytical and numerical modelling	
Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	A Groundwater Modelling Technical Report (Appendix E) has been prepared and provides a detailed description of the numerical model.
Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Section 6.0
Undertaken groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	The numerical modelling for this project was peer reviewed has been undertaken in accordance with the Australian Groundwater



Relevant Items	Report section
	Modelling Guidelines as outlined in Appendix E .
Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	See the Groundwater Modelling Technical Report (Appendix E)
Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	See the Groundwater Modelling Technical Report (Appendix E)
Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Middlemis and Peeters 2018).	See the Groundwater Modelling Technical Report (Appendix E)
Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	See the Groundwater Modelling Technical Report (Appendix E)
Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	See the Groundwater Modelling Technical Report (Appendix E)
Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	See the Groundwater Modelling Technical Report (Appendix E) . See also summary modelling Section 7.0 .
Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters 2018).	
Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units.	See the Groundwater Modelling Technical Report (Appendix E) . See also summary modelling Section 7.0 .
Provide a program for review and update of models as more data and information become available, including reporting requirements.	A program for future model updates hasn't been provided but can be undertaken as additional information becomes available.
Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	See the Groundwater Modelling Technical Report (Appendix E) , Section 4.0
Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Not relevant to the Project which does not include any change to the extent or depth of mining. Predicted changes to groundwater levels in the vicinity of the OOPD are described in Section 4.0 of the Groundwater Modelling Technical Report (Appendix E) , and summarised in Section 7.0 .
Undertake model verification with past and/or existing site monitoring data.	Model calibration is described in
Impacts to water resources and water-dependent assets	
Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: – any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. – the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. – the potential impacts on hydraulic and storage properties of hydrogeological units.	Predicted hydrogeological effects of the OOPD are described in Section 7 and Section 8 , as well see also the Groundwater Modelling Technical Report (Appendix E) ,



Relevant Items	Report section
including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. – the possible fracturing of and other damage to confining layers. – For each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	
Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Discussion of potential groundwater receptors Section 5.6 and potential impacts on these receptors in Section 7.10 and 8.0 . Site geology and the formations mined is discussed in Section 4.0 and 5.0
For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Discussion of potential impacts on groundwater receptors is presented in Section 7.10 , and 8.0 including a qualitative risk assessment informed by the numerical modelling.
Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Section 5.5.
Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	The numerical model (and impact predictions for the OOPD) includes all currently approved mining and restoration at neighbouring mines.
Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	The risks to groundwater resources from the OOPD are considered sufficiently low that no mitigation requirements are proposed.
Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	
Data and Monitoring	
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Groundwater quality statistics based on long term monitoring are presented in Section 5.5
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	
Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	The current DNM groundwater monitoring program is presented in Section 5.2.
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZG 2018) and relevant legislated state protocols (e.g. QLD Government 2013).	SLR have not completed any groundwater sampling at DNM, but we understand that ongoing groundwater sampling is compliant with relevant National and state protocols.
Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Additional groundwater monitoring is recommended in Section 9.0.



