

Memorandum

Date	11 November 2020
To	Chris Wake, Manager Environmental Services, Department of Environment and Science
From	Trudy Mazucco, Principal Closure Planning
Subject	Progressive Rehabilitation and Closure Plan BMA – Daunia Mine

Purpose:

The purpose of this memo is to provide context and background information for the purpose of completing a Progressive Rehabilitation and Closure Plan (PRCP) for the Environmental Authority (EA) noted below. This information is intended to facilitate the issuing of a notification for PRCP for this EA.

Environmental authority number:	EPML00561913
Environmental Authority Holders:	• BM Alliance Coal Operations Pty Ltd (BHP Billiton Mitsubishi Alliance (BMA)) • BHP Coal Pty Ltd • BHP Queensland Coal Investments Pty Ltd • Mitsubishi Development Pty Ltd • QCT Investment Pty Ltd • QCT Mining Pty Ltd and • QCT Resources Pty Limited • Umal Consolidated Pty Ltd.

PRCP Guideline analysis:

PRCP Requirement	BHP information submission for review
Introduction	Daunia Mine (DNM) is an open cut strip mine located 60 km east of the town of Moranbah in the Bowen Basin, Central Queensland. The mine is situated south of the Peak Downs Highway, directly to the east of the Poitrel Coal Mine (managed by BHP Billiton Mitsui Coal Pty Ltd (BMC)) and south of the Millennium Coal Mine (owned and operated by Peabody Millennium Pty Ltd) (Millennium). The site is operated on the mining leases (MLs) ML1781 (SA 2 and 3), ML70115 and ML70116. Mining operations use truck and shovel equipment to produce metallurgical coal. The coal seams are mined from pits located on ML70115 and ML1781, but due to

	the complex structural setting of the coal deposit, the deposit is divided into a series of individual pits and is not a traditional strip mine with all pits advancing in the same direction. ML70166 (referred to as 'Red Mountain') is situated to the west of the current mining pit - this ML is mostly undisturbed and includes the DNM CHPP, New Chum Creek and a rail corridor. BM Alliance Coal Operations Pty Ltd (BHP Billiton Mitsubishi Alliance (BMA) is the principal holder of EA EPML00561913 with the joint holders mentioned above.
Rehabilitation Planning Part	
Project Description	Mining at DNM involves the removal and stockpiling of topsoil, drilling and blasting of overburden and interburden waste material and truck/shovel to remove the waste material. Run-of-mine (ROM) coal is transported to the on-site Coal Handling and Preparation Plant (CHPP). Waste material is placed predominately in in-pit spoil dumps. Fine rejects from the CHPP are dewatered via belt press filters. The fine and coarse rejects are hauled and co-disposed within the mining spoil. A conveyor transfers product coal from the CHPP to the Train Load-Out (TLO) area located on Millennium ML70312. Product coal is transported by rail to the Hay Point Coal Terminal for export.
Mining Activities	The activities at DNM include: • Open cut mining • In-pit and out-of-pit spoils dumps (including co-disposal) • Mine water dams • Coal stockpile areas • Coal handling and preparation plant (CHPP) • Run-of-mine (ROM) area • Train load-out (TLO) area, with spur and loop • Haul roads and laydown areas DNM has no creek diversions, tailing storage facilities (TSFs), or underground workings.
Existing Rehabilitation	Rehabilitation commenced at DNM during 2013 and has been completed routinely each year. To date 127 ha have been re-profiled, covered and seeded.
PMLUs	The predominant pre-mining land use at DNM was cattle grazing. As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, BHP has transitional arrangements for DNM for the post-mining land uses (PMLUs) listed in Table E1 of the EA, which include: • Cattle grazing • Dryland cropping • Woodland habitat • Water storage • Watercourse The completion criteria in Table E1 will also be transitioned to milestone criteria in the PRCPs. The location, extent and viability of these PMLUs will be detailed in the PRCP.

NUMAs	As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, BHP has transitional arrangements for residual voids as NUMAs for DNM. Due to the complex structural setting of the coal deposit and the resultant pit design, a number of final voids will be located over the lease area. Void wall stability will determine the extent of a NUMA as it may extend past the mined void crest if necessary to allow for management of wall instability. This will be assessed for each void at DNM. As the EA does not state the area or location of the proposed NUMAs, the PRCP will include detail on how the total area of land as NUMAs will be minimised, as well as how the location will minimise risk to environment, as required in the guideline. The PRCP will also demonstrate no environmental harm is caused beyond the transitioned NUMAs.
Voids in Floodplains	As the transitioned NUMAs are not identified in land outcome documents, flood modelling in accordance with the <i>BHP PRCP Flood Modelling Position – 23072020</i> memo will be completed.
Community Consultation	As a transition site there is no requirement for consultation prior to submission of PRCP. However, BHP will follow an engagement plan over the life of the operation, in line with current internal stakeholder engagement frameworks.
Rehabilitation and Management Methodology	
Hydrogeology	The development of the rehabilitation and management methodologies for DNM relating to groundwater will utilise the existing groundwater monitoring network and monitoring data to complete the following: • update/calibrate/combine the existing numerical hydrogeological model as appropriate pending available time frames for PRCP delivery; • develop hydrological conceptual model for the point of closure; and • develop groundwater criteria where sufficient data is available.
Flooding	DNM falls within a sub-catchment of the Fitzroy Basin, which includes the major tributaries of the Isaac, Connors and Comet Rivers. As per the <i>BHP PRCP Flood Modelling Position – 23072020</i> memo, BHP will use a risk-based approach to determine if flood modelling is required for DNM. Where the risk-based approach identifies a flood modelling requirement, the modelling will be completed in line with the previous memorandum (22 June 2020) Flood Plain Modelling and Flood Risks.
Soil and Capping Material	As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, the soil and capping assessment at DNM will include: • Topsoil quality, quantity, treatments and management. • Availability and quantity of any other capping material required. • Strategies to address any deficits.

Waste Characterisation	Mine waste at DNM includes: • Overburden / interburden. • Mixed plant rejects comprising fine and coarse rejects. Historic geochemical and physical (for sodicity and dispersivity) characterisation test work will represent the bulk of the data utilised to assess the geochemical risk posed by key mine waste domain and landforms, as detailed in <i>BHP PRCP Geochem DES Update 26082020</i>, including site specific and data collected from other BHP sites extracting coal from the Moranbah Coal Measures (<i>PRCP memos – comments and feedback 25092020</i>). In addition to the historic samples listed in <i>BHP PRCP Geochem DES Update 26082020</i>, the following additional data are currently available: • 138 core samples, overburden • 8 fine and coarse rejects No further overburden sampling and testing is planned, but opportunistic sampling / testing will be conducted if / when possible as per Geology resource definition drilling schedule (<i>BHP PRCP Geochem DES Update 26082020</i>). Ongoing fine and coarse reject sampling testing will be conducted in FY21 to augment geochemical knowledge for these materials type (<i>BHP PRCP Geochem DES Update 26082020</i>). Sample prep and analytical tests varied slightly between the different sampling programs (and between drill-hole samples vs reject samples). However, the fundamental geochemical and physical (i.e. sodicity and dispersivity) characterisation methodology was the same or similar between programs. Therefore, all data is relevant and will be used in the assessment. Lab-work generally undertaken in stages includes, one or a combination of the following: • Stage 1 (screening – typically all samples): pH & EC (1:5 water extracts on pulps); total sulfur (S); • Stage 2 (typically selected samples): sulfur speciation; net acid generation (NAG); total metals; soluble metals (1:5 water extracts on pulps); exchangeable cations; Emerson Aggregate, acid neutralising capacity (ANC). • Stages 3+ (selected samples): acid buffering characterisation curves (ABCC); Extended Boil NAG; Sequential NAG; Kinetic-NAG; Quantitative XRD; ASLP Leaching; OxCon Historic and new data for all mine waste will be reinterpreted to provide a consistent understanding and definition of the geochemical and physical risk (i.e. AMD and salinity/dispersivity, as applicable) across key material domains including pit wall geochemical stability. One of the outcomes of the geochemical and physical characterisation will be a classification system that will confidently identify beneficial and problematic waste from a chemical and physical stability perspective. The PRCP will detail the waste categories to ensure problematic waste, based on both chemical and physical behaviour, is managed at DNM. Conceptual waste categories at DNM are shown in the table below but modification may be made in the PRCP submission once the final assessments have been completed:
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	<table><tr><th>Waste Category</th><th>Final Placement Guideline</th></tr><tr><td>Tertiary/ Weathered Permian waste</td><td> - Fine textured, often saline and sodic - Not to be placed on outside of final landforms unless testing shows it is acceptable or there is no alternative material - If used on the outside of the landforms, ameliorants to be considered for sodic materials to limit dispersion </td></tr><tr><td>Permian waste</td><td> - Rockier, lower in salinity and sodicity - To be planned and placed on the outside of the dumps - Preference for sandstone on the outside of the dumps if available </td></tr><tr><td>Rock</td><td> - Basalt and competent sandstone - Can be used on outside slopes to achieve steeper, more stable landforms (rock mulching) </td></tr><tr><td>AMD potential: Carbonaceous material (carbonaceous overburden/ interburden, coarse rejects, co-disposal, tailings, thin partings)</td><td> - To be covered with fresh Permian </td></tr></table> A risk based approach will be used to determine what work is required to characterise existing waste dumps if issues are identified.	Waste Category	Final Placement Guideline	Tertiary/ Weathered Permian waste	- Fine textured, often saline and sodic - Not to be placed on outside of final landforms unless testing shows it is acceptable or there is no alternative material - If used on the outside of the landforms, ameliorants to be considered for sodic materials to limit dispersion	Permian waste	- Rockier, lower in salinity and sodicity - To be planned and placed on the outside of the dumps - Preference for sandstone on the outside of the dumps if available	Rock	- Basalt and competent sandstone - Can be used on outside slopes to achieve steeper, more stable landforms (rock mulching)	AMD potential: Carbonaceous material (carbonaceous overburden/ interburden, coarse rejects, co-disposal, tailings, thin partings)	To be covered with fresh Permian
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Landform Design	The main structures of the DNM final landform include spoil dumps and final voids. The spoil dumps include mined waste and co-disposed reject material. The PRCP will include the detail for landform design as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i> .										
Cover Design	A risk-based approach will be used to determine areas that may require a cover design.										
Water Management	As outlined in the BHP (25 September 2020) <i>Groundwater scope of work to satisfy PRCP requirements</i> memorandum, the indicated timeframe for transitional PRCP delivery will not provide for the completion of Detailed Site Investigations and fate and transport modelling. However, a Preliminary Site Investigation undertaken in accordance with the National Environment Protection Council (1999) National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM Rev: 2013), will be undertaken to assist with the understanding of the contaminants that may pose a risk to environmental values. This investigation will provide an initial conceptual site model and an understanding of additional investigation requirements. The design of the final landforms will include, where required, infiltration and seepage intervention and collection controls, where these measures are deemed to be required. There are no creek diversions at DNM.										
Revegetation	The PRCP will include the detail for revegetation as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i> .										
TSFs	Not applicable – no TSFs at DNM.										
Voids	Voids at DNM are progressively backfilled with overburden and mine waste as mining advances during the operational stage. At closure, only the final void (location of final cut) will remain. BHP will use a risk-based approach to assess each final void at DNM. The PRCP will include the detail for voids as per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i> .										

	Void closure planning relating to water resources will include the following: • An update of the hydrogeological model; • Void water balance; • Void water quality prediction; • Hydrologic conceptual site model; and • A risk based approach to assess the potential impacts of flooding and the need for any flood modelling.																				
Underground Mining	Not applicable - DNM is not an underground operation.																				
Infrastructure	The main on-site infrastructure at DNM will include: CHPP, TLO facility, permanent and temporary buildings, bitumen roads and car parks, mine industrial area (MIA) (workshops, sheds etc.), ROM pad and coal stockpiles (conveyors, stackers, etc.). As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, all required information on decommissioning or retainment of infrastructure will be included.																				
Risk Assessment																					
Risk assessment	To be completed.																				
Rehabilitation Trails and Monitoring and Maintenance	Rehabilitation trials will be conducted throughout the life of mine but will not be including in the PRCP. Monitoring and maintenance will be based on current BHP processes. As per the <i>BHP PRCP Landform and Rehabilitation DES memo Final 28082020</i>, all required information will be included.																				
PRCP Schedule																					
PRCP schedule	To be completed as part of the PRCP.																				
Other Matters for Consideration																					
Pandora Pit EA	The Pandora Pit Development Project is currently underway which will require an EA amendment. The expected submission date for this EA amendment is early November 2022 (with an estimated approval: July 2023).																				
Study timelines	<table> <tr> <th>Site Note: Times lines based on work packages discussed in subject specific memos</th><th>Daunia Mine</th></tr> <tr> <td>PRCP Submission</td><td></td></tr> <tr> <td>- Flood interaction studies</td><td>Apr-23</td></tr> <tr> <td>- Diversions</td><td></td></tr> <tr> <td>- Groundwater</td><td>Apr-23</td></tr> <tr> <td>- Stakeholder engagement</td><td>Feb-21</td></tr> <tr> <td>- Landform and Rehabilitation design</td><td>Feb-22</td></tr> <tr> <td>- Geochemistry</td><td>Sep-21</td></tr> <tr> <td>- TSFs</td><td></td></tr> <tr> <td>- Consolidation, report writing and submission</td><td>Jul-23</td></tr> </table>	Site Note: Times lines based on work packages discussed in subject specific memos	Daunia Mine	PRCP Submission		- Flood interaction studies	Apr-23	- Diversions		- Groundwater	Apr-23	- Stakeholder engagement	Feb-21	- Landform and Rehabilitation design	Feb-22	- Geochemistry	Sep-21	- TSFs		- Consolidation, report writing and submission	Jul-23
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Recommendation:

Review and consider the above information as a basis for PRCP compilation for DNM.

Yours sincerely

Trudy Mazucco
Principal Closure Planning
0475 300 433

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Memorandum

Appendix 1: Daunia Mine - Supporting Maps



Figure 1: BHP Operations in Queensland

Permit

Environmental Protection Act 1994

Environmental authority EPML00561913

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00561913

Environmental authority takes effect on 30 June 2022

Environmental authority holder(s)

Name(s)	Registered address
QCT MINING PTY. LTD.	Level 16, 480 Queen Street BRISBANE CITY QLD 4000
Mitsubishi Development Pty Ltd	Level 16, 480 Queen Street BRISBANE CITY QLD 4000
BHP COAL PTY LTD	Level 14, 480 Queen Street BRISBANE CITY QLD 4000
QCT Resources Pty Limited	Level 16, 480 Queen Street BRISBANE CITY QLD 4000
QCT INVESTMENT PTY. LTD.	Level 16, 480 Queen Street BRISBANE CITY QLD 4000
Umal Consolidated Pty Ltd	Level 14, 480 Queen Street BRISBANE CITY QLD 4000
BHP Queensland Coal Investments Pty Ltd	Level 14, 480 Queen Street BRISBANE CITY QLD 4000

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Schedule 3 13: Mining black coal	ML1781 ML70115 ML70116
Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML1781 ML70115 ML70116
Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t	ML1781 ML70115 ML70116
Ancillary 62 - Resource recovery and transfer facility operation 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing- (c) category 2 regulated waste	ML1781 ML70115 ML70116
Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ML1781 ML70115 ML70116

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days);

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

- a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or
- b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or
- c) otherwise-on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Sustainable Planning Act 2009* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Alison Cummings
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Date issued: 30 June 2022

Enquiries:
Coal & Gemstone Mining
Department of Environment and Science

Phone: 07 4987 9320
Email: crmining@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Conditions of environmental authority

Schedule A: General	
Condition number	Condition
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	Prevent and /or minimise likelihood of environmental harm In carrying out the environmentally relevant activities, the environmental authority holder must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused. Any environmentally relevant activity, that, if carried out incompetently, or negligently, may cause environmental harm, in a manner that could have been prevented, shall be carried out in a proper manner in accordance with the conditions of this environmental authority.
A3	Maintenance of measures, plant and equipment The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; c) that such measures, plant and equipment are operated in a proper manner; and d) that all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
A4	Monitoring and records Except where specified otherwise in another condition of this environmental authority, all monitoring records and reports required by this environmental authority must be kept for a period of not less than five (5) years.
A5	Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person(s).
A6	Upon request from the administering authority, copies of monitoring results, records, registers, management plans and reports required by the conditions of this environmental authority must be made available and provided to the administering authority within ten (10) business days or an alternative timeframe agreed between the administering authority and the environmental authority holder.
A7	Notification of emergencies, incidents and exceptions The environmental authority holder must notify the administering authority by written notification within twenty-four (24) hours after becoming aware of any emergency or incident that results in the release of contaminants not in accordance, or reasonably expected to be not in accordance, with the conditions of this environmental authority.

A8	Within ten (10) business days following the initial notification under condition A7, or the receipt of monitoring results associated with the notification made under condition A7, whichever is the latter, the environmental authority holder must provide further written advice to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
A9	Complaints The environmental authority holder must record all environmental complaints received about the mining activities, including: a) name, address and contact number for of the complainant; b) time and date of complaint; c) reasons for the complaint; d) investigations undertaken; e) conclusions formed; f) actions taken to resolve the complaint, including the use of appropriate dispute resolution if required; g) any abatement measures implemented; and h) person responsible for resolving the complaint.
A10	A register of alternative arrangements must be established and maintained by the environmental authority holder. The register must include: a) the location to which the alternative arrangement applies; b) the period of the alternative arrangement; c) details about the particular environmental nuisance impact or impacts the arrangement is for; and d) details about the mitigation measures, where relevant.
A11	Monitoring on request When requested by the administering authority, the environmental authority holder must investigate any nuisance, or contaminant release, or environmental harm, or complaint that is neither frivolous nor vexatious in the opinion of the authorised person, by: a) undertaking the monitoring specified by the administering authority; b) undertaking the monitoring in the timeframe nominated or agreed to by the administering authority; c) completing an analysis and interpretation of the monitoring results; and d) implementing abatement measures, where required.

A12	The results of the investigation undertaken in accordance with condition A11 must be provided to the administering authority within twenty (20) business days of completion of the monitoring timeframe in accordance with condition A11(b) , or a longer timeframe agreed to by the administering authority.
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Schedule B: Air	
Condition number	Condition
B1	Odour nuisance The release of noxious or offensive odour or any other noxious or offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
B2	If the administering authority determines odour released from the mining activities to constitute an environmental nuisance, the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.
B3	Dust nuisance The release of dust or particulate matter or both resulting from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
B4	Monitoring of dust and particulate matter resulting from the mining activities, undertaken in accordance with condition A11, must be carried out at a place relevant to the potentially affected sensitive place or commercial place and must not exceed the following levels when measured at any sensitive place or commercial place: a) dust deposition, measured as total insoluble matter, of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 <i>Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method</i>. b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either: i) Australian Standard AS3580.9.6 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 high volume sampler with size selective inlet – Gravimetric method</i>; or ii) Australian Standard AS3580.9.8 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 continuous direct mass method using a tapered element oscillating microbalance analyser</i>; or iii) Australian Standard AS3580.9.9 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 low volume sampler – Gravimetric method</i>; or iv) Australian Standard AS3580.9.11 <i>Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM10 beta attenuation monitors</i>. <i>NOTE: Exceedances due to events that cannot be managed by the environmental authority holder, such as bushfires, fuel reduction burning for fire management purposes or dust storms, would not be considered to be in breach of condition B4 if the environmental authority holder can demonstrate that the exceedance was caused by such events.</i>

B5	If monitoring, undertaken in accordance with condition A11 , indicates exceedance of the relevant limits in condition B4 , the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.
B6	Monitoring of ambient weather conditions A weather station for continuous representative monitoring and recording of wind direction and wind speed must be installed and operated on the mining leases.
B7	Background dust and particulate matter monitoring The environmental authority holder must develop and implement a background dust and particulate matter monitoring program. The program must be able to detect a significant change to dust levels to sensitive receptors due to the activities that are part of this mining project.
B8	The program must include, but not be limited to, the details as specified in Table B1 (Background Dust and Particulate Matter Monitoring) . <i>NOTE: Monitoring must be carried out in accordance with Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.</i>

Table B1 (Dust Deposition Monitoring)

Air Quality Determination	Easting (GDA94)	Northing (GDA94)	Monitoring Point Description
Particulate matter deposition rate in milligrams per square metre per day (averaged over one month)	633898	7552925	Olive Downs Residence
	639553	7558511	Daunia Station Residence

Schedule C: Noise and Vibration	
Condition number	Condition
C1	Noise nuisance Noise from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
C2	Noise is not considered an environmental nuisance under condition C1 if monitoring shows that noise does not exceed the limits in Table C1 (Noise Limits) , at any sensitive place or commercial place.
C3	Noise monitoring Noise monitoring, undertaken in accordance with condition A11 , must comply with the most recent version of the administering authority's <i>Noise Measurement Manual</i> , and must include the following descriptors, characteristics and conditions: a) L_{Aeq}, adj, 10 mins; b) L_{Amax}, adj, 10 mins; c) the level and frequency of occurrence of impulsive or tonal noise; d) atmospheric conditions including wind speed and direction; e) effects due to extraneous factors such as traffic noise; and f) location, date and time of recording.
C4	If monitoring, undertaken in accordance with condition A11 , indicates exceedance of the relevant limits in Table C1 (Noise Limits) , the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.

Table C1 (Noise Limits)

Noise Level dB(A)	Monday to Sunday (including public holidays)		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
Sensitive Place			
L_{Aeq} , adj, 10 mins	B/g + 5	B/g + 5	B/g + 3
L_{Amax} , adj, 10 mins	B/g + 10	B/g + 10	B/g + 8
Commercial Place			
L_{Aeq} , adj, 10 mins	B/g + 10	B/g + 10	B/g + 5
L_{Amax} , adj, 10 mins	B/g + 15	B/g + 15	B/g + 10

C5	Vibration nuisance Vibration from the mining activities must not cause an environmental nuisance, at any sensitive place or commercial place.
C6	Vibration is not considered an environmental nuisance under condition C5 if monitoring shows that vibration does not exceed the limits specified in Table C2 (Vibration Limits) .
C7	Airblast overpressure nuisance The airblast overpressure level from blasting operations on the mining leases must not cause an environmental nuisance, at any sensitive place or commercial place.
C8	Airblast overpressure is not considered an environmental nuisance under condition C7 if monitoring shows that airblast overpressure does not exceed the levels specified in Table C3 (Airblast Overpressure Level) .
C9	Vibration and/or airblast overpressure monitoring Vibration and/or airblast overpressure monitoring, undertaken in accordance with condition A11, must comply with the most recent version of the administering authority's <i>Noise Measurement Manual</i>, and must include the following descriptors, characteristics and conditions: a) location of the blast(s) within the mining area (including which bench level); b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and c) location, date and time of recording.
C10	If monitoring, undertaken in accordance with condition A11 , indicates exceedance of the relevant limits in Table C2 (Vibration Limits) or Table C3 (Airblast Overpressure Level) , the environmental authority holder must immediately implement abatement measures so that emissions from the mining activities do not result in further environmental nuisance.

Table C2 (Vibration Limits)

Location	Vibration Measured
Sensitive place or commercial place	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

Table C3 (Airblast Overpressure Level)

Location	Airblast Overpressure Measured
Sensitive place or commercial place	115 dB (Linear peak) for nine (9) out of ten (10) consecutive blasts and not greater than 120 dB (Linear peak) at any time. Blasting is only to occur between the hours of 7am and 5pm.

Schedule D: Waste	
Condition number	Condition
D1	Waste management A Waste Management Plan must be developed by an appropriately qualified person and implemented. The Waste Management Plan must include, but is not limited to: a) a description of the mining activities that may generate waste; b) a description of all waste activities being carried out; c) the location/s (including GPS coordinates) of where all waste activities are, or have been, carried out, including: i) the type of waste disposed of, treated, or reprocessed; and ii) the volume of waste disposed of, treated, or reprocessed; d) identification of the potential risks to the environment from all waste activities carried out; e) control measures to be implemented to minimise the potential for environmental harm associated with carrying out of the waste activities, including but not limited to: i) segregation of the wastes; ii) storage of the wastes; iii) transport of the wastes; and iv) monitoring and reporting matters concerning the wastes; f) how the waste will be managed in accordance with the waste management hierarchy (that is, avoid, reuse, recycling, energy recovery, disposal); g) the hazardous characteristics of the wastes generated including disposal procedures for hazardous wastes; h) procedures for reprocessing waste in accordance with condition D4; i) procedures for managing accidents, spills and other incidents; j) the indicators or other criteria on which the performance of the waste management program will be assessed; and k) staff training.
D2	The environmental authority holder must submit the Waste Management Plan required by condition D1 to the administering authority prior to commencing a new process, or varying an existing process, for reprocessing any waste.
D3	Waste receipt The only waste permitted to be received is: a) the types of waste specified in conditions D5 to D7 (inclusive); and b) sewage and sludge for treatment in accordance with Schedule H: Sewage Treatment; and c) from a BHP Billiton Mitsui Coal (BMC) or BHP Mitsubishi Alliance (BMA) site in Queensland.

D4	Waste reprocessing The only waste permitted to be reprocessed is: a) spoil or overburden; b) vegetation; c) water or sediment containing hydrocarbons; d) fuels, oils, lubricants and coolants; e) bulk rubber; f) inert waste; g) poly-pipe and other plastic; h) fibreglass; i) treated and untreated timber; and j) asphalt.
D5	Waste disposal Unless otherwise specified in conditions D6 and D7, waste, other than spoil or overburden or vegetation removed as part of the mining activity, must not be disposed of within the mining leases listed on this environmental authority and must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the <i>Environmental Protection Act 1994</i>.
D6	The following types of waste are permitted to be disposed of within the specified features for the waste type: a) rejects: i) in spoil emplacements.
D7	The following types of waste are permitted to be disposed of within the mining leases listed on this environmental authority: a) bulk rubber; b) inert waste; c) poly-pipe and other plastic; d) fibreglass; e) treated and untreated timber; f) asphalt; and g) asbestos. These types of waste may be disposed of: a) in pits or voids; b) in spoil emplacements; and c) left in situ below ground level.

Schedule E: Land	
Condition number	Condition
E1	Topsoil Topsoil must be strategically stripped ahead of mining in accordance with a Topsoil Management Plan.
E2	A topsoil inventory, which identifies the topsoil requirements for rehabilitation and availability of suitable topsoil on site, must be provided with any Estimated Rehabilitation Cost application.
E3	Rehabilitation landform criteria Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with Table E1 (Rehabilitation Requirements) .

Table E1 (Rehabilitation Requirements)

Post Mining Land Use	Goal	Objective	Indicator	Acceptance Criteria
Cattle grazing	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
		Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover >50% 2. 70% of slopes ≤20%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with <i>LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland)</i> unless otherwise agreed in writing between the administering authority and the environmental authority holder.
			Leucaena stem density	<250 stems >2m height per ha (1 per 40m ²), mean total area

Post Mining Land Use	Goal	Objective	Indicator	Acceptance Criteria
Dryland cropping	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
		Rehabilitation is erosionally stable	Percentage of cultivation at >1% slope gradient with functional contour banks	100% of rehabilitated areas
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable dryland cropping	Land suitability assessment for dryland cropping	Land suitability class ≤3 or not different from pre-mining class if ≥4. Assessment completed in accordance with the <i>Regional Land Suitability Frameworks for Queensland 2013</i> unless otherwise agreed in writing between the administering authority and the environmental authority holder.
Woodland habitat	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5 unless an alternative is justified by an appropriately qualified person
		Rehabilitation is erosionally stable	Groundcover (steep slopes, >15%)	80%
			Groundcover (lesser slopes, ≤15%)	50%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Native bushland characteristics	Species richness Trees Shrubs Grasses	≥2 ≥3 ≥4
			Tree canopy cover	≥16%

Post Mining Land Use	Goal	Objective	Indicator	Acceptance Criteria
Water Storage	Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
	Stable	Rehabilitation is geotechnically stable	Factor of Safety	≥1.5
		Rehabilitation is erosionally stable (banks and immediate surrounds)	Groundcover	>50%
	Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
		Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or, (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines.
	Able to sustain the agreed post-mining land use	Rehabilitation retains water that is a potential resource for cattle grazing, with quality according to ANZECC guidelines version October 2000	TDS	≤5,000mg/L
			Calcium	≤1,000mg/L
			Magnesium	≤2,000mg/L
			Nitrate	≤400mg/L
			Nitrite	≤30mg/L
			Sulphate	≤1,000mg/L

E4	Progressive rehabilitation for all areas except for Skoll Pit must commence within two (2) years of when areas become available within the mining leases.
E5	Rehabilitation of Skoll Pit must be carried out in accordance with Table E2 (Rehabilitation of Skoll Pit) .

Table E2 (Rehabilitation of Skoll Pit)

Reporting Period	Total Cumulative Established Rehabilitation Area (ha)
Years 1 to 7 (inclusive) ¹	7
Years 8 to 11 (inclusive)	30
Years 12 to 15 (inclusive)	75
Years 16 to 25 (inclusive)	75 + Void ²

NOTES:

1 Year 1 occurs upon commencement of overburden excavation in Skoll Pit

*2 Rehabilitation of the final void includes reshaping of the high wall and low wall which must be consistent with the findings of the Void Investigation Report required by condition **E9**.*

E6	By 31 May of the year following each Reporting Period (as set out in Table E2 (Rehabilitation of Skoll Pit)), the environmental authority holder must provide to the administering authority a rehabilitation progress report for the Skoll Pit. The report must include an analysis of the following: a) for the relevant Reporting Period – the actual amount of rehabilitation completed in the Skoll Pit for that period; and b) for the immediately preceding Reporting Period, if applicable – the estimated amount of rehabilitation to be completed in the Skoll Pit in that period.
E7	If the Total Cumulative Established Rehabilitation Area completed in a Reporting Period is: a) less than the area specified in Table E2 (Rehabilitation of Skoll Pit), the shortfall of progressive rehabilitation for Skoll Pit must be completed in the next Reporting Period; or b) more than the Total Cumulative Rehabilitation Area required for that Reporting Period, the environmental authority holder is not required to complete additional progressive rehabilitation in Skoll Pit in the next Reporting Period, above that stipulated in Table E2 (Rehabilitation of Skoll Pit).
E8	Where a shortfall of rehabilitation has occurred as referenced in condition E7 , the following information must be provided to the administering authority: a) a justification of why the Total Cumulative Established Rehabilitation Area was not achieved; and b) an action program that describes how the Total Cumulative Established Rehabilitation Area shortfall will be met in the subsequent Reporting Period.

E9	Residual void outcome Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria and landform design criteria for departmental review and comment. On acceptance of the criteria proposed in the Residual Void Management Plan, the criteria must be specified in the environmental authority. The investigation must at a minimum include the following: a) a study of options available for minimising final void area and volume; b) develop design criteria for rehabilitation of final voids; c) a void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term; d) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; e) a study of void capability to support native flora and fauna; and f) a proposal/s for end of mine void rehabilitation success criteria and final void areas and volumes. These studies will be undertaken during the life of the mine, and will include detailed research and modelling.
E10	Rehabilitation Monitoring Program Once rehabilitation has commenced, the environmental authority holder must conduct a Rehabilitation Monitoring Program at an interval no greater than twenty-four (24) months, which must include sufficient spatial and temporal replication to enable statistically valid conclusions as established under the rehabilitation program.
E11	The Rehabilitation Monitoring Program must be developed and implemented by a person possessing appropriate qualifications and experience in the field of rehabilitation management, nominated by the environmental authority holder.
E12	The Rehabilitation Monitoring Program must be included in the annual return and updated with each subsequent annual return, describing: a) how the rehabilitation objectives will be achieved; and b) verification of rehabilitation success.
E13	Post Closure Management Plan A Post Closure Management Plan for the site must be prepared at least eighteen (18) months prior to the final coal processing on site and implemented for a nominal period of at least thirty (30) years following final coal processing on site.

E14	The Post Closure Management Plan must include the following elements: a) operation and maintenance of: i) wastewater collection and reticulation systems; ii) wastewater treatment systems; iii) the groundwater monitoring network; iv) final cover systems; and v) vegetative cover. b) monitoring of: i) surface water quality; ii) groundwater quality; iii) seepage rates; iv) erosion rates; v) the integrity and effectiveness of final cover systems; and vi) the health and resilience of native vegetation cover.
E15	Mining waste management For the purpose of condition E16, 'mining waste' is defined as waste rock, spoil and overburden.
E16	A Mining Waste Management Plan together with the certification by an appropriately qualified person must be developed and implemented during the continuation of the environmental authority. The Mining Waste Management Plan must at a minimum include: a) characterisation programs to ensure that all mining waste is progressively characterised during disposal for net acid producing potential, salinity and the following contaminants: pH, electrical conductivity (EC), acid neutralising capacity (ANC), net acid generation (NAG) (reporting NAG capacity and NAG pH after oxidation), net acid producing potential (NAPP), total sulfur (S), chromium reducible sulfur (Scr), boron (B) cadmium (Cd), iron (Fe), aluminium (Al), copper (Cu), magnesium (Mg), manganese (Mn), calcium (Ca), sodium (Na), zinc (Zn) and sulfate (SO₄); b) characterisation programs to ensure that the physical properties of the mining waste is progressively characterised during disposal; c) the availability or leachability of metals from the mining waste; d) quantity of PAF mining waste; e) review potential impacts of PAF mining waste on the success of proposed rehabilitation methods; f) management actions for mining waste that has been identified as having a high availability or leachability of metals; g) management actions for mining waste that has been defined as PAF; h) identification of environmental impacts and potential environmental impacts; i) control measures for routine operations to minimise likelihood of environmental harm; j) contingency plans and emergency procedures for non-routine situations; and k) periodic review of environmental performance and continual improvement.

E17	Preventing contaminant release to land Contaminants must not be released to land in manner that constitutes a nuisance, material harm or serious environmental harm.
E18	Storage and handling of chemicals and flammable or combustible liquids All chemicals and flammable or combustible liquids must be stored and handled in accordance with the most recent version of an Australian Standard where such is applicable. Where no relevant Australian Standard exists, store such materials within an effective on-site containment system.
E19	Infrastructure All infrastructure, constructed by or for the environmental authority holder during the mining activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining landowner/ landholder. <i>NOTE: This is not applicable where the landowner/ landholder is also the environmental authority holder.</i>
E20	Exploration The environmental authority holder must rehabilitate in accordance with this environmental authority, any disturbance from mining activities which were undertaken under: a) this environmental authority; or b) any other environmental authority that applied to the land that is the subject of this environmental authority.
E21	Impacts to Prescribed Environmental Matters Significant residual impacts to prescribed environmental matters except for the impacts that were authorised by an existing authority issued before the commencement of the <i>Environmental Offsets Act 2014</i> are not authorised under this environmental authority or the <i>Environmental Offsets Act 2014</i> unless the impact(s) is specified in Table E3 (Significant Residual Impacts to Prescribed Environmental Matters) and Figure 1 (Significant Residual Impacts to Prescribed Environmental Matters) attached to this environmental authority.
E22	An environmental offset made in accordance with the <i>Environmental Offsets Act 2014</i> and <i>Queensland Environmental Offsets Policy</i>, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in Table E3 (Significant Residual Impacts to Prescribed Environmental Matters) and Figure 1 (Significant Residual Impacts to Prescribed Environmental Matters) attached to this environmental authority.
E23	The notice of election for the environmental offset required by condition E22 must be provided to the administering authority no less than three months before the proposed commencement of the significant residual impacts for which the environmental offset is required.
E24	Records demonstrating that each impact to a prescribed environmental matter not listed in Table E3 (Significant Residual Impacts to Prescribed Environmental Matters) did not, or is not likely to, result in a significant residual impact to that matter must be: a) completed by an appropriately qualified person; and b) kept for the life of the environmental authority.

Table E3 (Significant Residual Impacts to Prescribed Environmental Matters)

Prescribed Environmental Matter	Location of Impact	Maximum Extent of Impact	Environmental Offset Required
Endangered Regional Ecosystem – RE 11.4.9 and RE 11.9.5	ML1781	40.9 ha	Yes
Protected wildlife habitat – vulnerable species Ornamental Snake Regulated vegetation – essential habitat Ornamental Snake	ML1781	44.34 ha	Yes
Protected wildlife habitat – species least concern Echidna	ML1781	36.1 ha	No
Connectivity	ML1781	40.9 ha	Yes

Schedule F: Water	
Condition number	Condition
F1	Contaminant Release Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the mining activities, except as permitted under the conditions of this environmental authority.
F2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in Table F1 (Mine Affected Water Release Points) .
F3	The release of mine affected water to internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with conditions F29 to F30 inclusive is permitted.

Table F1 (Mine Affected Water Release Points)

Release Point (RP)	Easting (GDA94)	Northing (GDA94)	Mine Affected Water Source and Location	Monitoring Point	Receiving Waters Description
RP1	631319	7561566	DAM 2 and integrated water system	End of outlet pipe or spillway	Isaac River via New Chum Creek

F4	The release of mine affected water to waters in accordance with condition F2 must not exceed the release limits stated in Table F2 (Mine Affected Water Release Limits) when measured at the monitoring points specified in Table F1 (Mine Affected Water Release Points) for each quality characteristic.
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Table F2 (Mine Affected Water Release Limits)

Quality Characteristic	Release Limit	Monitoring Frequency
Electrical Conductivity (µS/cm)	5,000	Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits. Daily grab samples if telemetry not available (the first sample must be taken as soon as practicable)
pH (pH units)	6.5 (minimum) 9.0 (maximum)	
Sulphate (SO ₄ ²⁻) (mg/L)	1,000	Commencement of release and weekly thereafter during release when safe to do so and access permits

F5	The release of mine affected water to waters from the release points must be monitored at the locations specified in Table F1 (Mine Affected Water Release Points) for each quality characteristic and at the frequency specified in Table F2 (Mine Affected Water Release Limits) and Table F3 (Release Contaminant Trigger Investigation Levels). <i>NOTE: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.</i>
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Table F3 (Release Contaminant Trigger Investigation Levels)

Quality Characteristic	Trigger Level (µg/L)	Comment of Trigger Level	Monitoring Frequency
Aluminium	55	For aquatic ecosystem protection, based on SMD guideline	Commencement of release and thereafter weekly during release
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on 80 th percentile of background data	
Lead	4	For aquatic ecosystem protection, based on low reliability guideline	
Mercury (inorganic)	0.2	For aquatic ecosystem protection, based on LOR for CV FIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	1.4	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1900	For aquatic ecosystem protection, based on low reliability guideline	
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride	2000	Protection of livestock and short term irrigation guideline	
Sodium	TBA		

NOTES:

1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
2. The list of quality characteristics required to be monitored as per **Table F3** will be reviewed once the results of the monitoring data is gathered for the interim period until **31 December 2011** or an earlier date if the data is, or becomes, available and if it is determined that there is no need to monitor for certain individual quality characteristics these can be removed from **Table F3**.
3. SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMICANZ (2000).
4. LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

F6	If quality characteristics of the release exceed any of the trigger levels specified in Table F3 (Release Contaminant Trigger Investigation Levels) during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in Table F3 (Release Contaminant Trigger Investigation Levels) and: (1) where the trigger values are not exceeded then no action is to be taken; or (2) where the downstream results exceed the trigger values specified in Table F3 (Release Contaminant Trigger Investigation Levels) for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; (a) if the result is less than the background monitoring site data, then no action is to be taken; or (b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: i. details of the investigations carried out; and ii. actions taken to prevent environmental harm. <i>NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with condition F6(2)(b), no further reporting is required for subsequent trigger events for that quality characteristic.</i>
F7	If an exceedance in accordance with condition F6(2)(b) is identified, the environmental authority holder must notify the administering authority within twenty-four (24) hours of receiving the result.
F8	Mine Affected Water Release Events The environmental authority holder must ensure a stream flow gauging station(s) is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in Table F4 (Mine Affected Water Release During Flow Events).
F9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition F2 must only take place during periods of natural flow events in accordance with the receiving water flow criteria for discharge specified in Table F4 (Mine Affected Water Release During Flow Events) for the release point(s) specified in Table F1 (Mine Affected Water Release Points).
F10	The 80th percentile of electrical conductivity (EC) values recorded in the Isaac River at the downstream monitoring points listed in Table F6 (Receiving Waters Upstream Background and Downstream Monitoring Points) must not exceed 720µS/cm over the duration of the release influence period and have a maximum value of no greater than 864µS/cm. The 80th percentile must be calculated using all EC values recorded by the monitoring station during the release influence period. <i>NOTE: Release influence period is the period during which the downstream monitoring points are influenced by mine affected water releases and includes both the duration of release and any lag time between the release point/s and downstream monitoring point/s.</i>
F11	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in Table F1 (Mine Affected Water Release Points).
F12	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.

Table F4 (Mine Affected Water Release During Flow Events)

Receiving waters	Release Point (RP)	Gauging Station	Gauging Station Easting (GDA94)	Gauging Station Northing (GDA94)	Receiving Water Flow Criteria for Discharge [#] (m ³ /s)	Receiving Water Flow Recording Frequency ^A
Isaac River via New Chum Creek	RP1	Isaac River Upstream (MP3)	627831	7556405	≥3 m ³ /s	Daily

F13	Notification of release event The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than twenty-four (24) hours after commencing to release mine affected water to the receiving environment. The release commencement notification must include the submission of written advice to the administering authority of the following information: a) release commencement date and time; b) expected release cessation date and time; c) release point(s); d) release rate; e) receiving water(s) including the natural flow rate; and f) any details (including available data) regarding likely impacts on the receiving water(s).
F14	The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than twenty-four (24) hours after cessation of a release event notified under condition F13. The release cessation notification must include the submission of written advice to the administering authority of the following information: a) release cessation date and time; b) receiving water(s) including the natural flow rate; and c) volume of water released. <i>NOTE: Successive or intermittent releases occurring within twenty-four (24) hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions F13 and F14 and F15, provided the relevant details of the release are included within the notification provided in accordance with conditions F13 and F14 and F15.</i>

F15	Within twenty-eight (28) days of notification under condition F14, the environmental authority holder must provide the administering authority via WaTERS the following information in writing: a) confirmation of: i) the release commencement date and time; ii) the release cessation date and time; iii) receiving water(s) including the natural flow rate; iv) volume of water released; b) all in-situ and laboratory water quality monitoring results; c) details regarding the compliance of the release with the conditions of Schedule F: Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume); d) whether the release of water resulted in any impacts to the receiving environment; and e) any other matter(s) pertinent to the water release event.
F16	Notification of release event exceedance If the release limits defined in Table F2 (Mine Affected Water Release Limits) are exceeded, the environmental authority holder must notify the administering authority within twenty-four (24) hours of receiving the results.
F17	The environmental authority holder must, within twenty-eight (28) days of the notification provided in accordance with condition F16, provide a report to the administering authority via WaTERS detailing: a) the reason for the release; b) the location of the release; c) the total volume of the release and which (if any) part of this volume was non-compliant; d) the total duration of the release and which (if any) part of this period was non-compliant; e) all water quality monitoring results; f) any general observations; g) all calculations; and h) any other matters pertinent to the water release event.
F18	Receiving Environment Monitoring and Contaminant Trigger Levels The quality of the receiving waters must be monitored at the locations specified in Table F6 (Receiving Water Upstream Background and Downstream Monitoring Points) for each quality characteristic and at the monitoring frequency stated in Table F5 (Receiving Waters Contaminant Trigger Levels) and Table F3 (Release Contaminant Trigger Investigation Levels).

F19	If quality characteristic(s) of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in Table F5 (Receiving Waters Contaminant Trigger Levels) during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or (2) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: (a) details of the investigations carried out; and (b) actions taken to prevent environmental harm. <i>NOTE: Where an exceedance of a trigger level has occurred and is being investigated in accordance with F19(2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.</i>
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Table F5 (Receiving Waters Contaminant Trigger Levels)

Quality Characteristic	Trigger Level	Monitoring Frequency
pH (pH units)	6.5 to 8.5	Real time telemetry for EC and pH (excluding alternate MP3) with grab samples at commencement and weekly thereafter when safe to do so and access permits. Limits only apply at MP4
Electrical Conductivity (µS/cm)	864 – cease release	
Sulphate (SO ₄ ²⁻) (mg/L)	1000	

Table F6 (Receiving Waters Upstream Background and Downstream Monitoring Points)

Monitoring Point (MP)	Receiving Waters Location Description	Easting (GDA94)	Northing (GDA94)
Upstream Background Monitoring Points ^a			
MP1	New Chum Creek – on the lease boundary with Millennium Mine	631895	7562009
MP3	Isaac River – upstream of the confluence of New Chum Creek and Isaac River	627831	7556405
Downstream Monitoring Points			
MP4	Isaac River – downstream of the confluence of New Chum Creek and the Isaac River	631808	7553672

NOTES:

(a) The data from background monitoring points must not be used where they are affected by releases from other mines.

F20	Receiving Environment Monitoring Program (REMP) The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Isaac River and connected or surrounding waterways within fifteen (15) kilometres downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
F21	The REMP must: a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality); b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected; c) include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release (as a minimum, the locations specified in Table F6 (Receiving Water Upstream Background and Downstream Monitoring Points)); d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the <i>Queensland Water Quality Guidelines 2009</i>. This should include monitoring during periods of natural flow irrespective of mine or other discharges; e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in Table F2 (Mine Affected Water Release Limits) and Table F3 (Release Contaminant Trigger Investigation Levels)); f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments); g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology, h) apply procedures and/or guidelines from ANZECC & ARMCANZ 2000 and other relevant guideline documents; i) describe sampling and analysis methods and quality assurance and control; and j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.
F22	A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with conditions F20 and F21 must be prepared annually. This report must include the following: a) an assessment of background reference water quality; b) the condition of downstream water quality compared against water quality objectives; and c) the suitability of current discharge limits to protect downstream environmental values.

F23	Water reuse Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of: a) supplying stock water subject to compliance with the quality release limits specified in Table F7 (Stock Water Release Limits); or b) supplying irrigation water subject to compliance with quality release limits in Table F8 (Irrigation Water Release Limits); or c) supplying water for construction and/or road maintenance in accordance with the conditions of this environmental authority.
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Table F7 (Stock Water Release Limits)

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	5000

Table F8 (Irrigation Water Release Limits)

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	Site specific value determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines

F24	Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, for the purpose of supplying water to any operation licensed for either ERA13 (mining black coal) or ERA31 (mineral processing). The volume, pH and electrical conductivity of water transferred must be monitored and recorded.
F25	If the responsibility for mine affected water is given or transferred to another person in accordance with conditions F23 or F24: a) the responsibility for the mine affected water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) the third party agreement must include a commitment from the person utilising the mine affected water to use it in such a way as to prevent environmental harm or public health incidents and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the <i>Environmental Protection Act 1994</i>, environmental sustainability of the water disposal and protection of environmental values of waters; and c) the third party agreement must be signed by both parties to the agreement.

F26	Water general All determinations of water quality and biological monitoring must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the administering authority's <i>Monitoring and Sampling Manual</i>; c) collected from the monitoring locations identified within this environmental authority, within ten hours of each other where possible; d) carried out on representative samples; and e) analysed at a laboratory accredited (e.g. NATA) for the method of analysis being used. <i>Note: Condition F26 requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.</i>
F27	The release of any contaminants as permitted by this environmental authority, directly or indirectly to waters, other than internal water management infrastructure that is installed and operated in accordance with a Water Management Plan that complies with conditions F29 to F30 inclusive: a) must not produce any visible discolouration of receiving waters; and b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.
F28	Annual water monitoring reporting The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.

F29	Water Management Plan A Water Management Plan must be developed by an appropriately qualified person(s) and implemented for all mining activities. The Water Management Plan must address, as a minimum, the following: a) provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority; and b) be developed in accordance with administering authority's guideline <i>Preparation of water management plans for mining activities</i> and include: i) a study of the source of contaminants; ii) a water balance model for the site; iii) a water management system for the site; iv) measures to manage and prevent saline drainage; v) measures to manage and prevent acid rock drainage; vi) contingency procedures for emergencies; and vii) a program for monitoring and review of the effectiveness of the Water Management Plan.
F30	The Water Management Plan must be reviewed each calendar year by an appropriately qualified person(s).
F31	Saline drainage The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
F32	Acid rock drainage The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
F33	Stormwater and water sediment controls An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
F34	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F33; and b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions F29 to F30 inclusive, for the purpose of ensuring water does not become mine affected water.
F35	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.

F36	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.
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Schedule G: Structures	
Condition number	Condition
G1	Assessment of consequence category The consequence category of any structure must be assessed by a suitably qualified and experienced person, in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>, at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) prior to any change in its purpose or the nature of its stored contents.
G2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> .
G4	Design and construction of a regulated structure Conditions G5 to G9 inclusive do not apply to existing structures. <i>NOTE: Construction of a dam includes modification of an existing dam – see definitions.</i>
G5	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>. <i>NOTE: Certification of design and construction may be undertaken by different persons.</i>
G6	Construction of a regulated structure is prohibited unless the environmental authority holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this environmental authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> , and must be recorded in the Register of Regulated Structures.

G8	Regulated structures must: a) be designed and constructed in accordance with and conform to the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>; b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: a) floodwaters from entering the regulated dam from any watercourse or drainage line; and c) for regulated dams associated with a failure to contain – seepage, have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and b) construction of the regulated structure is in accordance with the design plan.
G10	Operation of a regulated structure Operation of a regulated structure, except for an existing structure, is prohibited unless the environmental authority holder has submitted to the administering authority: a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition G6; b) a set of 'as constructed' drawings and specifications; c) certification of those 'as constructed drawings and specifications' in accordance with condition G9; d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan; e) the requirements of this environmental authority relating to the construction of the regulated structure have been met; f) the environmental authority holder has entered the details, required under this environmental authority, into the Register of Regulated Structures; and g) there is a current operational plan for the regulated structures.
G11	For existing structures that are regulated structures: a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the environmental authority holder must submit to the administering authority within twelve (12) months of the commencement of this condition a copy of the certified system design plan including that structure; and b) there must be a current operational plan for the existing structures.

G12	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G13	Mandatory Reporting Level Conditions G14 to G17 inclusive only apply to regulated structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
G14	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that, during routine inspections of that dam, it is clearly observable.
G15	The environmental authority holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
G16	The environmental authority holder must immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G17	The environmental authority holder must record any changes to the MRL in the Register of Regulated Structures.
G18	Design Storage Allowance The environmental authority holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.
G19	By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
G20	The environmental authority holder must notify the administering authority as soon as possible and within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year.
G21	The environmental authority holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G22	Annual inspection report Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.

G23	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.
G24	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i> .
G25	The environmental authority holder must: a) within twenty (20) business days of receipt of the annual inspection report, provide to the administering authority: a) the recommendations section of the annual inspection report; and if applicable, any actions being taken in response to those recommendations; and b) if, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the environmental authority holder, provide this to the administering authority within ten (10) business days of receipt of the request.
G26	Transfer arrangements The environmental authority holder must provide a copy of any reports, documentation and certifications prepared under this environmental authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G27	Decommissioning and rehabilitation Dams must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition G28; or b) be left in-situ for a beneficial use(s) provided that: i) it no longer contains contaminants that will migrate into the environment; and ii) it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and iii) the administering authority, the environmental authority holder and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).

G28	After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria: a) the landform is safe for humans and fauna; b) the landform is stable with no subsidence or erosion gullies for at least three (3) years; c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated d) not allowing for acid mine drainage; or e) there is no ongoing contamination to waters (including groundwater); f) rehabilitation is undertaken in a manner such that any actual or potential acid sulphate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the <i>Instructions for the treatment and management of acid sulfate soils (2001)</i>; g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class; h) for land that is not being cultivated by the landholder: i) groundcover, that is not a declared pest species is established and self-sustaining vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining, and the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the mining activity(ies). i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of mining activities being completed.
G29	Register of Regulated Structures A Register of Regulated Structures must be established and maintained by the environmental authority holder for each regulated structure.
G30	The environmental authority holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated structure is submitted to the administering authority.
G31	The environmental authority holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition G10 and G11 has been achieved.
G32	The environmental authority holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
G33	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the environmental authority holder, or their delegate, as being accurate and correct.
G34	The environmental authority holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.

G35	Transitional arrangements All existing structures that have not been assessed in accordance with either, the Manual or the former <i>Manual for Assessing Hazard Categories and Hydraulic Performance of Dams</i>, must be assessed and certified in accordance with the Manual within six (6) months of amendment of the environmental authority adopting this schedule.
G36	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in Table G1 (Transitional Requirements for Existing Structures), depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.
G37	Table G1 (Transitional Requirements for Existing Structures) ceases to apply for a structure once any of the following events has occurred: a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or b) it has been decommissioned; or c) it has been certified as no longer being assessed as a regulated structure.
G38	Certification of the transitional assessment required by G35 and G36 (as applicable) must be provided to the administering authority within six (6) months of amendment of the environmental authority adopting this schedule.

Table G1 (Transitional Requirements for Existing Structures)

Transition period required for existing structures to achieve the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)</i>			
Compliance with Criteria	High	Significant	Low
>90% and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70% to ≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50 to ≤70%	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50%	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing)	Review consequence assessment every 5 years.

Schedule H: Sewage Treatment	
Condition number	Condition
H1	Treated sewage effluent The cumulative total daily peak design capacity of the sewage treatment plant/s must not exceed 1500 equivalent persons (EP). Small package plants and/or septic systems, each with a daily peak design capacity less than 21EP, are not included in the cumulative total daily peak design capacity.
H2	Treated sewage effluent must not be directly released from the sewage treatment plant/s to any waters. <i>Note: 'waters' does not include structures associated with the mine affected water management system.</i>
H3	Treated sewage effluent may be: a) released to the mine affected water management system for mixing with other mine affected water; b) released to land via a sub-surface infiltration trench; c) irrigated or sprayed for dust suppression or firefighting or evaporation; or d) removed as waste.
H4	Treated sewage effluent that is released in accordance with condition H3(a) and has mixed with other mine affected water must be managed as mine affected water in accordance with the conditions of this environmental authority.
H5	Treated sewage effluent that is released in accordance with condition H3(b) or H3(c) must be carried out in a manner such that: a) vegetation is not damaged; b) there is no surface ponding of effluent; and c) there is no run-off of treated sewage effluent to waters.
H6	Treated sewage effluent released in accordance with condition H3(a) or H3(b) or H3(c) from any sewage treatment plant that has a daily peak design capacity of greater than 21EP must be monitored: a) at the point where the treated sewage effluent is released from the sewage treatment plant/s; b) for the quality characteristics specified in Table H1 (Treated Sewage Effluent Monitoring Requirements); and c) at the frequency specified in Table H1 (Treated Sewage Effluent Monitoring Requirements).

Table H1 (Treated Sewage Effluent Monitoring Requirements)

Quality Characteristic	Units	Monitoring Frequency
5-day Biochemical Oxygen Demand (uninhibited)	mg/L	Monthly
pH	pH units	Monthly
Thermotolerant coliforms	Colonies per 100mL	Monthly
Total nitrogen	mg/L	Monthly
Total phosphorus	mg/L	Monthly

H7	If treated sewage effluent is being released in accordance with condition H3(c): a) the results of monitoring in accordance with condition H6 must not exceed the release limits specified in Table H2 (Treated Sewage Effluent Contaminant Release Limits); and b) the release must not cause spray drift or over spray to any sensitive place or commercial place.
H8	If the release limits specified in Table H2 (Treated Sewage Effluent Contaminant Release Limits) are exceeded in accordance with condition H7(a), the environmental authority holder must notify the administering authority in accordance with conditions A7 and A8.

Table H2 (Treated Sewage Effluent Contaminant Release Limits)

Quality Characteristic	Release Limit	Units	Limit Type
5-day Biochemical Oxygen Demand (uninhibited)	50	mg/L	Maximum
pH	6.0 to 9.0	pH units	Range
Thermotolerant coliforms, based on the average of a minimum of five samples collected	1000	Colonies per 100mL	Maximum

Schedule I: Groundwater	
Condition number	Condition
I1	Groundwater The holder of this environmental authority must not release contaminants to groundwater.
I2	Groundwater Monitoring and Management Program A Groundwater Monitoring and Management Program must be: a) developed by an appropriately qualified person; and b) implemented by the environmental authority holder for all stages of mining activities.
I3	The Groundwater Monitoring and Management Program required by condition I2 must: a) identify potential groundwater impacts due to the mining activities; b) include a site conceptual groundwater model; c) describe the sampling and monitoring methodology; d) detail an appropriate quality assurance and quality control program; and e) provide the process for notifying the administering authority and investigating exceedances in accordance with conditions I4-I5.
I4	Groundwater monitoring Groundwater quality and standing water levels must be monitored: a) at the locations and at the frequencies specified in Table I1 (Groundwater Monitoring Program); and b) for the quality characteristics specified in Table I2 (Groundwater Trigger Levels).
I5	If the groundwater trigger levels defined in Table I2 (Groundwater Trigger Levels) are exceeded on three (3) consecutive monitoring occasions, the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within twenty (20) business days of receiving the analysis results.
I6	The Groundwater Monitoring and Management Program must be reviewed by 31 November 2023 and thereafter every two (2) years by an appropriately qualified person. The review report must: a) analyse the results of groundwater monitoring to: i. describe any impacts to groundwater levels and groundwater quality due to the mining activity; ii. determine trends in groundwater levels and groundwater quality; b) assess the adequacy of the Groundwater Monitoring and Management Program; and c) provide recommendations to the environmental authority holder to address the findings of parts (a) and (b) of the review.

17	Within twenty (20) business days of receiving the review report, the environmental authority holder must provide to the administering authority: a) the review report; b) if applicable, any actions being taken by the environmental authority holder to address the recommendations of the review report; and c) if action is not being taken to address a recommendation, the environmental authority holder must provide justification for not taking action.
18	Annual groundwater monitoring data must be submitted to the administering authority via WaTERS by 30 September each calendar year.
19	Bore construction The construction, management, maintenance, and decommissioning of groundwater monitoring bores must be undertaken in a manner that: a) prevents contaminants entering the groundwater; b) ensures the integrity of the bores to obtain representative groundwater samples from the target aquifer; and c) maintains the hydrogeological environment within the aquifer.

Table I1 (Groundwater Monitoring Program)

Monitoring Location	Easting (GDA94)	Northing (GDA94)	Monitoring Frequency
Interpretation Bores			
BMB	639591	7560458.38	Quarterly
Compliance Bores			
PZ02	635302.01	7560233.39	Quarterly
PZ04	635530.01	7554547.41	Quarterly
PZ05	632574.02	7561916.38	Quarterly
PZ06	631774.02	7561217.39	Quarterly
PZ07	631741.02	7559719.39	Quarterly

Table I2 (Groundwater Trigger Levels)

Quality Characteristics	Units	Trigger Levels					
		BMB	PZ02	PZ04	PZ05	PZ06	PZ07
Water Level	RL	Monitored for interpretative reasons only – no triggers apply	Fluctuations in excess of 2m per year excluding changes from pumping of licenced bores				
pH	pH units		6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5 ¹
Electrical Conductivity	µS/cm		16,000	20,100	16,000	18,800	16,000 ¹
Sulphate	mg/L		398	490	398	398	398 ¹
Dissolved Iron	mg/L		2.4	4.2	1.5	3.5	0.7 ¹
Dissolved Aluminium	mg/L		0.126	0.2	0.055	0.055	0.055 ¹
Dissolved Antimony	mg/L		0.009	0.009	0.009	0.009	0.009 ¹
Dissolved Arsenic	mg/L		0.013	0.013	0.082	0.013	0.013 ¹
Dissolved Mercury	mg/L		0.0006	0.0006	0.0006	0.0006	0.0006 ¹
Dissolved Molybdenum	mg/L		0.034	0.057	0.034	0.034	0.034 ¹
Dissolved Selenium	mg/L		0.011	0.011	0.011	0.011	0.011 ¹
Dissolved Silver	mg/L		0.001	0.001	0.001	0.001	0.001 ¹
Total recoverable hydrocarbons C6-C10	µg/L		20	20	20	20	20
Total recoverable hydrocarbons >C10-C40	µg/L		100	100	100	100	100

Notes:

1. Fewer than the recommended 18 data points have been used to derive these trigger levels, therefore the adopted trigger levels are considered as interim and may require subsequent revision.

END OF CONDITIONS

Definitions

Key terms and/or phrases used in this document are defined in this section. Environmental authority holders should note that where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

Acceptance criteria means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly been disturbed by the mining activities. Acceptance criteria may include information regarding:

- a) vegetation establishment, survival and succession;
- b) vegetation productivity, sustained growth and structure development;
- c) fauna colonisation and habitat development;
- d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;
- e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
- f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
- g) resilience of vegetation to disease, insect attack, drought and fire; and
- h) vegetation water use and effects on ground water levels and catchment yields.

Acid rock drainage means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

Administering authority is the agency or department that administers the environmental authority provisions under the *Environmental Protection Act 1994*.

Airblast overpressure means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

Alternative arrangement in relation to a sensitive place or a commercial place, means:

- a) A written agreement:
 - i. between the environmental authority holder and a third party;
 - ii. that identifies a particular type(s) of environmental nuisance;
 - iii. about the way in which the particular environmental nuisance impact(s) will be dealt with;
 - iv. at a particular location; and
 - v. for a defined period of time.
- b) An alternative arrangement must make clear to the third party that by entering in to the agreement that:
 - i. their place will be excluded as a sensitive place or commercial place; and
 - ii. the consequences of exclusion as a sensitive place or commercial place.

Note: An alternative arrangement may include, but is not limited to, details of the nuisance abatement measures to be implemented, provision of alternative accommodation, or agreement between the parties that the location will not be considered a sensitive place or commercial place for the purposes of the Environmental Authority, for the duration of the alternative arrangement. The written agreement may be in any form, with some examples being a lease, or an agistment, or a conduct and compensation agreement under the *Mineral Resources Act 1989*.

Annual exceedance probability or AEP means the probability that at least one event in excess of a particular magnitude will occur in any given year.

Annual inspection report means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan):

- a) against recommendations contained in previous annual inspections reports;
- b) against recognised dam safety deficiency indicators;
- c) for changes in circumstances potentially leading to a change in consequence category;
- d) for conformance with the conditions of this authority;
- e) for conformance with the 'as constructed' drawings;
- f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems); and
- g) for evidence of conformance with the current operational plan.

ANZECC means the Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000

Appropriately qualified person means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

Assessed or assessment by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

- a) exactly what has been assessed and the precise nature of that determination;
- b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
- c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

Associated works in relation to a dam, means:

- a) operations of any kind and all things constructed, erected or installed for that dam; and
- b) any land used for those operations.

Authority means an environmental authority or a development approval.

Bed and banks for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

Beneficial use in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

- a) of benefit to that owner in that it adds real value to their business or to the general community;
- b) in accordance with relevant provisions of the *Environmental Protection Act 1994*;
- c) sustainable by virtue of written undertakings given by that owner to maintain that dam; and
- d) the transfer and use have been approved or authorised under any relevant legislation.

Biosolids means the treated and stabilised solids from sewage.

Blasting means the use of explosive materials to fracture:

- a) rock, coal and other minerals for later recovery; or
- b) structural components or other items to facilitate removal from a site or for reuse.

Bulk rubber means tyres, conveyor belt, and other similar rubber waste.

Certification in relation to regulated structures, means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* or this environmental authority, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

Certifying, certify or certified have a corresponding meaning as 'certification' in relation to regulated structures.

Chemical means:

- a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)*; or
- b) a dangerous good under the dangerous goods code; or
- c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*; or
- d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or
- e) any substance used as, or intended for use as:
 - i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or
 - ii. a surface active agent, including, for example, soap or related detergent; or
 - iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or
 - iv. a fertiliser for agricultural, horticultural or garden use; or
- f) a substance used for, or intended for use for:
 - i. mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
 - ii. manufacture of plastic or synthetic rubber.

Commercial place means:

- a) A work place that is used as:
 - i. an office; or
 - ii. a place of business; or
 - iii. a place used for commercial purposes.
- b) Despite paragraph (a), the following places are not commercial places:
 - i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or
 - ii. places that are part of the mining activity; or
 - iii. employees accommodation or public roads; or
 - iv. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.
- c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a commercial place for the purposes of that type(s) of environmental nuisance, however, remains a commercial place for the purpose of other types of environmental nuisances.

Consequence in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

Consequence category means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

Construction or constructed in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

Contaminate means to render impure by contact or mixture.

Contaminated means the substance has come into contact with a contaminant.

Contaminant can be

- a) a gas, liquid or solid; or
- b) an odour; or
- c) an organism (whether alive or dead), including a virus; or
- d) energy, including noise, heat, radioactivity and electromagnetic radiation; or
- e) a combination of contaminants.

Control measure means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

Dam means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

Dam crest volume means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

Design plan is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

Design storage allowance or DSA means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

Designer for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

Disturbance of land includes:

- a) compacting, removing, covering, exposing or stockpiling of earth;
- b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;
- c) carrying out mining within a watercourse, waterway, wetland or lake;
- d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;
- e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased; or
- f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of disturbance:

- a) areas off lease (e.g. roads or tracks which provide access to the mining lease);
- b) areas previously disturbed which have achieved the rehabilitation outcomes;
- c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);
- d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner; or
- e) disturbance that pre-existed the grant of the tenure.

Dwelling means any of the following structures or vehicles that is principally used as a residence:

- a) a house, unit, motel, nursing home or other building or part of a building; or
- b) a caravan, mobile home or other vehicle or structure on land; or
- c) a water craft in a marina.

Effluent means treated waste water released from sewage treatment plants.

Emergency action plan means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact.

End of pipe means the location at which water is released to waters or land.

Environmental authority means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

Environmental authority holder means the holder of this environmental authority.

Environmentally relevant activity means an environmentally relevant activity as defined under section 18 of the *Environmental Protection Act 1994*.

EPBC means the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

ERC decision means a decision made by the administering authority under section 300 of the *Environmental Protection Act 1994* about the estimated rehabilitation cost for a resource activity.

ERC period for the estimated rehabilitation cost for a resource activity, means:

- a) if a PRCP schedule applies for the activity, the period of between 1 and 5 years stated in the application for an ERC decision under section 298(2)(b); or
- b) if the activity is a petroleum activity that is an ineligible ERA, other than a petroleum activity to which a plan of operations applies, or the activity relates to a 1923 Act petroleum tenure granted under the *Petroleum Act 1923*, the period of between 1 and 5 years stated in the ERC decision about the estimated rehabilitation cost; or
- c) if a plan of operations applies for the activities, the plan period for the plan of operations; or
- d) otherwise, the total period during which the resource activity is likely to be carried out under the environmental authority for the activity.

Estimated rehabilitation cost (ERC) for a resource activity, see section 300(2) of the *Environmental Protection Act 1994*.

Existing authority has the meaning in section 94 of the *Environmental Offsets Act 2014*.

Existing structure means a structure that was in existence prior to 24 October 2014.

Extreme storm storage means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Floodwater means water overflowing, or that has overflowed, from waters, river, creek, stream, lake, pond, wetland or dam onto or over riparian land that is not submerged when the watercourse or lake flows between or is contained within its bed and banks.

Flowable substance means matter or a mixture of materials that can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

Foreseeable future is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

General waste means waste other than regulated waste.

Hazardous waste means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

Holder, for a mining tenement, means a holder of the tenement under the *Mineral Resources Act 1989*, and the holder of the associated environmental authority under the *Environmental Protection Act 1994*.

Hydraulic performance means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*.

Inert waste means bricks, pavers, ceramics, concrete, glass, steel, or similar waste that does not biodegrade or decompose.

Infrastructure means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long-term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the mining leases or the background land owner.

L_{Aeq}, adj, 10 mins means the A-weighted sound pressure level of a continuous steady sound (adjusted for tonal character) that within a 10 minute period has the same mean square sound pressure of a sound that varies with time.

L_{Amax, adj, 10 mins} means the average maximum A-weighted sound pressure level (adjusted for noise character) measured over any 10 minute period.

Lake includes:

- a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and
- b) the bed and banks and any other element confining or containing the water.

Land in the “land schedule” of this document means land excluding waters and the atmosphere.

Land use describes the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

Levee means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

Low consequence dam means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635).

Mandatory reporting level or MRL means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635) published by the administering authority.

Manual means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014)* (EM635) published by the administering authority.

Matters of state environmental significance or MSES has the meaning in schedule 2 of the *Environmental Offsets Regulation 2014*.

Maximum extent of impact means the total, cumulative, residual extent and duration of impact to a prescribed environmental matter that will occur over a project's life after all reasonable avoidance and reasonable on-site mitigation measures have been, or will be, undertaken.

mbgl means metres below ground level.

mg/L means milligrams per litre.

Mechanically reprocessing waste includes mechanically crushing, milling, grinding, shredding or sorting waste, whether or not for the purpose of recycling the waste.

Mine affected water means the following types of water:

- a) pit water, tailings dam water, processing plant water;
- b) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;
- c) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage runoff containing sediment only, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
- d) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
- e) groundwater from the mine's dewatering activities; or
- f) a mix of mine affected water (under any of paragraphs (a) to (e)) and other water.

Mineral means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes:

- a) clay if mined for use for its ceramic properties, kaolin and bentonite;
- b) foundry sand;
- c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from;
- d) limestone if mined for use for its chemical properties;
- e) marble;
- f) mineral oil or gas extracted or produced from shale or coal by in situ processes;
- g) peat;
- h) salt including brine;
- i) shale from which mineral oil may be extracted or produced;
- j) silica, including silica sand, if mined for use for its chemical properties; or
- k) rock mined in block or slab form for building or monumental purposes;

But does not include:

- a) living matter;
- b) petroleum within the meaning of the *Petroleum Act 1923*;
- c) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form; or
- d) water.

Mining activities means the activities:

- a) authorised as per the definition in section 110 of the *Environmental Protection Act 1994*; and
- b) all environmentally relevant activities authorised under this environmental authority;
- c) waste activities.

Modification or modifying (see definition of 'construction').

Natural flow means the flow of water through waters caused by nature.

Notice of election has the meaning in section 18(2) of the *Environmental Offsets Act 2014*.

Noxious means harmful or injurious to health or physical wellbeing.

Offensive means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

Operational plan includes:

- a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance); and
- b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

Peak particle velocity or ppv means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mm/s).

Prescribed environmental matters has the meaning in section 10 of the *Environmental Offsets Act 2014*, limited to the matters of State environmental significant listed in schedule 2 of the *Environmental Offsets Regulation 2014*.

Protected area means

- a) a protected area under the *Nature Conservation Act 1992*; or
- b) a marine park under the *Marine Parks Act 1992*; or
- c) a World Heritage Area.

Progressive rehabilitation means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

Receiving environment, in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

- a) a watercourse;
- b) groundwater;
- c) land; and
- d) sediments.

Receiving waters means the waters into which this environmental authority authorises releases of mine affected water.

Reference site (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

Register of Regulated Structures includes:

- a) date of entry in the register;
- b) name of the dam, its purpose and intended/actual contents;
- c) the consequence category of the dam as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)*;
- d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all documents(s) lodged as part of a design plan for the dam;
- e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
- f) for the regulated dam, other than in relation to any levees –
 - i. the dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
 - ii. coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
 - iii. dam crest volume (megalitres);
 - iv. spillway crest level (metres AHD).
 - v. maximum operating level (metres AHD);
 - vi. storage rating table of stored volume versus level (metres AHD);
 - vii. design storage allowance (megalitres) and associated level of the dam (metres AHD);
 - viii. mandatory reporting level (metres AHD);
- g) the design plan title and reference relevant to the dam;
- h) the date construction was certified as compliant with the design plan;
- i) the name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
- j) details of the composition and construction of any liner;
- k) the system for the detection of any leakage through the floor and sides of the dam;
- l) dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
- m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority; and
- n) dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

Regulated dam means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Regulated structure includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.

Regulated waste is defined in the *Environmental Protection Regulation 2008*.

Rehabilitation means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

Rejects means:

- a) breaker rejects; or
- b) coarse rejects; or
- c) mid/fine size rejects; or
- d) tailings that have been dewatered; or
- e) any combination of rejects (under any of paragraphs a to d).

Representative means a sample set that covers the variance in monitoring or other data due to either natural changes or operational phases of the mining activities.

Reprocessing includes:

- a) recycling; or
- b) mechanical treatment; or
- c) thermal treatment; or
- d) biological treatment; or
- e) chemical treatment.

Residual void means an open pit resulting from the removal of ore and/or waste rock that will remain following the cessation of all mining activities and completion of rehabilitation processes.

Resource activity is an activity that involves

- a) a geothermal activity; or
- b) a GHG storage activity; or
- c) a mining activity; or
- d) a petroleum activity.

Saline drainage is the movement of waters, contaminated with salt(s), as a result of the mining activity.

Scheme fund means the scheme fund established under section 24 of the *Mineral and Energy Resources (Financial Provisioning) Act 2018*.

Self-sustaining means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

Sensitive place means:

- a) Any of the following:
 - i. a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
 - ii. a motel, hotel or hostel; or
 - iii. an educational institution; or
 - iv. a medical centre or hospital; or
 - v. a protected area; or
 - vi. a public park or gardens.
- b) Despite paragraph (a), the following places are not sensitive places:
 - i. subject to paragraph (c), a place that is the subject of an alternative arrangement; or
 - ii. a mining camp (i.e. accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority), whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the environmental authority holders for the mining project, or a related company; or
 - iii. a property owned or leased by one or more of the environmental authority holders, or a related company, whether or not it is subject to an alternative arrangement.
- c) A place that is the subject of a current alternative arrangement in relation to a particular type(s) of environmental nuisance, is not a sensitive place for the purposes of that type(s) of environmental nuisance, however, remains a sensitive place for the purpose of other types of environmental nuisances.

Sewage means the used water of persons to be treated at a sewage treatment plant.

Significant residual impact has the meaning in section 8 of the *Environmental Offsets Act 2014*.

Spillway means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

Stable in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

Stormwater means all surface water runoff from rainfall.

Structure means dam or levee.

Suitably qualified and experienced person in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and has demonstrated competency and relevant experience:

- a) for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design.
- b) for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

System design plan means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

Tailings means fines from mineral processing that have not been dewatered.

The Act means the *Environmental Protection Act 1994*.

Void means any constructed, open excavation in the ground.

Waste as defined in section 13 of the *Environmental Protection Act 1994*.

Waste activities means receiving, storing, disposing, treating, or reprocessing wastes, and does not include composting.

Waste and resource management hierarchy has the meaning given by section 9 of the *Waste Reduction and Recycling Act 2011*.

Water quality means the chemical, physical and biological condition of water.

Watercourse has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means a river, creek or stream in which water flows permanently or intermittently:

- a) in a natural channel, whether artificially improved or not; or
- b) in an artificial channel that has changed the course of the watercourse.

Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

Waters includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

WaTERS means the Water Tracking and Electronic Reporting System.

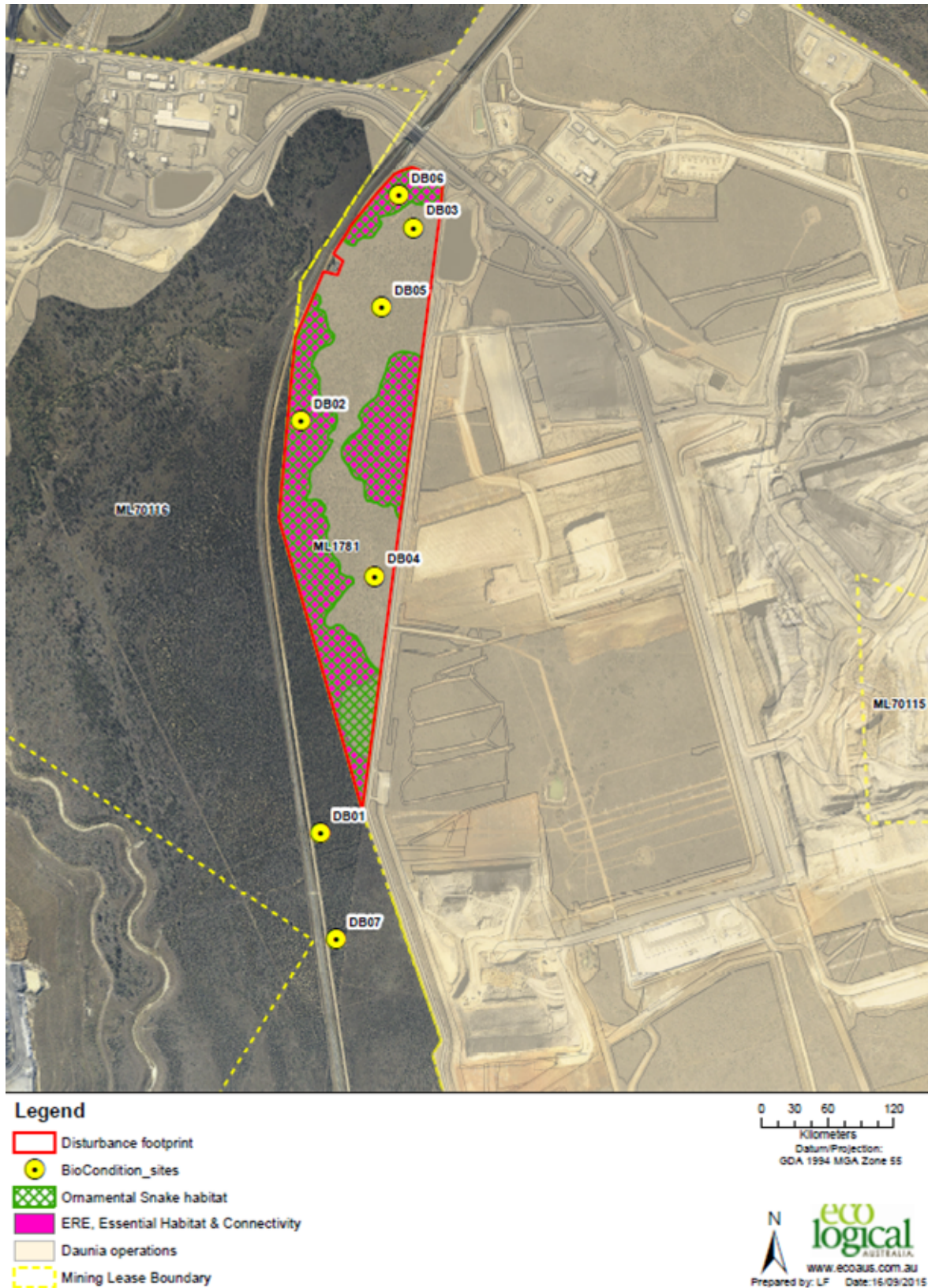
Wet season means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination, this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

µg/L means micrograms per litre.

µS/cm means microsiemens per centimetre.

END OF DEFINITIONS

Figure 1 (Significant Residual Impacts to Prescribed Environmental Matters)



END OF ENVIRONMENTAL AUTHORITY

Notice

Environmental Protection Act 1994

Progressive rehabilitation and closure plan transition notice

This statutory notice is issued by the administering authority¹ under section 754 of the Environmental Protection Act 1994 to advise you that you must submit a proposed Progressive rehabilitation and closure plan (PRC plan).

BHP Coal Pty Ltd
Level 14, 480 Queen Street
BRISBANE CITY QLD 4000

Email: peter.conway@bhp.com; trudy.mazucco@bhp.com

Attention: Peter Conway & Trudy Mazucco

Our reference: EPML00561913

Transition Notice for a PRC plan

1 Environmental authority details

Environmental authority EPML00561913 dated 13 August 2020 issued to QCT Mining Pty Ltd, Mitsubishi Development Pty Ltd, BHP Coal Pty Ltd, QCT Resources Pty Ltd, QCT Investment Pty Ltd, Umal Consolidated Pty Ltd, and BHP Queensland Coal Investments Pty Ltd.

Land description: ML1781, ML70115 and ML70116.

2 Required action

The holder(s) of environmental authority EPML00561913 must submit a proposed PRC plan that meets the requirements in sections 126C and 126D of the *Environmental Protection Act 1994*, pursuant to section 754 of the *Environmental Protection Act 1994*. The holder(s) must submit the proposed PRC plan to the administering authority, by **1 July 2023**.

3 Transitional provisions

Pursuant to the transitional provisions in section 754(3) of the *Environmental Protection Act 1994*, the holder(s) of the environmental authority is/are not required to comply with the requirements under section 126C(1)(g) or (h), or 126D(2) or (3) of the *Environmental Protection Act 1994* if—

- (a) an outcome for the land has been identified under a land outcome document; and

¹ The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

Notice

Progressive rehabilitation and closure plan transition notice

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

A land outcome document is defined under section 750 of the *Environmental Protection Act 1994*.

Section 126C(1)(g) or (h), or 126D(2) of the *Environmental Protection Act 1994* require reasons and evidence to be provided to support a proposed non-use management area.

Section 126D(3) of the *Environmental Protection Act 1994* provides for any void that is contained wholly or partly in a flood plain to be rehabilitated to a stable condition.

In accordance with section 754(4) of the *Environmental Protection Act 1994*, if a land outcome document does not state sufficient detail to identify either the location or area of the land to which the outcome relates, the proposed PRC plan must state—

- (a) if the area is not identified — how the total area of the land to which the outcome relates will be minimised; and
- (b) if the location is not identified — how the mining environmental authority holder will ensure the location of the land to which the outcome relates minimises risks to the environment.

4 Supporting information

As detailed in section 2 of this notice, your PRC plan and associated PRCP schedule is required to address the relevant legislative requirements.

Please refer to the guideline Progressive Rehabilitation and Closure Plans (ESR/2019/4964) for more information about the requirements of the PRC plan and associate PRCP schedule, and the assessment process.

5 Consultation

The administering authority recommends that you request a pre-lodgement meeting to discuss the requirements of the proposed PRC plan in more detail. To request a pre-lodgement meeting, please completed and lodge the form 'Application for pre-lodgement services' (ESR/2015/1664) to arrange a meeting.

Should you have any questions in relation to this notice, please contact Alison Sinclair on telephone 0436 693 333.



Signature

25/11/2020

Date

Chris Wake
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

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DAUNIA MINE

Transitional PRC Plan Hydrogeology

Prepared for:

BMA
480 Queen St
Brisbane QLD 4000 Australia

SLR Ref: 620.30984.00000-R02
Version No: -v4.0
March 2023



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BASIS OF REPORT

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

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30886.00000-R02-v4.0	28 March 2023	Derwin Lyons	Brian Rask	Derwin Lyons
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620.30886.00000-R02-v2.0	9 December 2022	Derwin Lyons	Brian Rask	Derwin Lyons
620.30886.00000-R02-v1.0	26 August 2022	Duncan Dawson	Derwin Lyons	Derwin Lyons

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1 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BM Alliance Coal Operations Pty Ltd (BMA) to undertake a hydrogeological assessment supporting the Daunia Mine (DNM) transitional Progressive Rehabilitation and Closure Plan (PRC Plan). This hydrogeological assessment is undertaken in accordance with the relevant requirements of the Queensland Government Department of Environment and Science (DES) Guideline: Progressive Rehabilitation and Closure Plans (DES Reference: ESR/2019/4964, version 2.00, effective 17 Mar 2021) - “the Guideline”. The assessment will be integrated into the design of the rehabilitation strategies and selection of post mining land uses (PMLUs) and Non-use Management Areas (NUMAs) within the DNM PRC Plan.

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

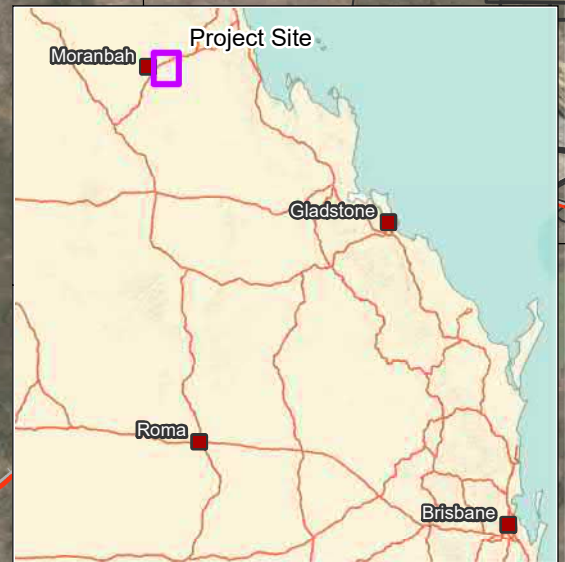
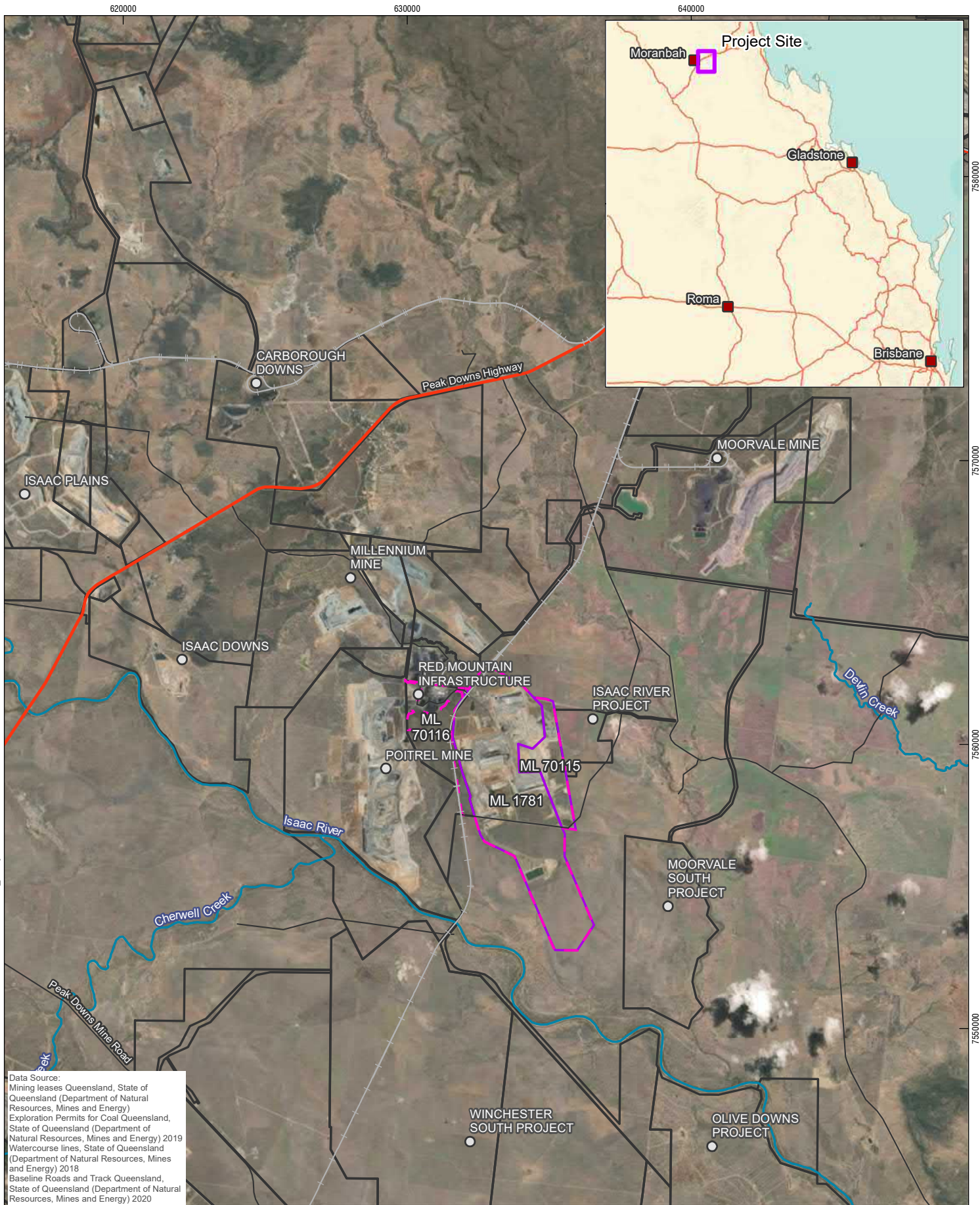
Located in the proximity of DNM are the following mining operations (**Figure 1-1**):

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

The most recent hydrogeological study relevant to the DNM transitional PRC Plan is the draft study undertaken for the Pandora Pit Project (SLR, 2022a). That body of work has been drawn upon as directly relevant to this hydrogeological assessment, including the development of a conceptual groundwater model for DNM. A numerical groundwater model for DNM, based on BMA’s regional numerical groundwater model, was developed by SLR (2021a) in support of Water License reporting and is also directly relevant to this hydrogeological assessment. That model was updated in 2022 for BMA’s Saraji East Mining Lease Project (SLR, 2022b) with the updated version of the model adopted for this hydrogeological assessment.

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

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



Data Source:
Mining leases Queensland, State of Queensland (Department of Natural Resources, Mines and Energy)
Exploration Permits for Coal Queensland, State of Queensland (Department of Natural Resources, Mines and Energy) 2019
Watercourse lines, State of Queensland (Department of Natural Resources, Mines and Energy) 2018
Baseline Roads and Tracks Queensland, State of Queensland (Department of Natural Resources, Mines and Energy) 2020



0 2.5 5 km

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:175,000 at A4
Project Number: 620.30984
Date: 01-Dec-2022
Drawn by: NT

LEGEND

- Surrounding Mine/Project
- Road
- Major Watercourse
- Rail
- Principal Road
- DNM EA Boundary
- DNM Mine Lease
- Mine Lease

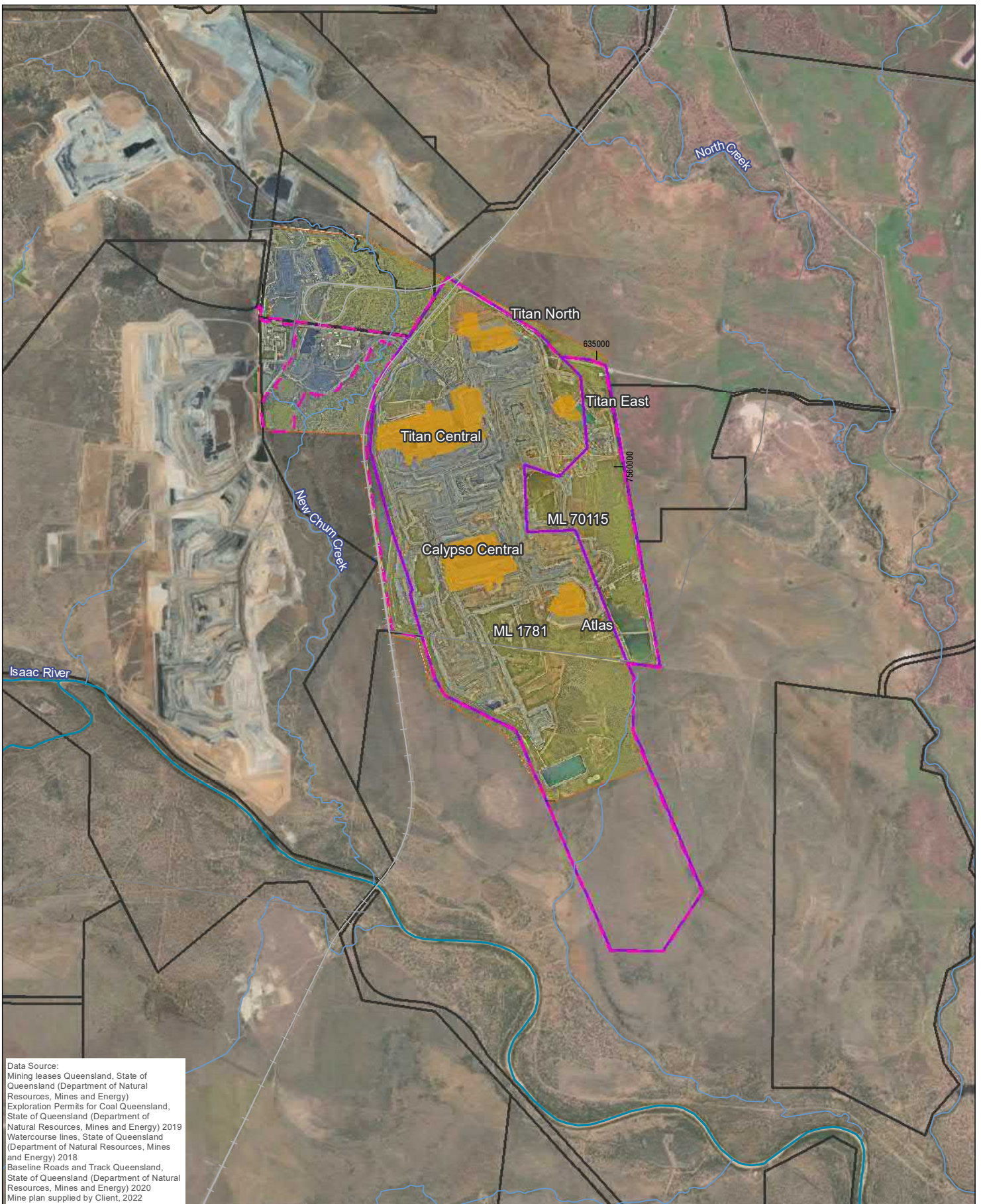
DAUNIA MINE TRANSITIONAL PRCP

LOCALITY PLAN



FIGURE 1-1

H:\Projects-SLR\620-BNE\620-BNE\620-30984-00000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\GIS\DNM\62030984_F01_2 Mining Areas.mxd



Data Source:
Mining leases Queensland, State of
Queensland (Department of Natural
Resources, Mines and Energy)
Exploration Permits for Coal Queensland,
State of Queensland (Department of
Natural Resources, Mines and Energy) 2019
Watercourse lines, State of Queensland
(Department of Natural Resources, Mines
and Energy) 2018
Baseline Roads and Track Queensland,
State of Queensland (Department of Natural
Resources, Mines and Energy) 2020
Mine plan supplied by Client, 2022



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 16-Mar-2023

Drawn by: NT

LEGEND

- | | |
|-------------------|-----------------|
| Major Watercourse | Active Pit |
| Minor Watercourse | DNM EA Boundary |
| Rail | DNM Mine Lease |
| Road | Mine Lease |

DAUNIA MINE TRANSITIONAL PRCP

CURRENT MINING AREAS



FIGURE 1-2

1.2 Final Landform (Landform #2)

The post-mining final DNM landform relevant to this hydrogeological assessment was provided by BMA (denoted Landform #2) and is shown as **Figure 1-3**. This is a preliminary final landform provided for the timely commencement of this hydrogeological assessment, however there are no fundamental changes in the final landform presented in the PRC Plan that would affect this assessment. The final landform contains three residual final voids: Titan North/Central Void, Titan East Void, and Pandora Void. The final landform was a preliminary (2nd iteration) final landform provided by BMA to assess the suitability of BMA's intended Post Mining Land Use (PMLU) at DNM, which includes 'Woodland Habitat', 'Grazing' and 'Water Course' as defined within Table E1 of the EA.

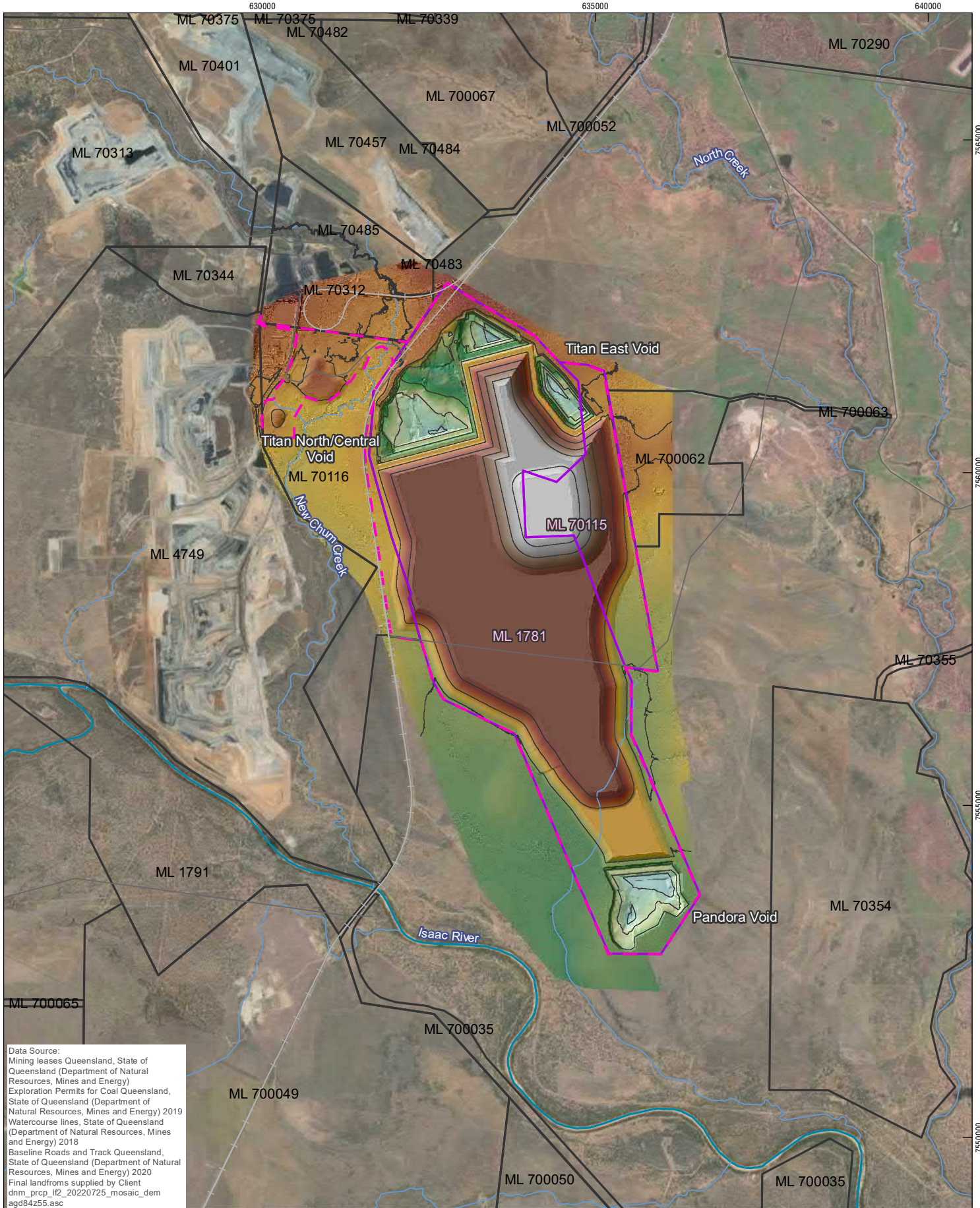
1.3 Objectives

The main objective of the hydrogeological assessment is to assess the potential groundwater related impacts at DNM at completion of mining and until conditions stabilise post rehabilitation (i.e. groundwater equilibrium). A focus of the hydrogeological assessment is demonstrating suitability of the landform for the intended PMLU with respect of the DNM groundwater system. As such, the key specific objectives adopted in this assessment from which to demonstrate this suitability are:

- That the final landform is non-polluting with respect to groundwater:
 - Final voids are demonstrated to be sinks for groundwater, including groundwater contained within spoil.
 - Final void lake levels remain below shallow groundwater bearing units, i.e. there is sufficient freeboard to negate risk of void water discharge to any shallow groundwater system.
- That there are minimal additional impacts to groundwater receptors post-closure caused by the final landform that have not already occurred as a result of approved mining:
 - Little to no additional groundwater drawdown at potential groundwater dependant ecosystem (GDE) locations.
 - Little to no additional groundwater drawdown at anthropogenic bore users.

1.4 Guideline Criteria

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



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 05-Dec-2022

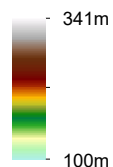
Drawn by: NT



LEGEND

- Major Watercourse
- Minor Watercourse
- Rail
- Road
- DNM EA Boundary
- DNM Mine Lease
- Mine Lease

Final Landform Elevation (m)



DAUNIA MINE TRANSITIONAL PRCP

POST MINING LANDFORM

FIGURE 1-3

Table 1-1 Guideline Requirements

Guideline Requirement	Section of this Report
Section 3.6.1 General rehabilitation practices – Hydrogeology	
Determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards	Section 3.2 Section 4.4
Locating groundwater recharge and discharge locations locally and regionally	Section 4.4
Groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs)	Section 4.5
Current and potential future uses of groundwater including existing groundwater extraction bores	Section 4.6
Groundwater flow direction and velocity, including field tests to determine hydraulic conductivity	Section 4.3 Section 4.5
The development of potentiometric mapping and hydro stratigraphic cross sections	Section 4.4 Section 5
Groundwater modelling to determine contaminant transport and potential changes to groundwater level from dewatering or waste storage.	Section 6

2 Climate, Topography and Drainage

2.1 Climate

The climate at the Study Area is sub-tropical with higher temperatures, higher rainfall and higher evaporation occurring over the summer months (December to February). The closest Bureau of Meteorology (BoM) weather station is located at Iffley (station 34100), 18 km to the southeast of DNM. This weather station has been in operation since 1998 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. Moranbah Airport weather station is relatively close to the site, being 20 km to the west of DNM, however has a comparatively short monitoring period, being opened in February 2012. **Table 2-1** provides the details of the nearby operational weather stations.

Table 2-1 Operational BoM Weather Stations near to DNM

Name	Site Number	Date Commenced	Easting (GDA94)	Northing (GDA94)	Elevation (mAHD)	Operational Status	Distance from DNM
Iffley	34100	1998	647356	7539801	173	Open	18 km SE
Moranbah Airport	34035	2012	610999	7559653	232	Open	20 km W
Nebo	33054	1870	674643	7600656	195	Open	57 km NE
Carfax	34016	1962	673063	7515595	128	Open	59 km SE

mAHD = metres Australian Height Datum.

The Queensland government operates a database of long term climate data termed SILO (Scientific Information for Land Owners) with interpolation across a state wide grid based on observation stations. Monthly averages for the four nearest stations and the SILO data are listed in SILO Grid point data (Latitude: -22.05, Longitude: 148.30), which was used to assess long-term rainfall trends in the vicinity of DNM. This dataset is interpolated from quality checked observational timeseries data collected at nearby stations by the BoM. Data from January 1900 until August 2022 was used to assess the long-term rainfall trends in the vicinity of DNM. From this data, the average annual site rainfall is 566.2 millimetres (mm). The two highest annual rainfalls were recorded for the years 1956 and 2010, with annual rainfalls of 960.2 mm and 1,063 mm, respectively. The minimum annual rainfall occurred in 2018 with 268.6 mm. Monthly averages for the stations discussed as well as the SILO grid point are listed in **Table 2-2**.

Table 2-2 Average Monthly Rainfall

Rainfall (mm)	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	33.8	59.9	87.4	554.3
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	539.5
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	747.4
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	614.5
SILO Grid Point Data	103.6	92.6	67.4	30.2	26.6	27.8	21.5	17.9	13.9	29.2	52.8	82.6	566.2

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 SILO Grid point data (Latitude: - 22.05, Longitude: 148.30) from 1962 are indicative of the cumulative deviation from mean (CDFM) monthly rainfall (**Figure 2-1**). Positive gradients on this curve (rising limbs) confirm wetter conditions than normal, while negative gradients (falling limbs) indicate dry conditions. Average rainfall conditions are inferred during periods of stable residual mass. **Figure 2-1** shows that, over the past 50 years, the wettest periods occurred during 1973-1979, 1987-1991, 1998-2001 and 2010-2012. The driest periods were 1963-1970, 1991-1998 and 2001-2007. As shown by the declining trend in the CDFM, since 2017 DNM has experienced drier than average conditions.

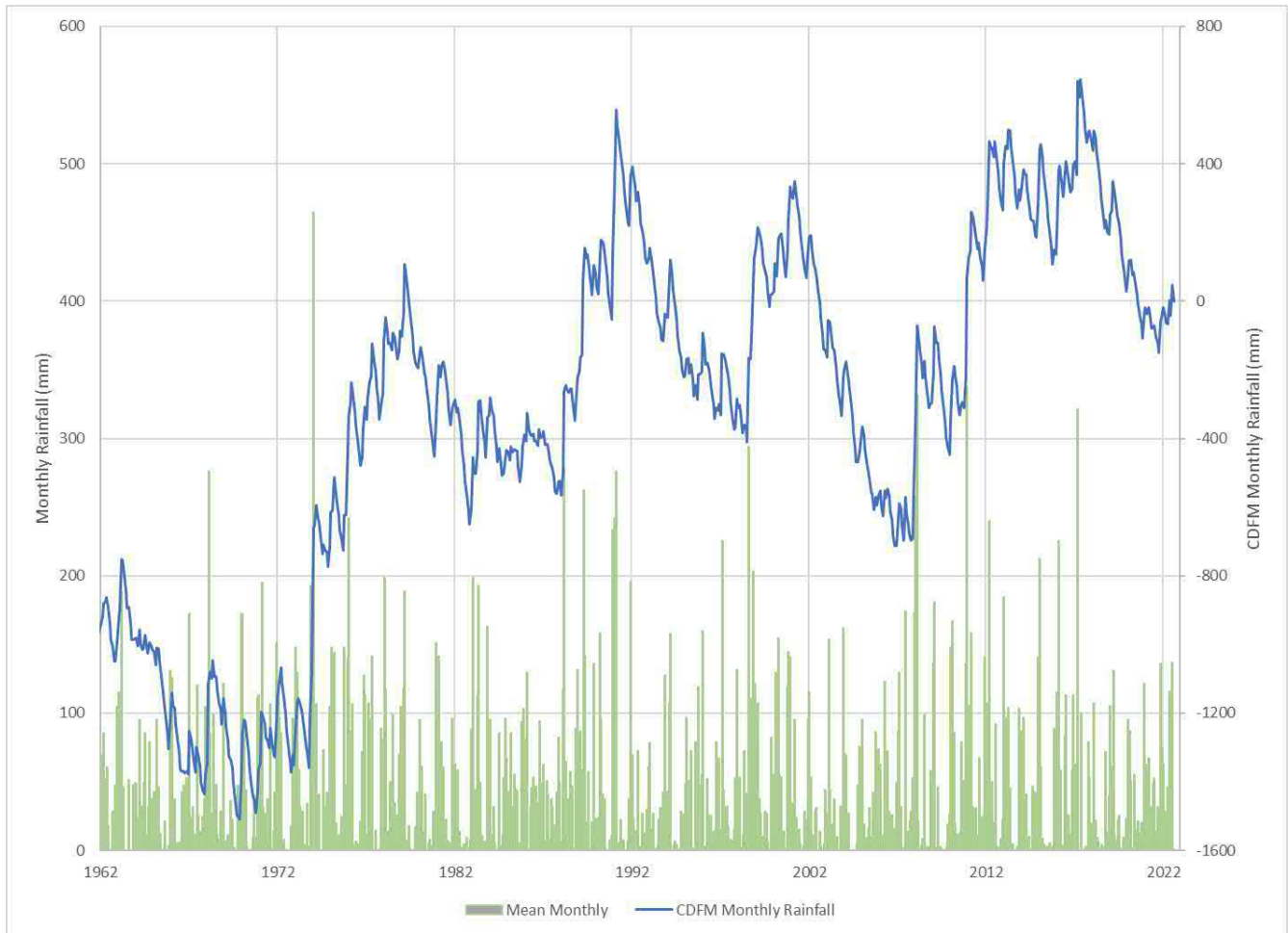


Figure 2-1 Long-term Monthly Rainfall and Rainfall Cumulative Deviation from Mean

The CDFM performs an additional service: if rainfall recharge is a significant source of groundwater, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of this curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, illustrated by the rainfall CDFM. Groundwater hydrographs showing the relationship between rainfall and groundwater levels are assessed in **Section 4**.

Actual and potential evapotranspiration (ET) have been taken from BoM's Australia wide interpolation dataset at the weather stations where modern measurement of ET has taken place (BoM, 2022). The potential ET in the district is approximately 2,302 mm/yr according to BoM (2022) (**Table 2-3**). 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. Further to this, where the water table approaches the ground surface, ET can also approach the potential ET value.

Table 2-3 Average Monthly Potential Evapotranspiration (PET)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	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

PE = Potential Evapotranspiration.

The actual ET in the district is approximately 1,156 mm/year according to BoM (2022) (**Table 2-4**). The definition for actual ET is: "... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the predicted ET that is occurring over a large area of land under the existing (mean) rainfall conditions.

Table 2-4 Average Monthly Actual Evapotranspiration (AET)

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

AE = Actual Evapotranspiration.

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

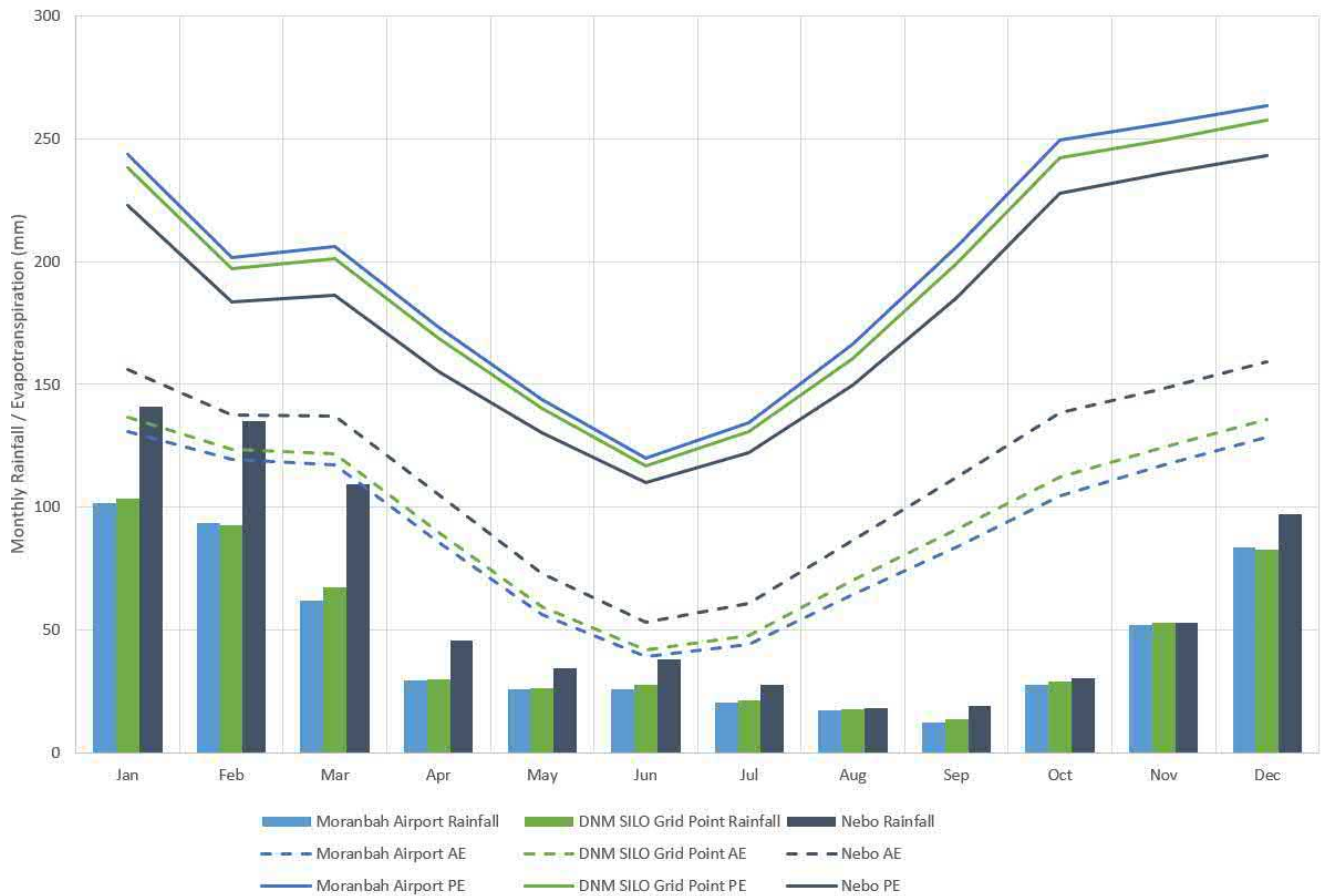


Figure 2-2 Average Monthly Rainfall and Evapotranspiration at Nearby Weather Stations

2.2 Topography and Drainage

DNM is located in the Upper Isaac surface water catchments of the Isaac River Sub-Basin. The topography of the DNM Area gradually slopes from northeast to southwest towards the Isaac River (which is located outside the DNM Area), with elevations ranging from approximately 210 mAHD to 240 mAHD (**Figure 2-4**).

All watercourses and tributaries within and in the vicinity of DNM are ephemeral and only flow briefly after rainfall. After significant rainfall, water remains in ponds that are used as livestock water sources.

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

North Creek is located approximately 3.5 km west of DNM, draining north to the south and joining the Isaac River approximately 7.5 km downstream of DNM.

There is a Queensland Government gauging station located at Isaac River at Deverill (station 130410A), located approximately 15 km downstream of DNM. As at 10 August 2022, three flow events (peak flow greater than 1,000 m³/s) have been recorded at this gauge; March 1979, March 1988 and February 2008. The greatest discharge was recorded in March 1988 at 1,530 m³/s.

Table 2-5 presents a summary of the stream gauge station along the Isaac River near DNM, derived from the Queensland Government Water Monitoring Information Portal (WMIP) (DoR, 2019). **Figure 2-4** shows the relative location of the stream gauging station.

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

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

ML/day = megalitres per day, GL/day = gigalitres per day.

Figure 2-3 presents daily mean stream discharge at the Isaac River at Deverill station (130410A) from 1968 to present, compared against daily rainfall at Carfax station (34016) 40 km to the southeast, which is the most appropriate rainfall station to compare the long term stream discharge data to since other nearby rainfall stations have a comparatively short historical record. The data show that flows within the Isaac River are typically ephemeral, with short-duration flows generally occurring over the summer months.

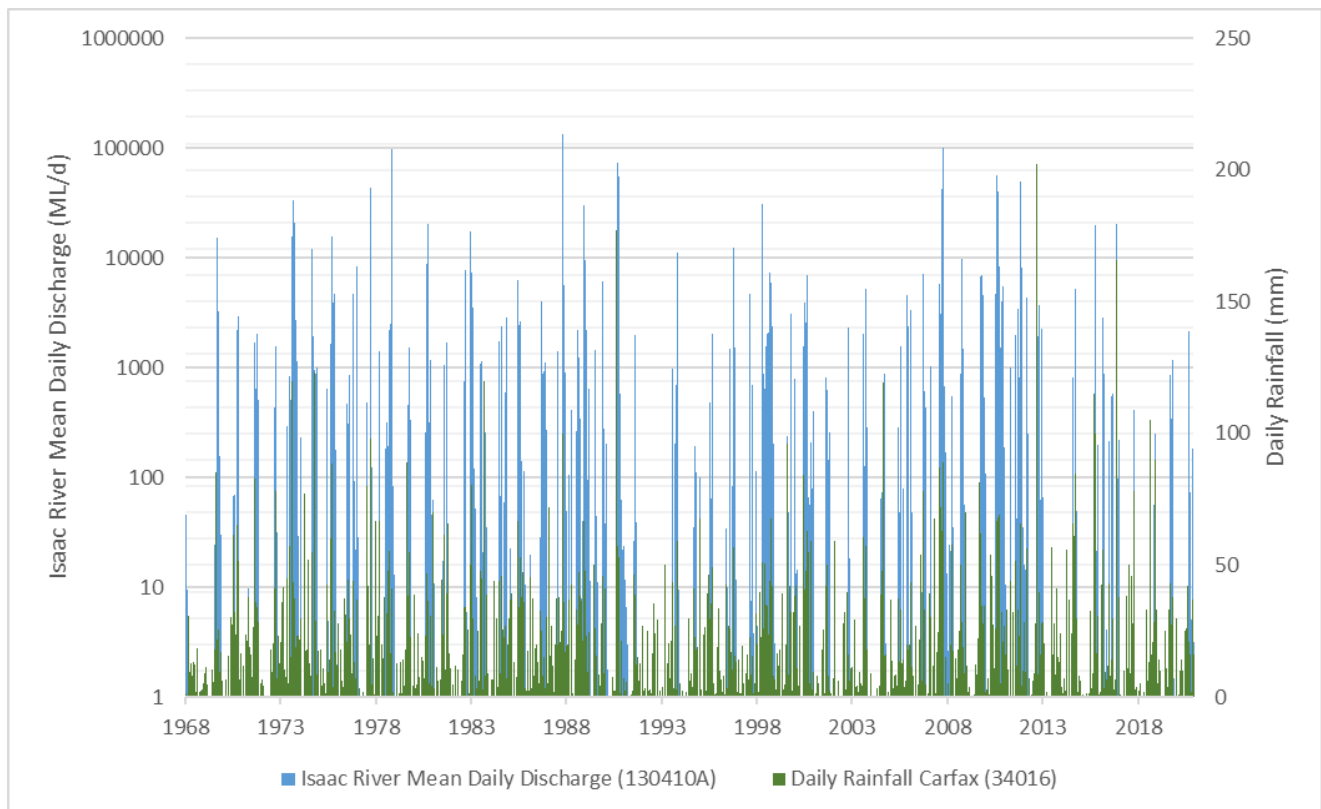
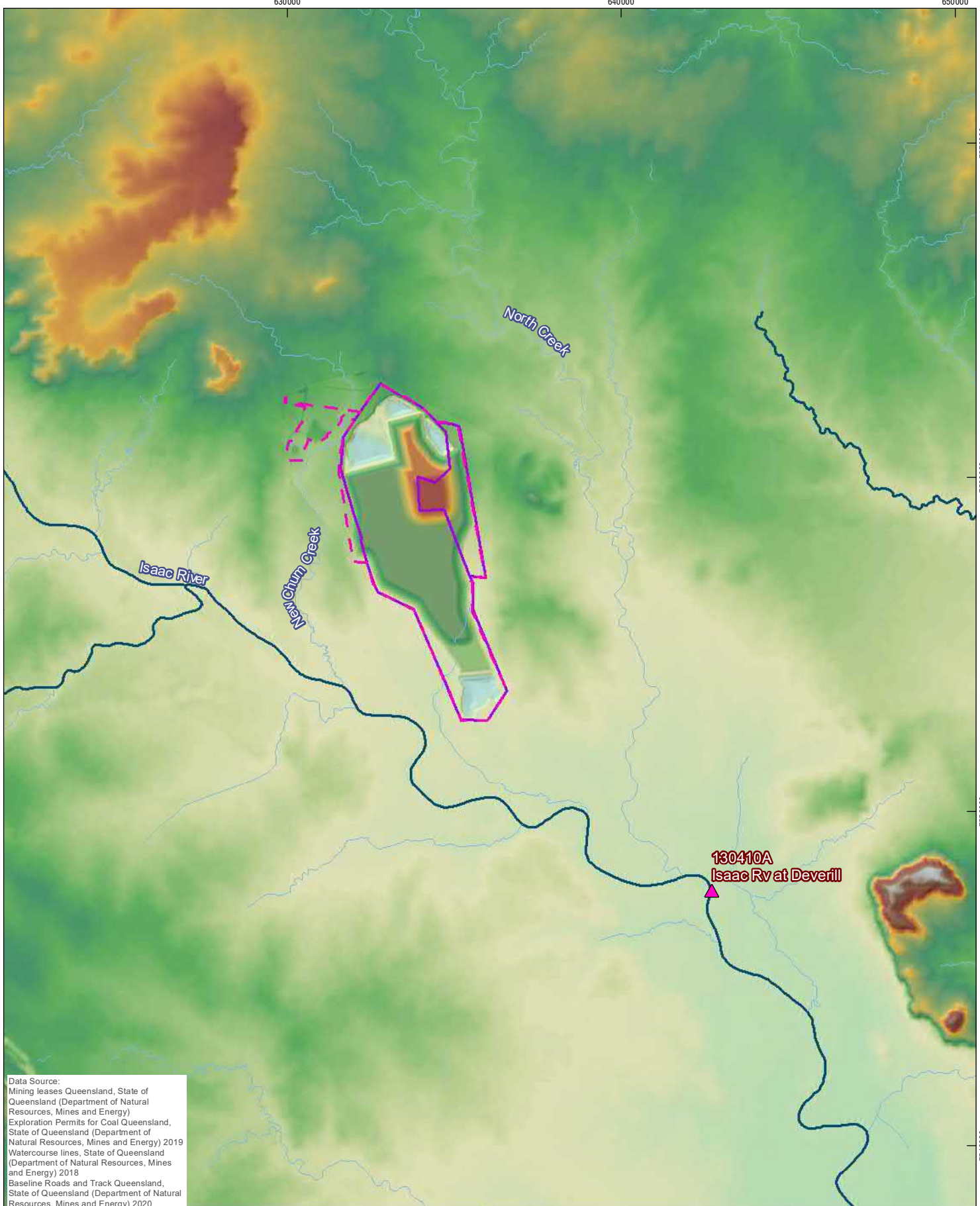
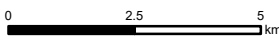


Figure 2-3 Isaac River (Station 130410A) Stream Flow and Rainfall at Carfax (Station 34016)



Data Source:
Mining leases Queensland, State of
Queensland (Department of Natural
Resources, Mines and Energy)
Exploration Permits for Coal Queensland,
State of Queensland (Department of
Natural Resources, Mines and Energy) 2019
Watercourse lines, State of Queensland
(Department of Natural Resources, Mines
and Energy) 2018
Baseline Roads and Track Queensland,
State of Queensland (Department of Natural
Resources, Mines and Energy) 2020

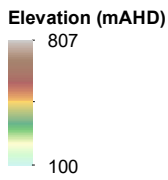


Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:150,000 at A4
Project Number: 620.30984
Date: 07-Dec-2022
Drawn by: NT



LEGEND

- ▲ Stream Gauge
- Major Watercourse
- Minor Watercourse
- - - DNM EA Boundary
- ▭ DNM Mine Lease



DAUNIAI MINE
TRANSITIONAL PRCP

TOPOGRAPHY AND DRAINAGE

FIGURE 2-4

Based on daily flow data since 1968, **Figure 2-5** shows that the Isaac River is highly ephemeral, flowing only 26 % of the time, with less than 9 % probability of flows exceeding 100 ML/day. Less than 0.3 % of readings exceed 10,000 ML/day, which includes high flow/flood events in 2008 (January and February), 2010 (December), 2012 (March), 2016 (February), 2017 (March) and 2021 (January).

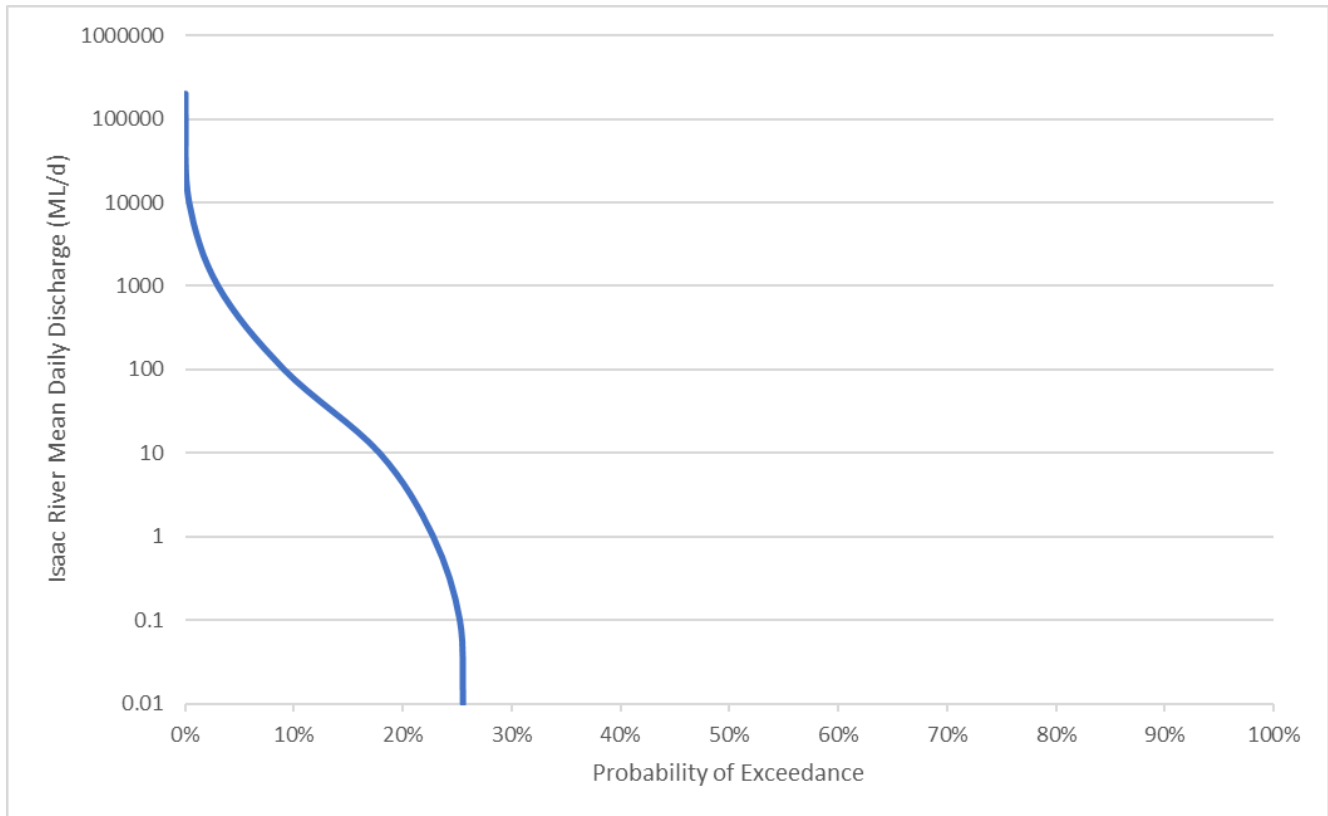


Figure 2-5 Isaac River (Station 130410A) Mean Daily Flow Duration Curve (1968 – 2022 data)

3 Geology

3.1 Regional Geology

DNM is located in the northern part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km² (**Figure 3-1**). The Bowen Basin is a north-northwest to south-southeast oriented basin and contains the largest coal reserves in Australia. The southern half of the Bowen Basin is covered by the Surat Basin, and the Galilee Basin exists to the west (Geoscience Australia, 2017).

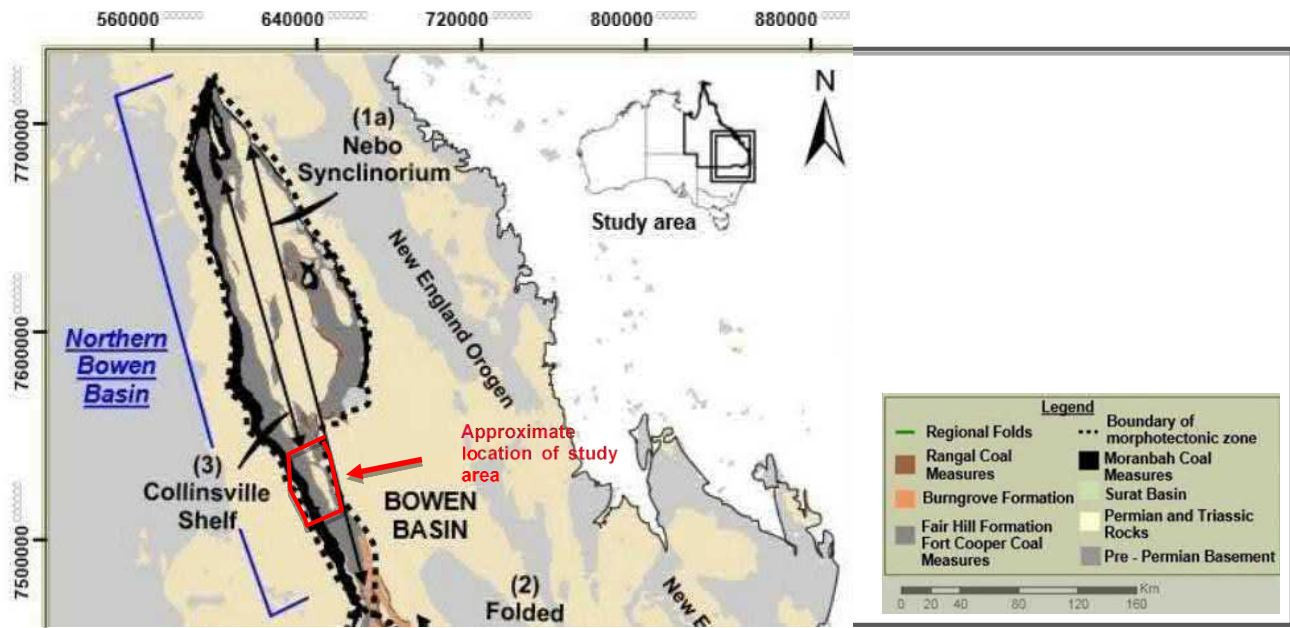


Figure 3-1 Structural Setting of the Bowen Basin (after Dickens and Malone, 1973)

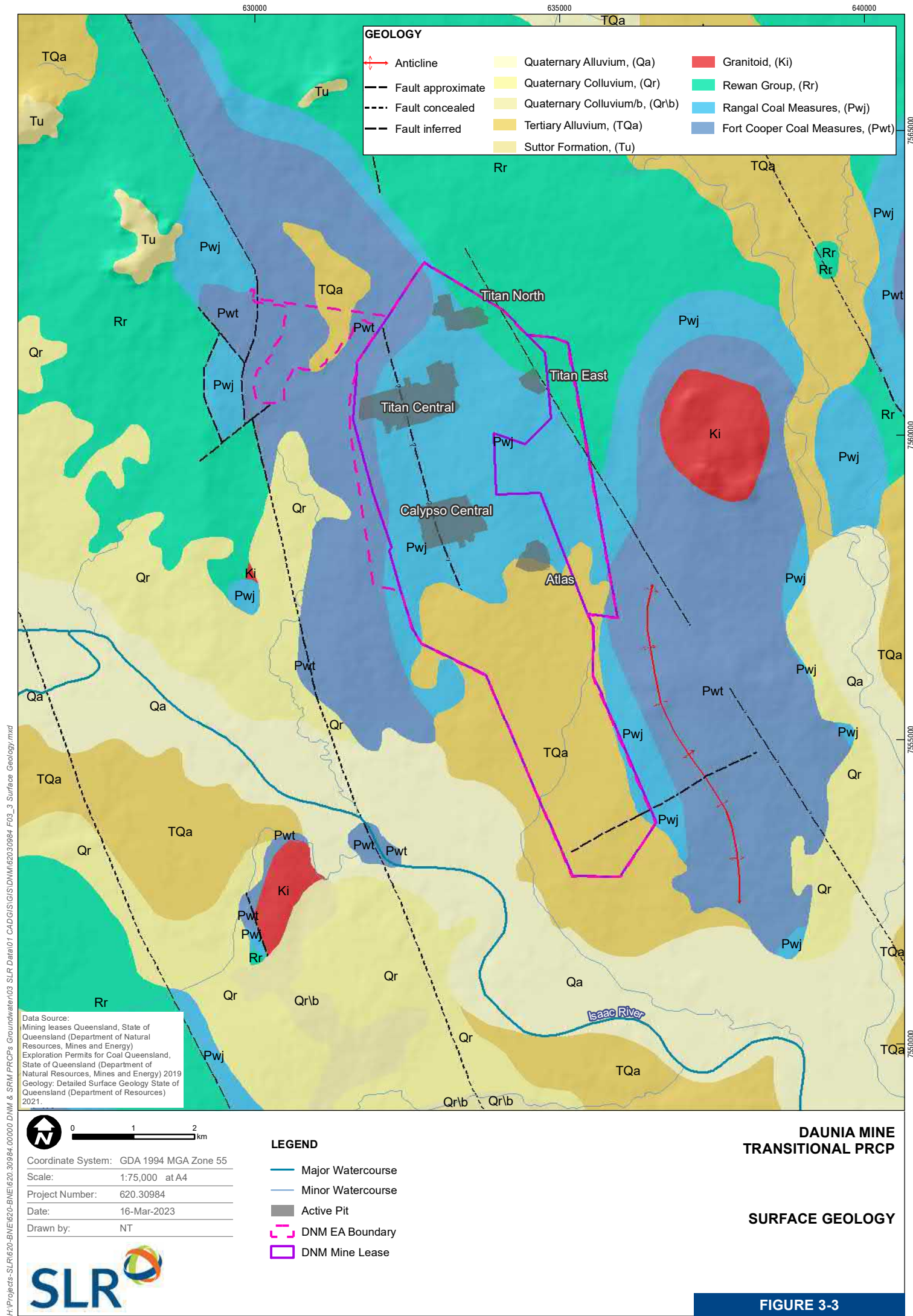
Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which generally comprises of generally fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Moranbah Coal Measures, Fort Cooper Coal Measures and Rangal Coal Measures. The economic seams at DNM are contained in the Rangal Coal Measures. The Permian strata occurs as outcrops on the eastern and western edges of the Basin and are unconformably overlain by the Triassic aged consolidated sedimentary rocks of the Rewan Group. Isolated pockets of remnant quartzose sandstones of the Middle Triassic Clematis Group are also mapped 8km southeast of the DNM Area, on the eastern side of the Isaac River.

The Permian and Triassic units are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (i.e. Isaac River and New Chum Creek). Whilst not present in the DNM Area, volcanic extrusions (i.e. basalt) are also present within the region.

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

Table 3-1 Regional Stratigraphy

Table 1 Regional Stratigraphy						
Period		Stratigraphic Unit		Description	Distribution	Max Thickness (m)
Cainozoic		Isaac River Quaternary alluvium (Qa)		Flood plain alluvium comprising clay, silt, sand and gravel.	Surficial cover localised along Isaac River and New Creek	~ 50 m
		“Regolith” - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qr, Qr\b and TQa)		Shallow unconsolidated and semi-consolidated sediments and weathered units outside of Quaternary alluvium (Qa), comprising 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 southern DNM, localised along Isaac River, New Chum Creek and unnamed drainage features.	~ 20 m
Triassic		Mimosa Group	Clematis Group (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	Isolated outcrop 8 km southeast of the DNM Area.	~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 located at northeastern boundary of DNM. Outcrops within the Study Area located 8 km to the southwest and 3km to the north of DNM.	~840
Permian	Late	Blackwater Group	Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone and mudstone.	Within/underlies the whole DNM Area.	~200
			Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff.	Underlies the Rangal Coal Measures within whole DNM Area. Subcrops directly west of DNM area	~350
			Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone and coal.	Within/underlies the whole of DNM. Subcrops along eastern extents of CVM, PDM and SRM to the west of DNM Area.	~ 400
	Early to Middle	Back Creek Group (Pb)	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies all of DNM;	~400	



3.2 Local Geology

The stratigraphic profile within the DNM Area comprises three distinct units:

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

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

3.2.1 Cainozoic Sediments

3.2.1.1 Isaac River Alluvium

State (Queensland Government) Detailed Surface Geology (SDSG) mapping (**Figure 3-3**) shows that Quaternary alluvium (symbolised as Qa) is localised along the Isaac River, to the west and south of DNM. Revised mapping extents of the Isaac River alluvium as identified from geophysical surveys, slope break analysis and soil mapping for the Winchester South Project (SLR, 2020) is presented on **Figure 3-4**.

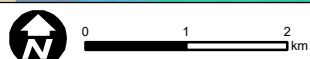
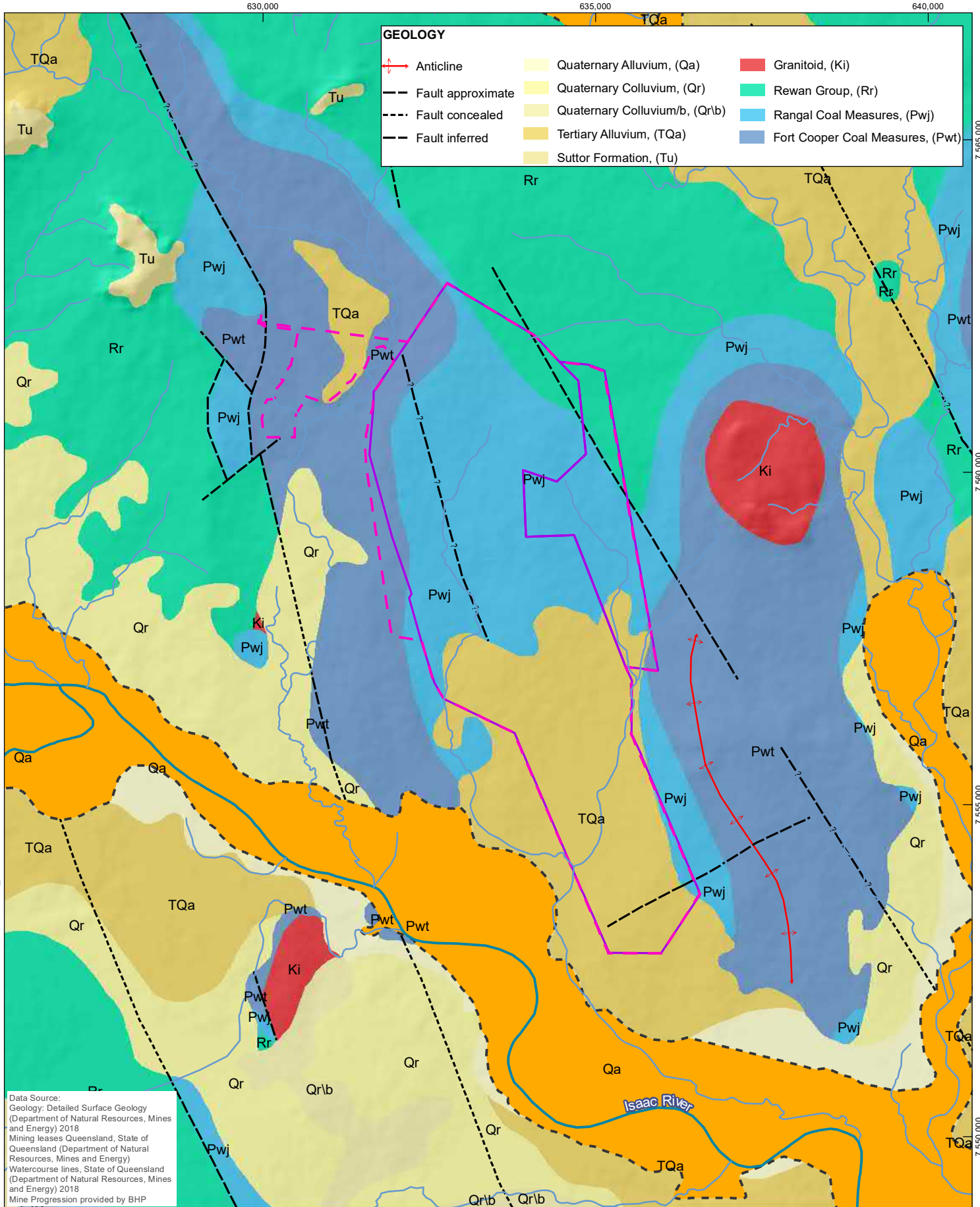
Quaternary alluvium deposits are described as unconsolidated sequences of clay, silt, sand and gravel sediments, which are generally less than 20 m in thickness (AGE, 2013) and are limited to the lower topographic areas outside the southern extent of DNM near to the Isaac River. Advisian (2018) report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

Figure 3-4 indicates that Quaternary alluvium associated with the Isaac River is mapped approximately 500 m to 1 km west of the DNM southwestern boundary.

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

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

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



Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:75,000 at A4
 Project Number: 620.30984
 Date: 30-Nov-2022
 Drawn by: NT



LEGEND

- Major Watercourse
- Minor Watercourse
- Revised Alluvium Extent (SLR, 2020)
- DNM EA Boundary
- DNM Mine Lease

**DAUNIA MINE
TRANSITIONAL PRCP**

**ISAAC RIVER
ALLUVIUM EXTENT**

FIGURE 3-4

3.2.1.2 Quaternary and Tertiary Sediments (Regolith)

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

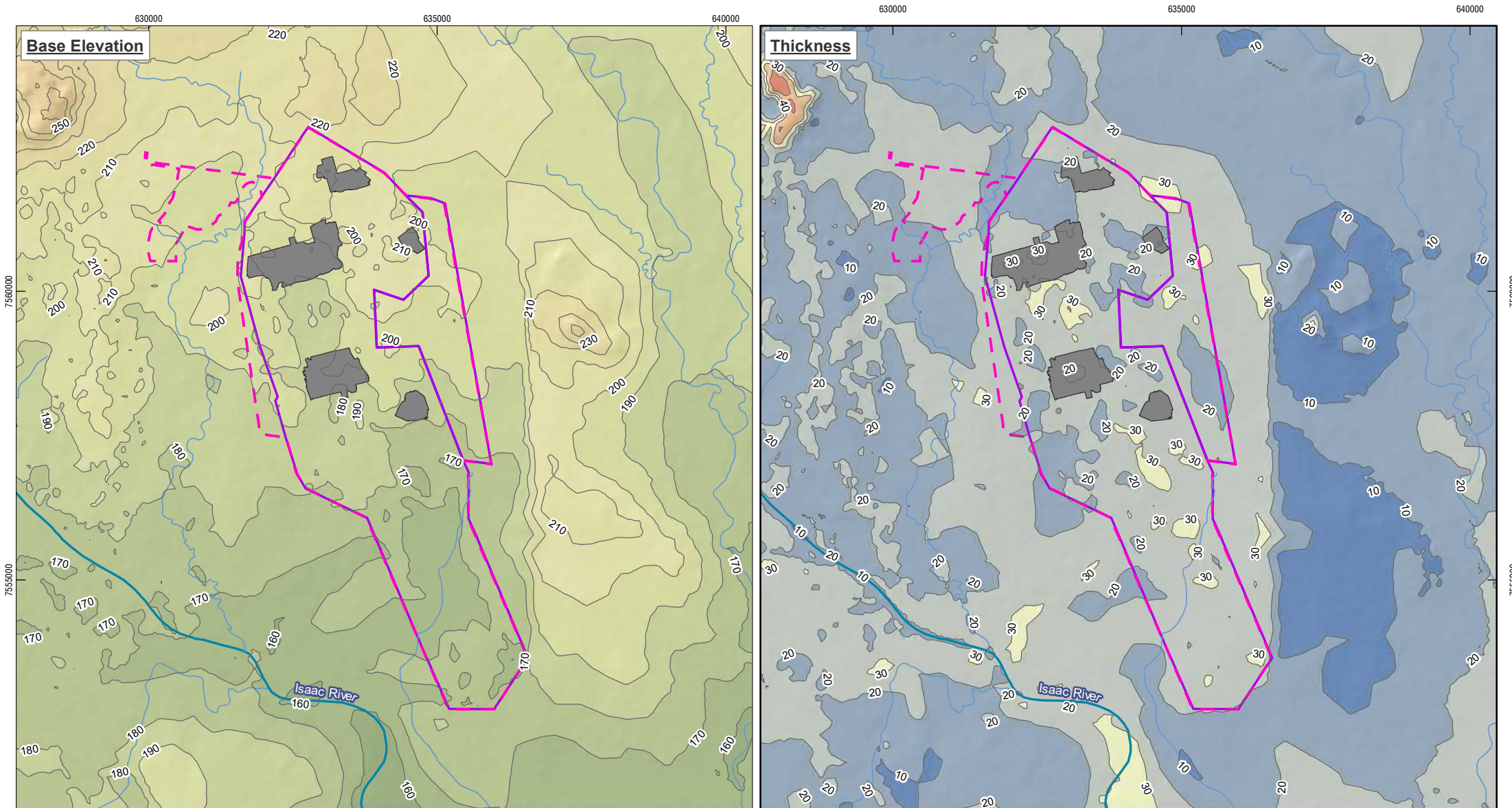
SDSG mapping shows Tertiary-Quaternary alluvium (TQa) deposits distributed in the southern areas of DNM only (**Figure 3-4**). TQa is defined in the SDSG mapping metadata as a poorly consolidated or unconsolidated alluvial deposit in an ancestral valley, which has been dissected by more recent channel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

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

3.2.2 Triassic Strata

The Triassic aged consolidated sedimentary rocks include the Rewan Group (Rr), which unconformably overlies the Permian coal measures as in-fill material. The Rewan Group regionally comprises Late Permian to Early Triassic strata with pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerates.

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



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:90,000 at A4
 Project Number: 620.30984
 Date: 30-Nov-2022
 Drawn by: NT

LEGEND

- Major Watercourse
- Minor Watercourse
- Active Pit
- DNM EA Boundary
- DNM Mine Lease

ELEVATION (mAHD)

- | | | |
|--|--|--|
| 150 - 160 | 190 - 200 | 230 - 240 |
| 160 - 170 | 200 - 210 | 240 - 250 |
| 170 - 180 | 210 - 220 | 250 - 260 |
| 180 - 190 | 220 - 230 | 260 - 270 |

— Elevation
 Contour
 (mAHD)

THICKNESS (m)

- | | |
|--|--|
| 0 - 10 | 30 - 40 |
| 10 - 20 | 40 - 50 |
| 20 - 30 | 50 - 60 |

— Thickness
 Contour (m)

DAUNIA MINE TRANSITIONAL PRCP

BASE ELEVATION AND THICKNESS OF SURFICIAL UNITS



FIGURE 3-5

3.2.3 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 decreasing depth (age) order, the major coal measures in the Study Area include (in order of increasing age):

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

Each of these units is discussed further below.

3.2.3.1 Rangal Coal Measures

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

The Leichhardt and Upper Vermont Seams occur within the Rangal Coal Measures and are the target seams for mining at DNM. The Leichhardt Seam (DL1) is typically 5 m thick and the Upper Vermont Seam (DV4) typically 3.5 m thick at DNM. The Leichhardt and Upper Vermont Seams are separated by approximately 10 m to 35 m of siltstone and sandstone interburden (BMA, 2009) (**Figure 3-6**). The Leichhardt Seam is highly weathered where it occurs at subcrop near the surface in the DNM Area. In the north of DNM, the Upper Vermont Seam splits into upper and lower plies (DV2 and DV1 respectively, **Figure 3-6**).

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

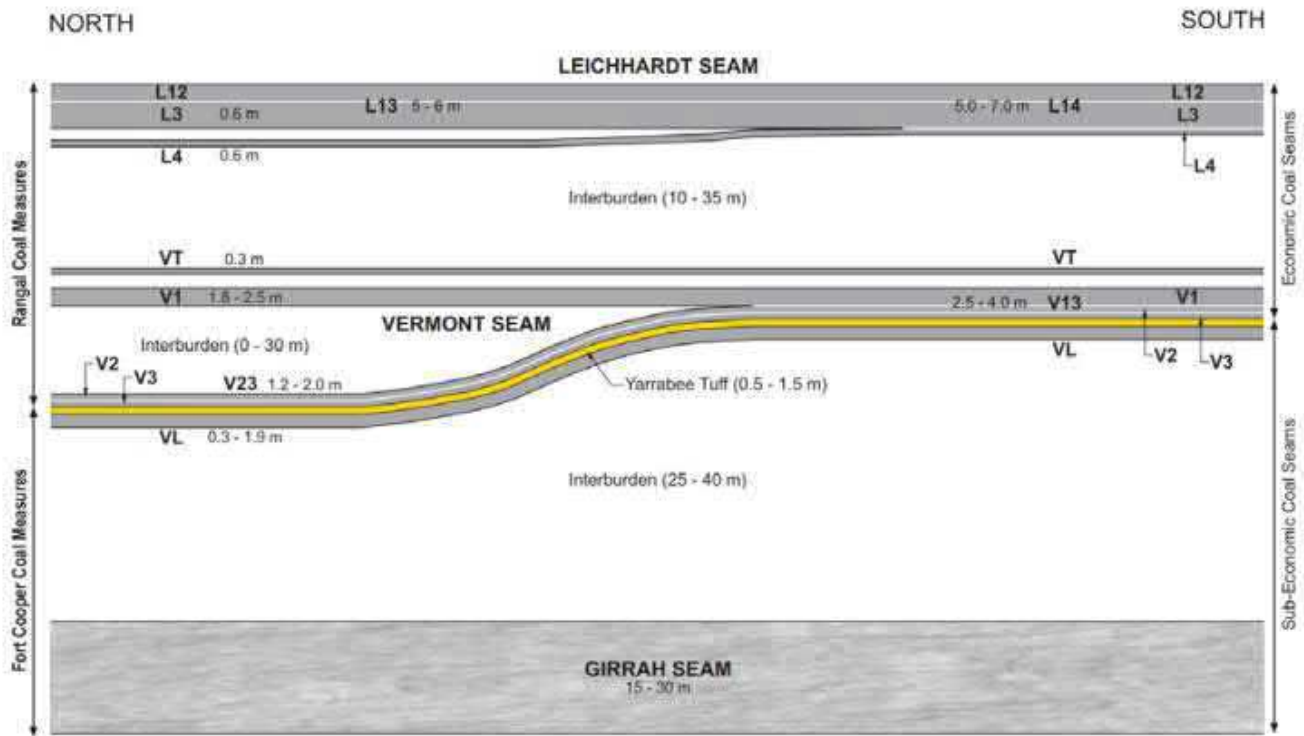


Figure 3-6 Schematic Correlation of Coal Seams at Daunia Mine (BHP, 2019)

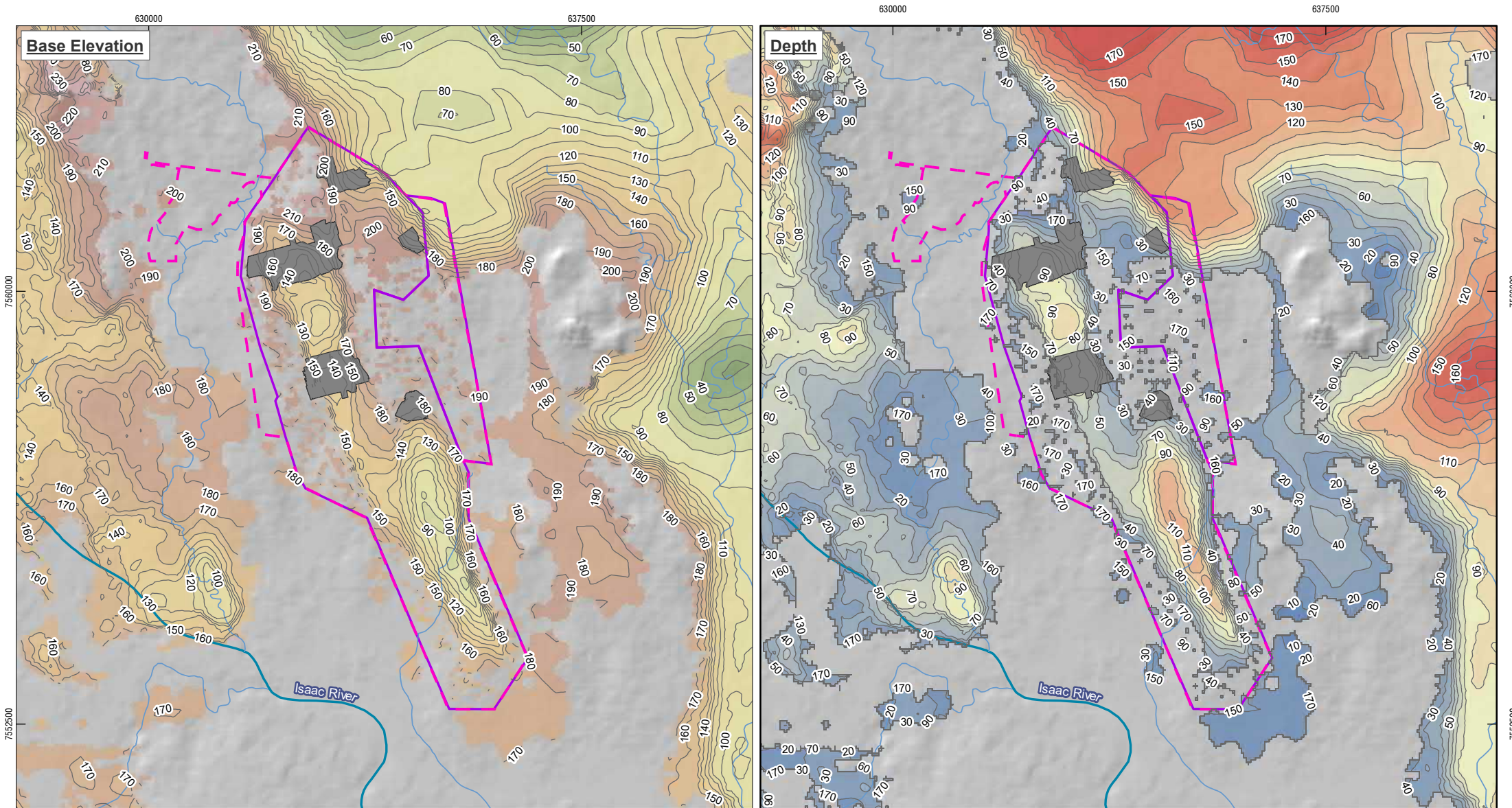
3.2.3.2 Fort Cooper Coal Measures

The Fort Cooper Coal Measures (Pwt) underlie the Rangal Coal Measures at DNM, and are only present at subcrop along the northwestern boundary of the DNM Area. The transition between the Rangal Coal Measures and the Fort Cooper Coal Measures is marked by the Yarrabee Tuff, which immediately overlies the Lower Vermont Seam (**Figure 3-6**). The Yarrabee Tuff is a basin-wide marker bed comprised of weak, brown tuffaceous claystone, with an average thickness of 0.7 m (ranging from 0.5 to 1.5 m thick at DNM). Note that in a hydrogeological sense, the Lower Vermont Seam of the Fort Cooper Coal Measures is considered collectively as a single hydrostratigraphic unit with the Upper Vermont Seam of the Rangal Coal Measures (see **Section 4.4.2**) given they are only separated by the thin Yarrabee Tuff.

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

3.2.3.3 Moranbah Coal Measures

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



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:90,000 at A4
 Project Number: 620.30984
 Date: 30-Nov-2022
 Drawn by: NT

LEGEND

- Major Watercourse
- Minor Watercourse
- Active Pit
- DNM EA Boundary
- DNM Mine Lease

ELEVATION (mAHD)

 20 - 30	 80 - 90	 140 - 150	 200 - 210
 30 - 40	 90 - 100	 150 - 160	 210 - 220
 40 - 50	 100 - 110	 160 - 170	 220 - 230
 50 - 60	 110 - 120	 170 - 180	 230 - 240
 60 - 70	 120 - 130	 180 - 190	 240 - 250
 70 - 80	 130 - 140	 190 - 200	 250 - 260

— Elevation Contour (mAHD)

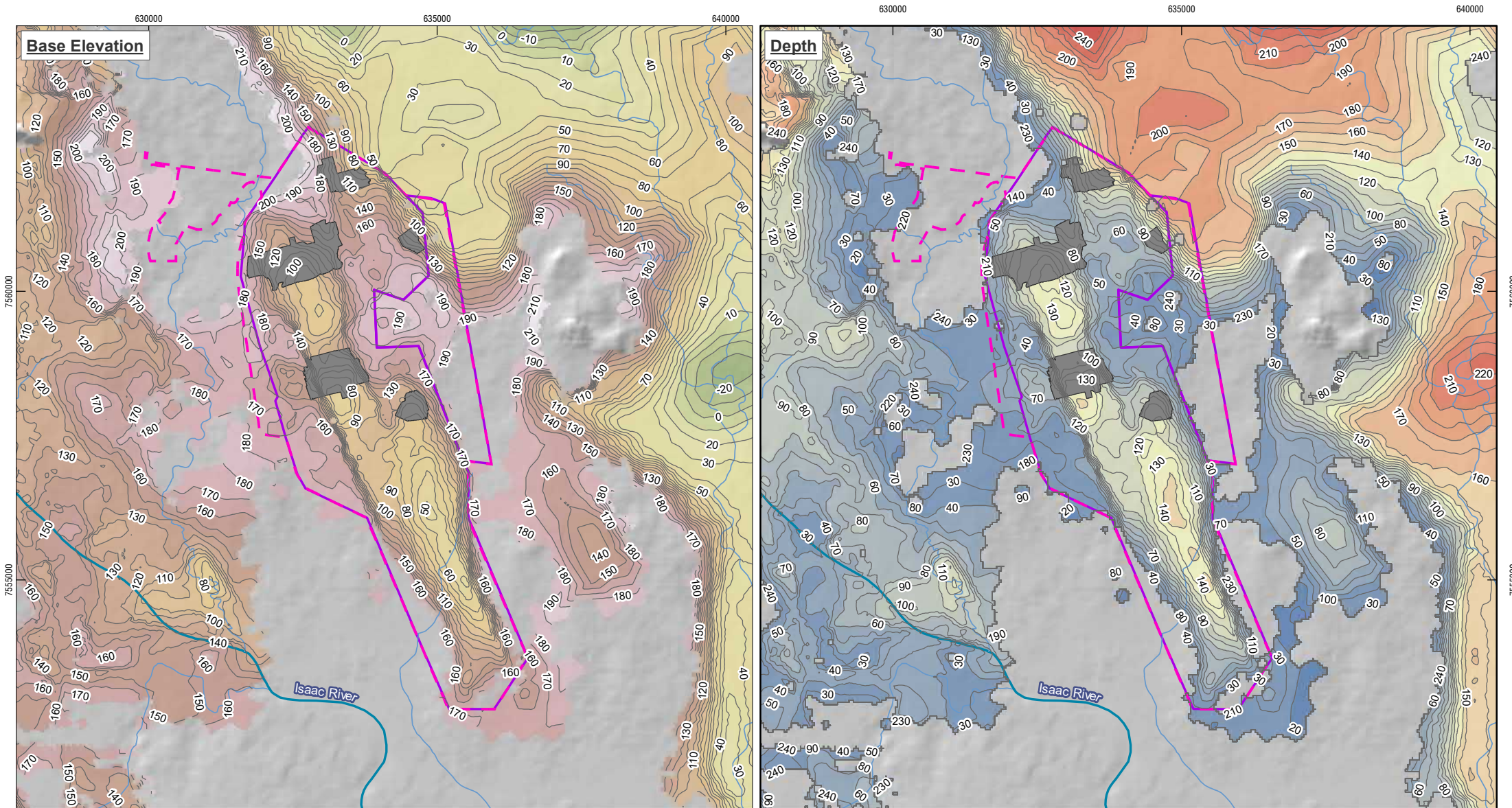
DEPTH (m)

 0 - 10	 60 - 70	 120 - 130
 10 - 20	 70 - 80	 130 - 140
 20 - 30	 80 - 90	 140 - 150
 30 - 40	 90 - 100	 150 - 160
 40 - 50	 100 - 110	 160 - 170
 50 - 60	 110 - 120	— Depth (m)

DAUNIA MINE TRANSITIONAL PRCP

BASE ELEVATION AND DEPTH TO LEICHHARDT SEAM

FIGURE 3-7



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:90,000 at A4
 Project Number: 620.30984
 Date: 22-Aug-2022
 Drawn by: NT

LEGEND

- Major Watercourse
- Minor Watercourse
- Active Pit
- - - DNM EA Boundary
- DNM Mine Lease

ELEVATION (mAHD)

■ -30 - -20	■ 40 - 50	■ 110 - 120	■ 180 - 190
■ -20 - -10	■ 50 - 60	■ 120 - 130	■ 190 - 200
■ -10 - 0	■ 60 - 70	■ 130 - 140	■ 200 - 210
■ 0 - 10	■ 70 - 80	■ 140 - 150	■ 210 - 220
■ 10 - 20	■ 80 - 90	■ 150 - 160	— Elevation Contour (mAHD)
■ 20 - 30	■ 90 - 100	■ 160 - 170	
■ 30 - 40	■ 100 - 110	■ 170 - 180	

DEPTH (m)

■ 0 - 20	■ 140 - 160
■ 20 - 40	■ 160 - 180
■ 40 - 60	■ 180 - 200
■ 60 - 80	■ 200 - 220
■ 80 - 100	■ 220 - 240
■ 100 - 120	■ 240 - 260
■ 120 - 140	— Depth (m)

DAUNIA MINE TRANSITIONAL PRCP

BASE ELEVATION AND DEPTH TO VERMONT SEAM

FIGURE 3-8

3.2.4 Structural Geology

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

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

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

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

- NNW-striking normal faults that are parallel to thrust systems. These faults are up to 3.6 km long and form overlaps or step zones with each other.
- NE-striking faults with throws up to 30 m and display both strike-slip and dip-slip senses of movement. They may be traced up to 1.35 km in length.
- 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 3-2**). Drilling in the DNM Area has also found that igneous intrusions are present at the southern end of ML 1781 not identified in Queensland Government geological mapping.

4 Hydrogeology

Based on the understanding of the geological setting presented in **Section 3**, the hydrogeological regime relevant to DNM comprises the following key hydrogeological units:

- Cainozoic sediments:
 - Quaternary alluvium – unconfined aquifer (water-bearing strata of permeable rock, sand, or gravel) localised along Isaac River;
 - Quaternary to Tertiary colluvium and weathered units (regolith) – unconfined and largely unsaturated unit bordering alluvium;
- Triassic Rewan Group – aquitard overlying Permian coal measures in places across DNM and more generally in areas north and west of the DNM Area;
- Permian coal measures with:
 - Low permeability interburden units with aquitard properties; and
 - Coal seams that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

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

The coal seams within the Rangal Coal Measures are the primary aquifer units within the DNM Area. These seams can be characterised as confined fractured rock aquifers, with the Leichardt Seam and combined Vermont Seams and immediate underlying strata being the main aquifer units. The overburden above the Leichardt Seam, including the Rewan Group where present, acts as an aquitard and is typically dry, or very low yielding.

Significant structural faulting associated with the Jellinbah Thrust System occurs at DNM and within the surrounding area (**Section 3.2.4**) 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) that found the major structural features are effectively barriers to groundwater flow perpendicular to the faults. The findings of these investigations in regard to hydrogeologic behaviour of the fault in are further discussed in **Section 4.3.3**. The major faults that repeatedly truncate the lateral east-west extent of the Permian units to both the west and east of DNM therefore result in hydrogeological compartmentalisation of the Permian groundwater system.

The following hydrogeological conceptual model discusses each of the hydrogeological units relevant to DNM, covering hydraulic properties (**Section 4.3**), groundwater occurrence (**Section 4.4**), hydraulic gradients (**Section 4.4**), recharge (**Section 4.4**), discharge (**Section 4.4**), groundwater quality (**Section 4.5**), and water use (**Section 4.6**).

4.1 DNM Groundwater Monitoring

The current and historic groundwater monitoring network at DNM comprises a total of 37 monitoring bores (18 active, 17 inactive and two decommissioned).

The locations of the current monitoring network are shown in **Figure 4-1** and details provided in **Table 4-1**.

Table 4-1 DNM Groundwater Monitoring Network Details

Bore ID	Easting (GDA94)	Northing (GDA94)	Surface Elevation (m AHD)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Monitored Unit	Install Date
PZ01	632534	7561905	230.8	164.8	158.8	FCCM	2009
PZ02	635300	7560237	229.8	154.8	148.8	RCM Interburden	2009
PZ03	632332	7558326	214.9	142.9	136.9	RCM Interburden	2009
PZ04	635531	7554554	193.2	112.2	103.2	RCM Overburden	2009
PZ05	632576	7561914	231.3	201.1	183.1	RCM Interburden	2016
PZ06	631776	7561217	220.7	186.2	165.2	Vermont Coal Seams	2016
PZ07	631627	7559539	219.4	120.4	114.4	FCCM	2017
PZ08	635192	7560075	229.7	150.7	144.7	Leichhardt Coal Seams	2017
BMB	639477	7560278	202.9	172.9	152.9	RCM Interburden	2013
MB19DNM01P	635935	7553725	198.5	138.0	132.0	Leichhardt Coal Seams	2019
MB19DNM02P	635924	7553718	198.5	104.0	98.0	Vermont Coal Seams and tuff	2019
MB20DNM01P_HY	635874	7558005	208.6	151.0	145.0	FCCM	2020
MB20DNM05A_WB_R01	634589	7553840	189.0	184.0	181.0	Alluvium	2020
MB20DNM06P_R_HY	633915	7555904	200.0	146.7	140.7	Leichhardt Coal Seams	2020
MB01P_HY_R01	634584	7553827	188.9	168.9	164.9	FCCM Mudstone / Sandstone	2020
MB02A	635295	7552703	196.1	191.1	188.1	Tertiary Sediments	2020
MB02P	635301	7552706	196.0	164.0	160.0	Vermont Coal Seams	2020
DNMMB02_01	635659	7561135	218.0	179.5	173.5	Tertiary Sandstone	2021
DNMMB08_01	635440	7558348	208.8	190.0	184.0	Tertiary	2020
DNMMB06_01	633903	7555902	200.3	115.3	109.3	Vermont Coal Seams	2020
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

Bore ID	Easting (GDA94)	Northing (GDA94)	Surface Elevation (m AHD)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Monitored Unit	Install Date
MB04	633383	7558513	212.8	126.8	122.8	Vermont Coal Seams	2012
MB05	633427	7558628	215.1	111.1	105.1	Vermont and interburden	2012
MB06	633550	7558561	214.6	170.6	167.6	Vermont Coal Seams	2012
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

Note: Coordinates in GDA 94 MGA Zone 55 mbgl – meters below ground level
* – estimated from DEM mAHD – meters above Australian Height Datum

The monitoring network was established in 2009 following the submission of the DNM EIS in 2008 (BMA, 2008). Routine monitoring as per EA EPML00561913 conditions is currently undertaken at five monitoring bores, three of which are screened within the Rangal Coal Measures interburden (PZ02, PZ04 and PZ05), one within the Fort Cooper Coal Measures interburden (PZ07), and one in the mined Upper Vermont coal seam (PZ06). A background interpretation monitoring bore (BMB) installed into the Rangal Coal Measures interburden is also included in the EA network, 4 km to the east of the DNM Area. Historical data for two previous EA monitoring bores installed into the Fort Cooper Coal Measures and Rangal Coal Measures interburden (PZ01 and PZ03 respectively) is available, ending in 2013 when the bores were mined through.

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. A further eleven monitoring bores were installed in 2019, 2020, and 2021 in this area (SLR, 2022). Monitoring of these bores was completed between 2020 and early 2022. The monitoring bores intersect a range of hydrostratigraphic units, including:

- Isaac River Alluvium (one monitoring bore);
- Tertiary/Quaternary Alluvium (one bore);
- Tertiary Sediments (two bores)
- Combined Vermont Seams of the Rangal Coal Measures (12 bores);
- Leichhardt Seam of the Rangal Coal Measures (four bores);
- Both the Vermont and Leichhardt Coal Seams of the Rangal Coal Measures (four bores screened across both seam units);
- Rangal Coal Measures overburden / interburden (seven bores);
- Fort Cooper Coal Measures overburden / interburden (four bores); and
- Fort Cooper Coal Measures coal Seams (two bores)

Groundwater has been monitored on a quarterly basis since November 2015 at PZ02, PZ04, BMB, and since April 2016 at PZ05 and PZ06. Monitoring of the 2012 installed bores in the south of the DNM Area was undertaken for water levels only between September 2012 and August 2013 (AGE, 2013). Monitoring of the further eleven monitoring bores in this area was undertaken on a quarterly to monthly basis between May 2020 and February 2022 (SLR, 2022).

4.2 Other Relevant Monitoring

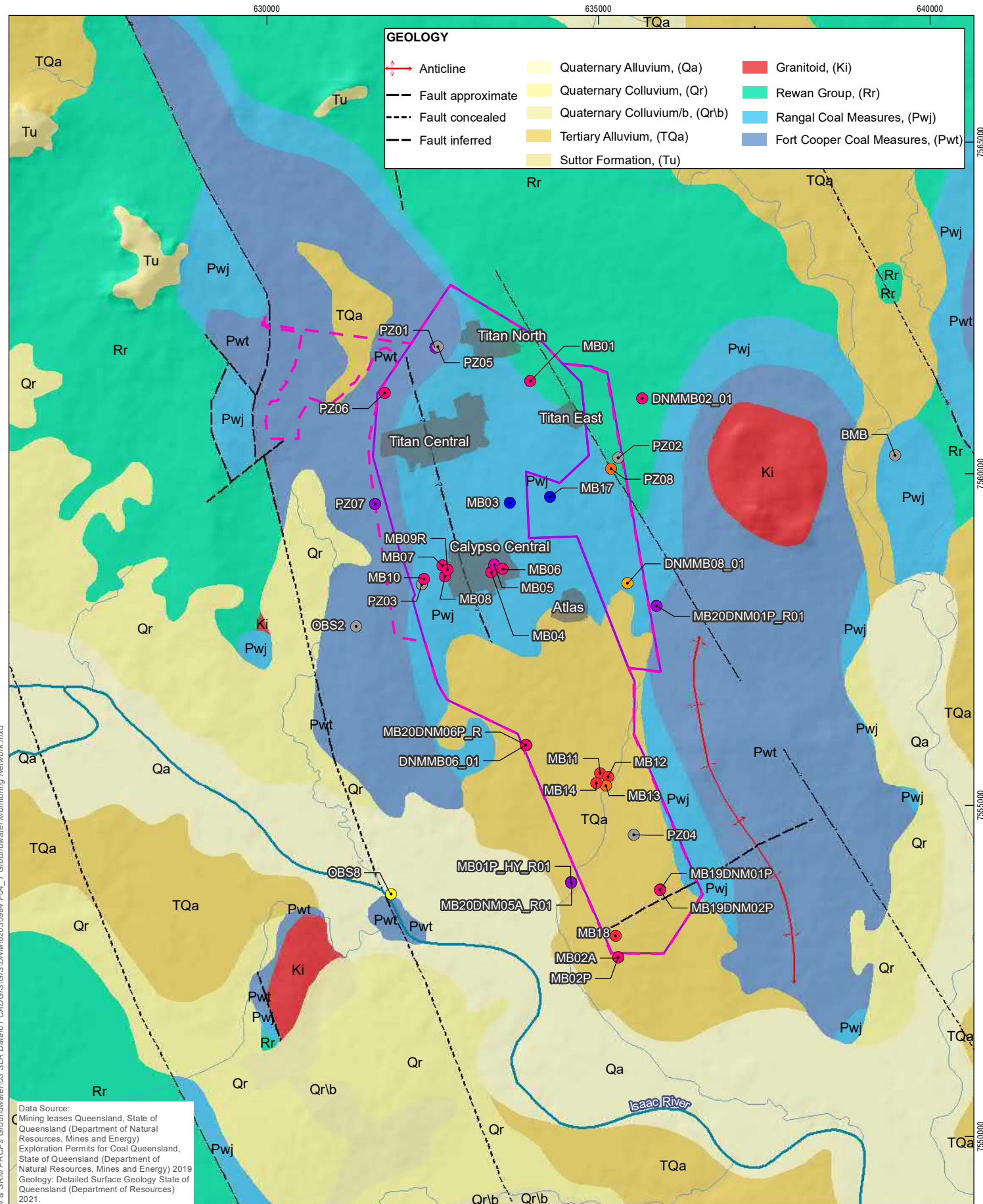
Given the close (adjacent) proximity to DNM, monitoring bores for the neighbouring Poitrel have been reviewed to support this hydrogeology assessment. The groundwater monitoring network at Poitrel includes 15 current and historic monitoring bores. Data availability for some bores is limited in more recent years, as bores have become dry and/or been mined through as a result of planned and approved Poitrel mining activities. The current and historic Poitrel monitoring network includes:

- Tertiary/Quaternary Alluvium (four bores);
- Rewan Group (one bore).
- Combined Vermont Seams of the Rangal Coal Measures (two bores);
- Leichhardt Seam of the Rangal Coal Measures (three bores);
- Rangal Coal Measures interburden (five bores)

The locations and constructions details of the Poitrel monitoring network are presented in **Table 4-2**.

Table 4-2 Poitrel Groundwater Monitoring Network Details

Bore ID	Easting (GDA94)	Northing (GDA94)	Surface Elevation (m AHD)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Monitored Unit	Install Date
OBS1	630111	7554627	193.18	172.18	169.18	Permian	2014
OBS2	631405	7557531	215.7	173.7	170.7	Permian	2014
OBS3a	628671	7562193	242.7	197.7	194.7	Permian	-
OBS3b	628671	7562193	242.7	212.7	209.7	Permian	-
OBS4	626685	7562094	229.3	167.3	164.3	Permian	2014
OBS5	626050	7557202	194.4	181.4	178.4	Cainozoic	2014
OBS6	628887	7556546	204.91	174.41	171.41	Permian	2014
OBS7	625570	7556820	198.3	190.3	184.3	Cainozoic	2015
OBS8	631867	7553655	194.94	186.04	183.04	Cainozoic	2015
OBS9	627800	7556217	203.19	161.34	155.34	Permian	2015
OBS10	627784	7556229	194.36	138.36	135.36	Permian	2015
OBS11	630313	7556960	202.68	200.18	190.68	Cainozoic	2015
OBS12	626899	7559552	209.77	142.77	136.77	Permian	2021
OBS13	626891	7559550	209.91	101.91	98.91	Permian	2021
OBS14	629680	7560815	236.1	215.1	209.1	Rewan Group (weathered)	2021



**DAUNIA MINE
TRANSITIONAL PRCP**

**GROUNDWATER
MONITORING NETWORK**

FIGURE 4-1

4.3 Hydraulic Properties

DNM Area groundwater hydraulic testing 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). An extensive database of hydraulic testing results in the DNM region is also available from external sources and is considered herein. This section presents a summary of the available field hydraulic data and comparison to reported hydraulic properties within external sources.

4.3.1 Hydraulic Data

The database of available field results for horizontal (Kh) and vertical (Kv) hydraulic conductivity is presented graphically as **Figure 4-2**. Tests from the DNM Area are provided as a separate classification on the plot. The data are also presented separately for each test method as results can vary based on the type of testing and analysis undertaken.

Figure 4-2 shows that the hydraulic conductivity of the alluvium is variable across the available dataset, ranging from 10^{-2} to almost 10^1 metres per day (m/day), which reflects the heterogeneous nature of the alluvial sediments. Hydraulic testing of the alluvium within the DNM Area 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 of 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, which is in the range of values provided by slug testing conducted across the Study Area.

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

Slug tests were performed in 2013 (AGE, 2013) and 2020 (BHP, 2021) on DNM monitoring bores targeting the coal seams of the Rangal Coal Measures. The testing reported the following horizontal hydraulic conductivities (Kh) ranges (**Figure 4-2**):

- 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; and
- 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 4-2** also shows that the hydraulic conductivity of the Permian coal measures generally declines with depth, due to increasing overburden pressure reducing the aperture of secondary porosity features.

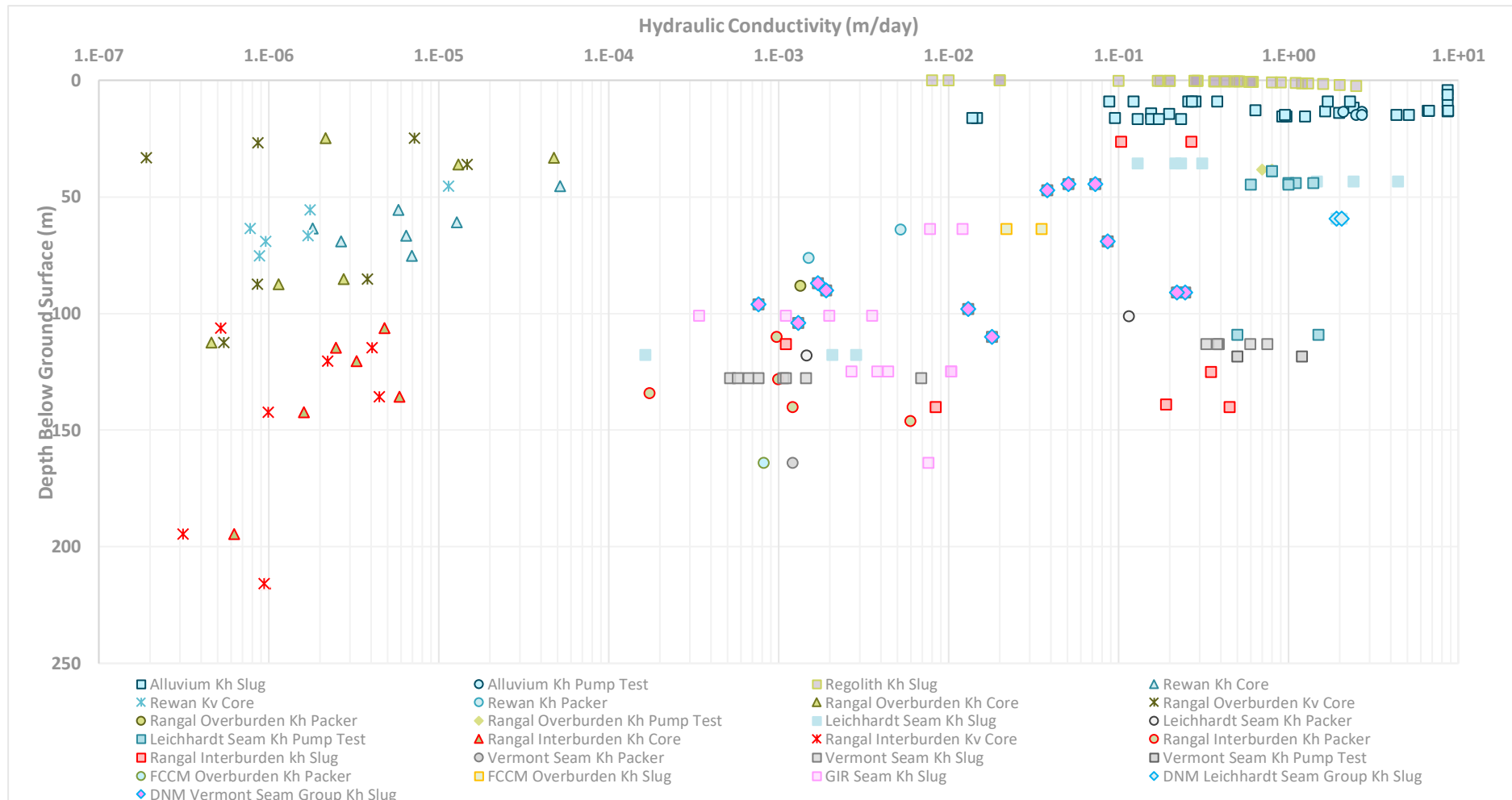
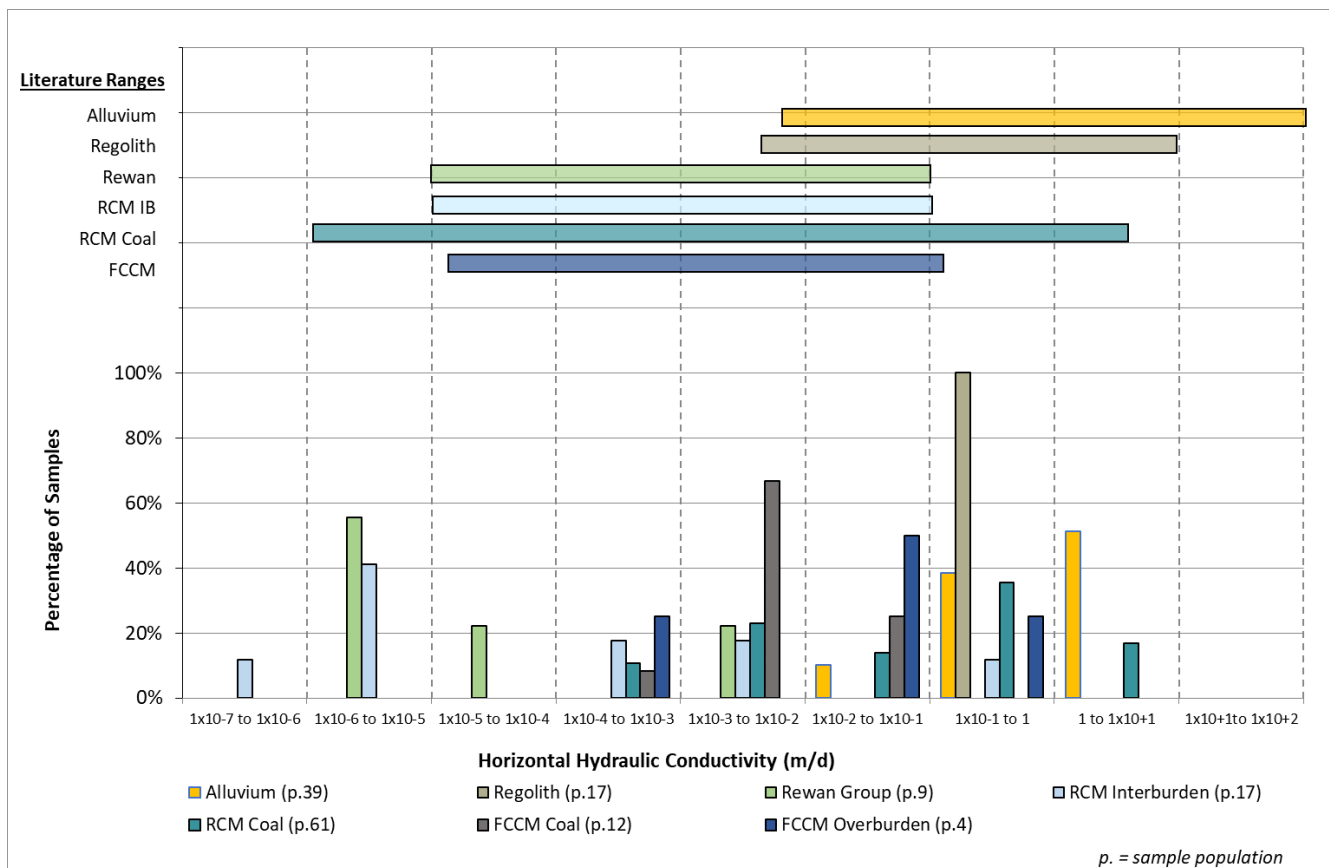


Figure 4-2 Summary of Results for All Hydraulic Testing

Review of **Figure 4-2** shows that within the Rangal Coal Measures the higher readings are attributed to the Leichhardt Seam where hydraulic conductivities are generally an order of magnitude greater than measured within the Vermont Seams. As discussed in **Section 3.2.3.1** the Leichhardt Seam is generally thicker than the Vermont Seams, which may result in wider cleats and fissures within the unit. In addition, hydraulic conductivities are generally greater where both seams are encountered at a shallower depths. It should be noted that the type of testing undertaken at DNM (i.e. slug testing) typically yields hydraulic conductivity estimates limited to the bore scale, whereas the regional dataset (**Figure 4-2**) includes estimates derived from pumping tests that are more representative of aquifer-scale properties.

4.3.2 Hydraulic Conductivity Ranges

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



RCM = Rangal Coal Measures, FCCM = Fort Cooper Coal Measures, RCM IB = Rangal Coal Measures Interburden

Figure 4-3 Histogram of Horizontal Hydraulic Conductivity Distribution

The comparison shows that the field results for alluvium, regolith, Rewan Group, Fort Cooper Coal Measures and Moranbah Coal Measures within the Study Area and immediate surrounds fall within the range of field data collected through other studies across the Bowen Basin. Results for the Rangal Coal Measures from the DNM Area recorded higher readings than previously identified in literature.

4.3.3 Faulting

As discussed in **Section 3.2.4**, 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 relates to filling of the fractured pore spaces over time through hydrothermal alteration and mineralisation (Uysal *et al.*, 2000). Drill core logs from within the Study Area show that where fractures and faults have been geologically logged, many fractures are “healed” with calcite and siderite. This indicates that although the system contains a fracture network, many of the existing fractures are cemented, which reduces the effective permeability of the fracture when compared to any open fracture network.

Hydrogeological field studies completed in the south of the DNM Area found variable groundwater flows indicating groundwater compartmentalisation across the site (AGE, 2013). AGE (2013) concluded that structural displacement of Permian sequences has formed hydraulic barriers due to vertical offset of the more permeable horizons, rather than enhanced groundwater movement. The barrier effect is most evident in an east-west direction across and adjacent to the DNM Area.

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 confirmed to be intersected at these drill holes due to the presence of fracturing, calcite infills, and slickensides in core obtained from the drill holes, all of which are considered an indicative marker of faulting. Testing results showed relatively low hydraulic conductivity values ranging from 6.93×10^{-5} to 2.07×10^{-3} m/day, and in line with those presented in **Figure 4-4**. These properties indicate that the faulting zones intercepted and tested are ‘healed’ and not pathways for preferential groundwater flow, given their hydraulic conductivities are generally lower than the adjacent Permian coal seams.

Laboratory geotechnical analysis of core samples of interburden immediately above and below coal seams proximal to a fault zone has previously been undertaken in support of groundwater assessments in the Study Area (SLR, 2020). The samples recorded vertical hydraulic conductivity of 50% to 160% of horizontal hydraulic conductivity; i.e. although some samples show a typical K_v of somewhat less than K_h , some samples also suggest greater K_v than K_h , which may be indicative of preferential vertical flow pathways associated with faulting. However, it was also noted that these areas of increased K_v are limited vertically, with samples collected from the same drill hole at horizons further above and below the fault zone (interburden and Rewan Group) returning a lower K_v of between 11% and 76% of K_h . This highlights the limitations of bore scale test methods (such as core or slug testing) that may bias results compared to methods that yield more aquifer scale estimates of hydraulic properties, such as pumping tests.

The impact of faults on groundwater flow within the Study Area was also assessed as part of the Bowen Gas Project (Arrow Energy, 2012). Kinnon (2010) assessed the movement of water and gas across a series of faults in the Bowen Basin using stable isotope and water quality analysis to assess zones of potential recharge, water mixing and flow pathways. Higher gas production rates were also observed on either side of a major fault, with differences in isotopic compositions of produced water for wells north and south of the major fault line at similar depths, implying little communication across the fault boundary, and suggesting that the fault acts as a horizontal permeability barrier to water and gas flow. The results of the study showed that compartmentalisation was evident and that this was due to the structural geology (faulting) in the basin.

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 4-4**), largely based on Jourde *et al.* (2002) and Flodin *et al.* (2001). This conceptualisation provided a means of inferring hydraulic conductivities of the fault core and the fault damage zone from regional hydraulic conductivity, with the fault core typically one to three orders of magnitude lower conductivity than the regional host rock, and the damage zone approximately an order of magnitude higher.

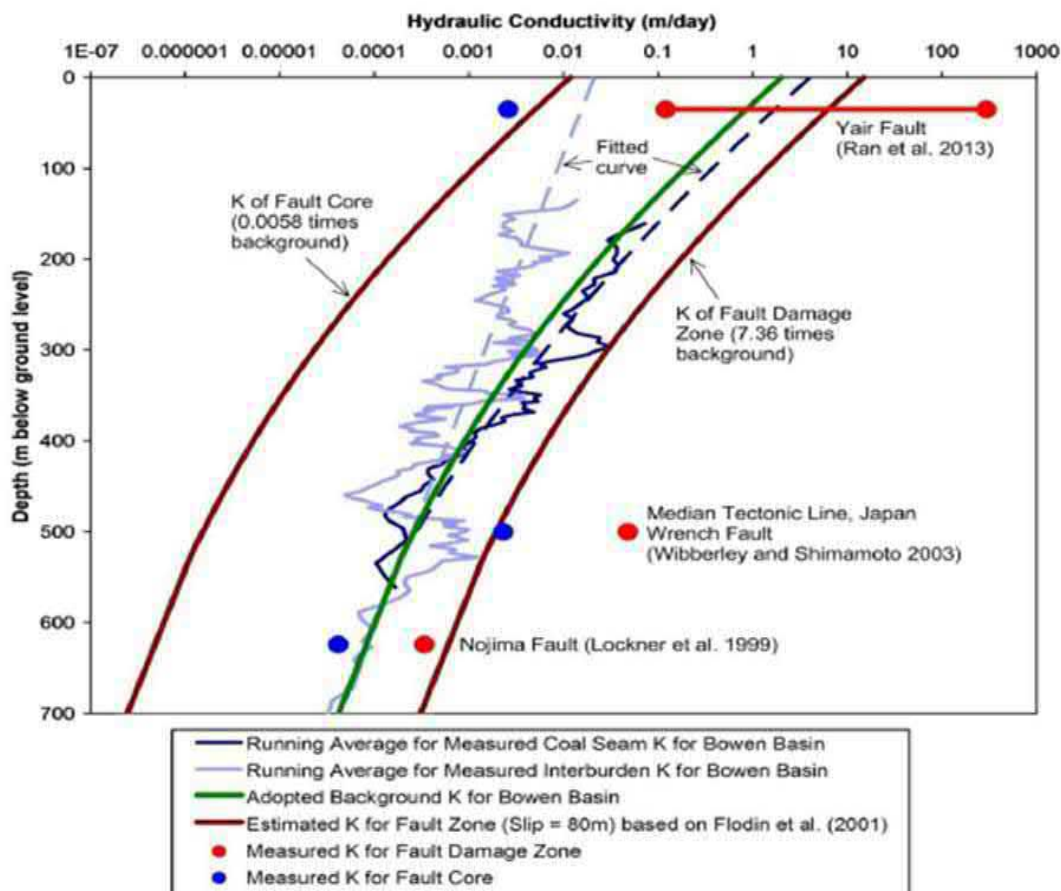


Figure 4-4 Faulting Conceptual Model Developed by Coffey (2014)

4.4 Groundwater Distribution, Flow, Recharge and Discharge

4.4.1 Cainozoic Sediments

4.4.1.1 Distribution and Flow

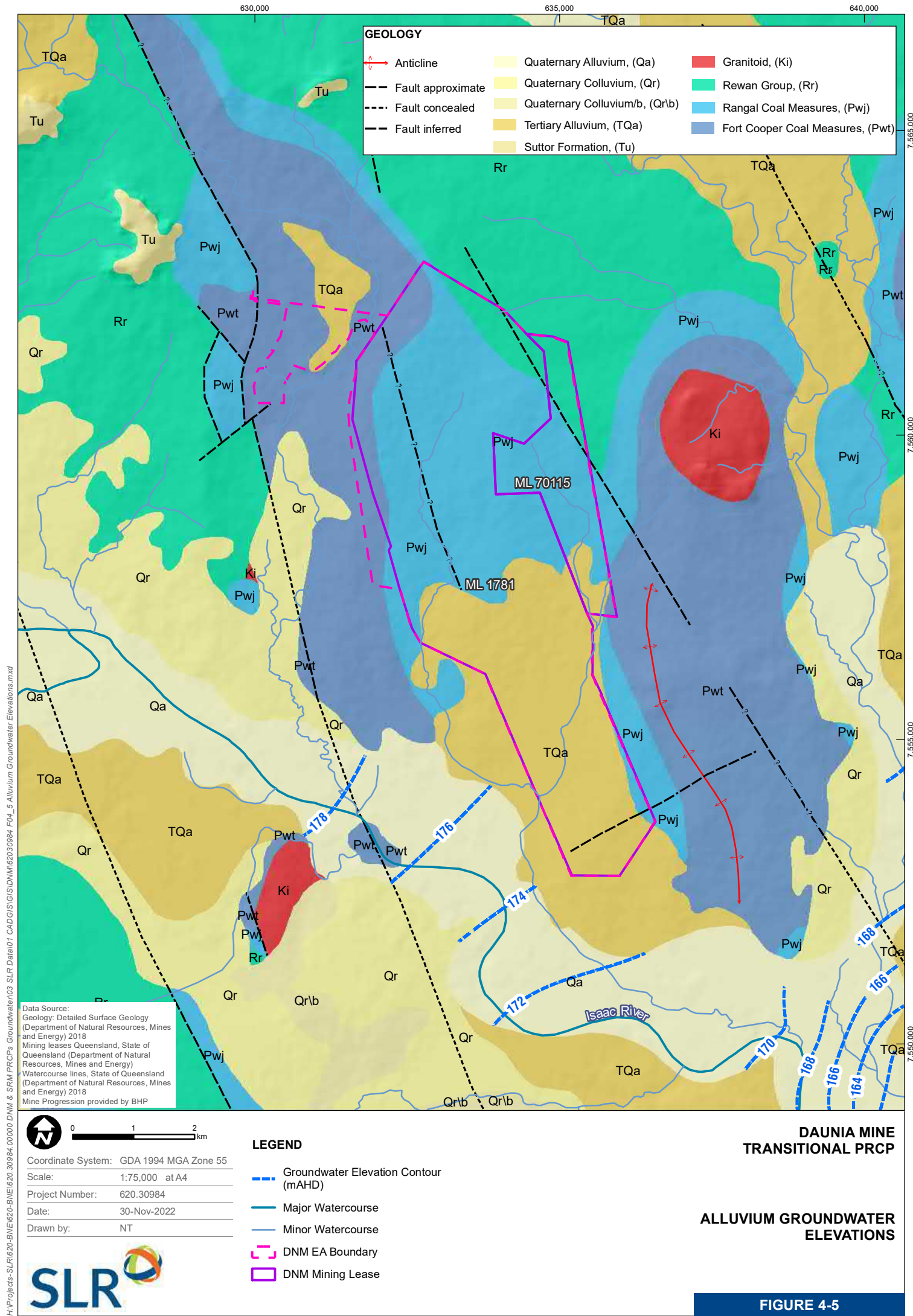
At DNM, the unconsolidated alluvial sediments of the Isaac River, other Cainozoic sediments (e.g. Quaternary-Tertiary sediments), and weathered regolith, generally function as one interconnected hydrogeologic unit, though with significant heterogeneity given the lithological and stratigraphic distinctions within.

No DNM groundwater monitoring bores are located within the mapped extents of the Isaac River alluvium. A single Poitrel groundwater monitoring bore (OBS8) is located within the mapped extents of the Isaac River alluvium. OBS8 showed alluvial deposits to be 8 m in thickness comprising clay and sandy clay. Groundwater monitoring at OBS8 was limited due to the sporadic occurrence of saturation recorded within the bore. Monitoring of OBS8 ceased in 2017. Bores MB20DNM05A_R01 and MB02A at DNM, installed within unconsolidated Quaternary-Tertiary sediments, were both recorded as 'dry' during the limited period when they were subject to monitoring in 2021.

As part of the Winchester South Project south of DNM, SLR (2020) report analysis of groundwater level data from three bores installed into the Isaac River alluvium downstream (southwest) of DNM, with two of the three bores located 0.7 to 1.2 km southwest of the DNM, near to Poitrel monitoring bore OBS8 (see **Figure 4-13** in **Section 4.6.2.1**). Groundwater elevations within the monitoring data range between 171 mAHD and 179 mAHD, approximately 16 mbgl and 14 mbgl respectively, with the higher groundwater elevations recorded in the bores positioned further upstream (northwest) of the Isaac River. Given the general interpreted thickness of the alluvium being up to 14 m (and not exceeding 20 m) in proximity to DNM (**Section 3.2.1**), these results suggest very limited saturation, supporting the sporadically dry nature of bore OBS8 intersecting the unit at Poitrel.

SLR (2020) also report that the regolith is considered to be largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (e.g. Ripstone Creek). Flow within the regolith where it is saturated is a reflection of topography, flowing towards nearby drainage lines.

A potentiometric surface for the Isaac River alluvium was developed by SLR (2020) using a combination of water levels obtained in the Winchester South Project's alluvial monitoring bores and from water level observations collected during the earlier Moorvale South Project (SLR, 2019) and Olive Downs Project (HydroSimulations, 2018) groundwater assessments. Groundwater modelling results presented by SLR (2020 and 2021) also provide potentiometric surfaces for the alluvium. The potentiometric surface for the Isaac River alluvium has been developed using data derived from the monitoring bores as discussed above, plus the information presented in SLR (2020 and 2021) and shown as **Figure 4-5**. The water levels in the Isaac River alluvium are shown to follow the flow direction of the Isaac River, with general south-easterly flow gradients. Alluvial groundwater elevations range from 178 mAHD near to the southwest corner of Poitrel, down to approximately 174 mAHD at the southwest extent of DNM downstream.



4.4.1.2 Recharge and Discharge

SLR (2020) report that recharge to the alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow subsurface. In support of this, alluvial groundwater levels at some Winchester South Project monitoring bores generally show trends similar to rainfall (SLR, 2020).

Recharge rates to the Cainozoic sediments were estimated using chloride mass balance (CMB) calculations by SLR (2021). The CMB calculations were based on available water quality results (chloride concentrations) collected from monitoring bores within the broader Study Area. Using the CMB method recharge rates for the various alluvium units in the Study Area were calculated:

- 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

SLR (2020) document that groundwater within the Isaac River alluvium is discharged as evapotranspiration from riparian vegetation growing along the Isaac River, as well as potential short term baseflow contributions after significant rainfall and flood events. Groundwater within the Isaac River alluvium is also discharged through the use of privately-owned bores in the region. Geological logs in the Study Area indicate the alluvium is underlain by low hydraulic conductivity stratigraphy (i.e. claystone, siltstone and sandstone), which restricts the rate of downward leakage to underlying formations. Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and floodplain wetlands) and occur where clay layers slow the percolation of surface water.

Non-alluvial regolith material comprises low hydraulic conductivity strata (i.e. clay and claystone), which restricts rainfall recharge (SLR, 2020). Groundwater discharge occurs primarily via evapotranspiration like the alluvium, with some short term baseflow to streams from the regolith following wet climatic conditions. Vertical seepage through the regolith is limited by the low hydraulic conductivity weathered units it is partially comprised of.

4.4.2 Permian Coal Measures

4.4.2.1 Distribution and Flow

Groundwater within the Permian coal measures is confined and sub-artesian. Groundwater level trends for DNM monitoring network bores intersecting the Permian Coal Measures are presented in **Figure 4-6** and **Figure 4-7**.

Groundwater levels for monitoring bores installed as part of a hydrogeological assessment in the south of the DNM Area (AGE, 2013) are presented in **Figure 4-6**. MB01, MB04 and MB08 are all screened within the combined Vermont Seam. MB13 is screened within the Leichhardt Seam and MB18 is screened across both the Vermont and Leichhardt Coal Seams. **Figure 4-6** shows that over the monitoring period (September 2012 to August 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). Groundwater elevations for several of these monitoring bores generally declined over the monitoring period. All bores monitored as part of the assessment show a slight response to a rainfall event in January 2013.

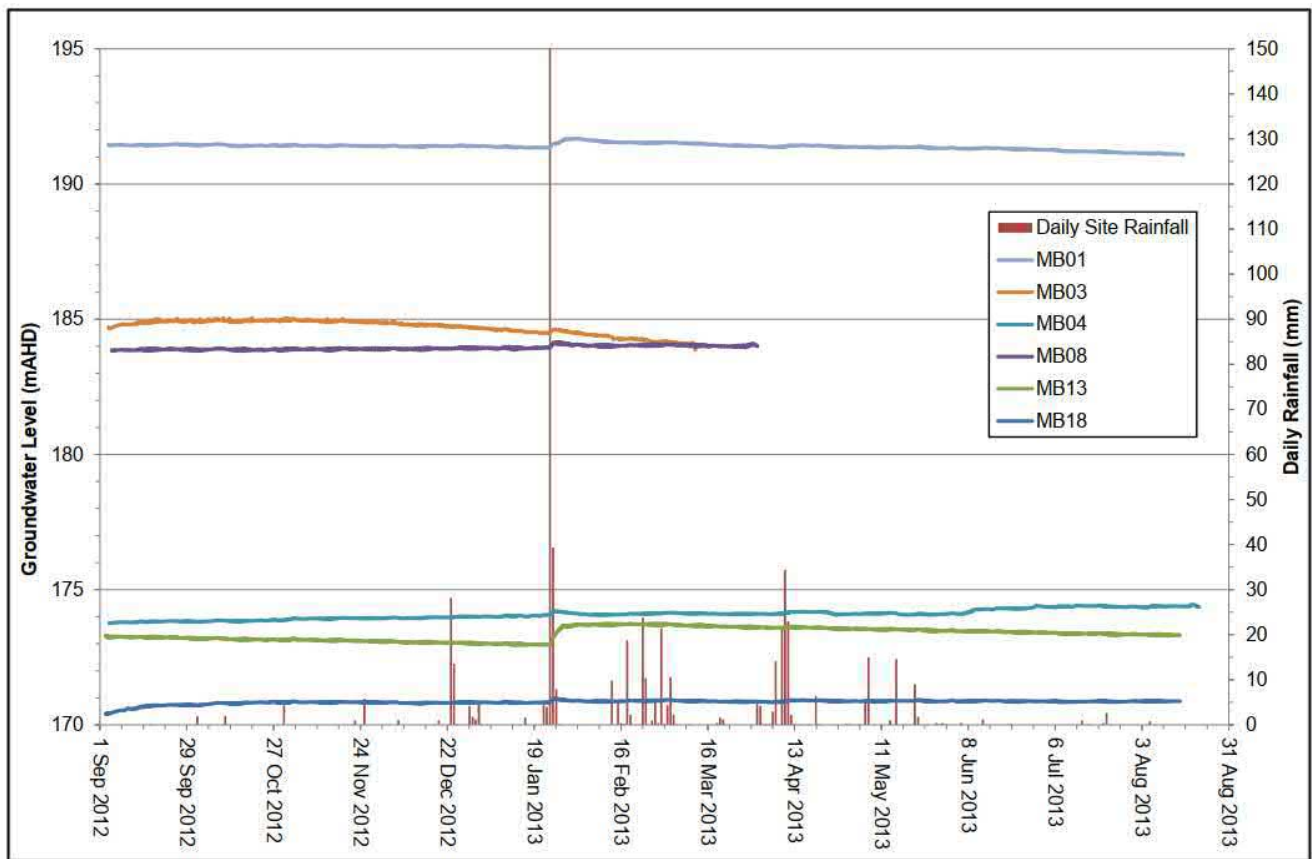


Figure 4-6 Permian Coal measures Monitoring Bore Hydrographs in the south of the DNM Area (AGE, 2013)

Hydrographs for remaining DNM monitoring bores intersecting the Permian Coal Measures, which have generally longer monitoring records than those shown in **Figure 4-6**, are presented in **Figure 4-7** and below.

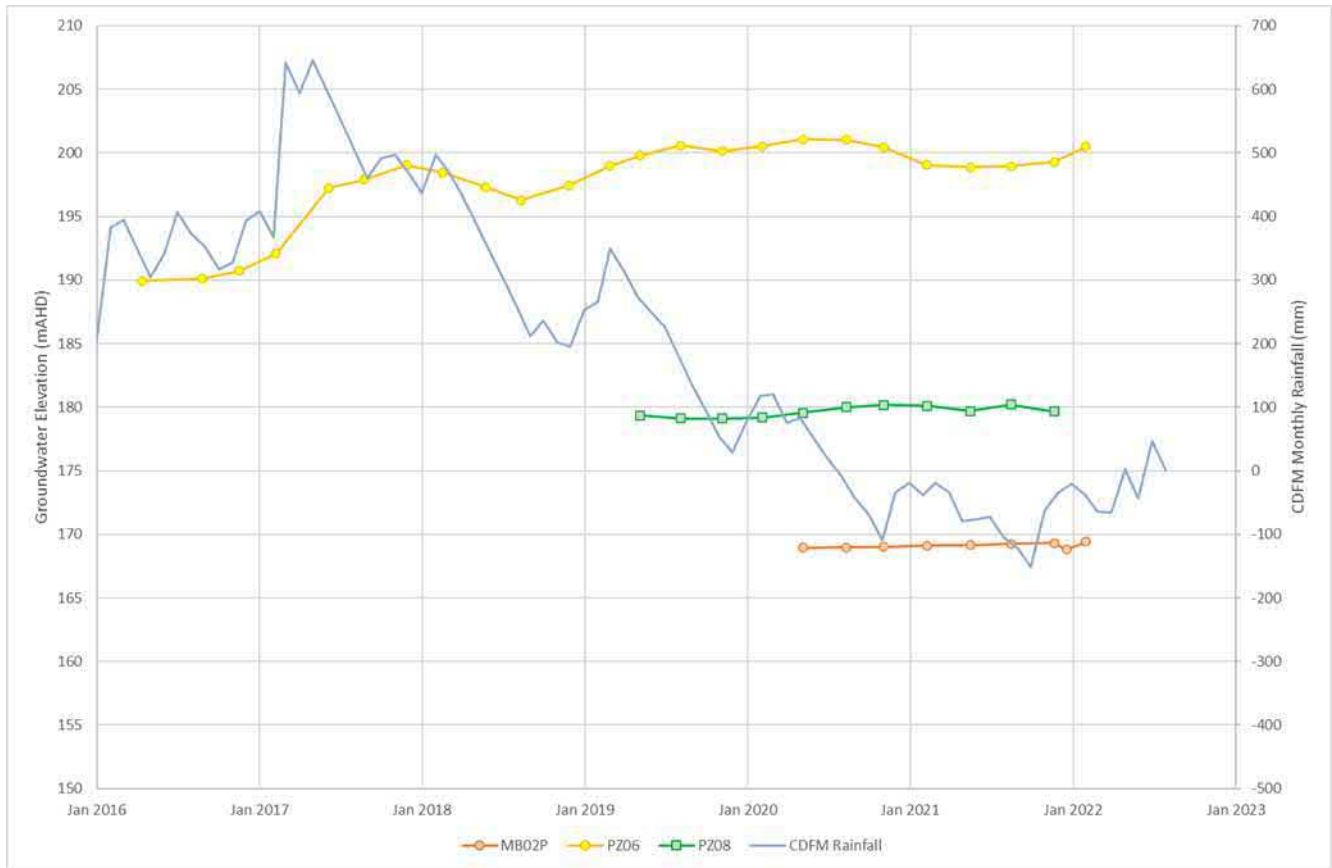


Figure 4-7 DNM Monitoring Bore Water Level Hydrographs – Vermont and Leichhardt Coal Seams

A review of the groundwater elevations in Vermont Seam monitoring bores shows differing responses largely related to proximity to active mining operations. Limited correlation with the rainfall CDFM is evident, whilst some local scale drawdown from mining activities is seen at bore PZ02. A general north to south hydraulic gradient is evident, with highest groundwater elevations of approximately 200 mAHD recorded at bores PZ06 and PZ01 in the north of the DNM Area, and lowest elevations of approximately 170 mAHD recorded at bore MB02P in the south of the DNM Area.

Groundwater level data for the Leichhardt Coal Seam is limited to one monitoring bore, PZ08. PZ08 is located on the eastern DNM Area boundary. **Figure 4-7** shows that groundwater elevations within PZ08 have remained relatively stable, fluctuating between approximately 179 mAHD and 180 mAHD.

Monitoring bores presented in **Figure 4-8** are screened within the Rangal Coal Measures interburden and overburden (PZ02, PZ03, PZ04 and PZ05) and Fort Cooper Coal Measures interburden (PZ01, PZ02 and MB01P_HY_R01). With the exception of MB01P_HY_R01 and PZ04, all monitoring bores within these units are located in the north of the DNM Area, in close proximity to the currently active mining pit voids.

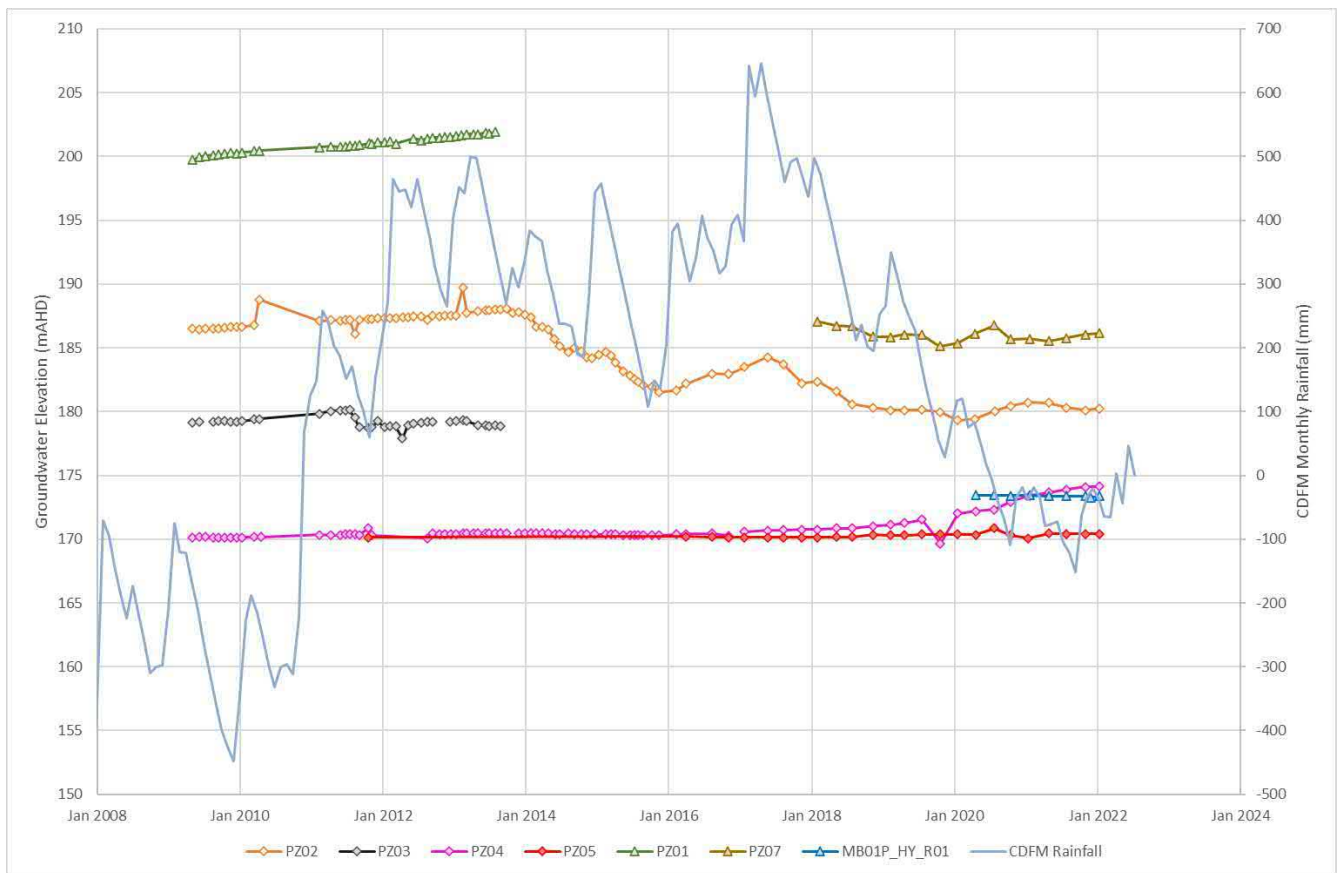


Figure 4-8 DNM Monitoring Bore Water Level Hydrographs – Non-Coal Permian Coal Measures

Groundwater elevations in monitoring bore PZ05, located on the northern boundary of the mining lease have remained stable at ~170 mAHD since the start of monitoring in October 2010. Groundwater elevations within monitoring bore PZ04, located in the south of the mining lease remained relatively stable at ~170 mAHD until February 2017 since which the elevation has steadily increased to 174 mAHD (February 2022). This increase does not appear to correspond to the climatic trends shown in the CDFM.

Groundwater elevations within PZ02 in the east of the DNM Area show the greatest variation of all the bores throughout the monitoring period, with elevations generally decreasing from 186.5 mAHD in May 2009 to approximately 180 mAHD in February 2022. Fluctuations over this period show some correlation with climate conditions with groundwater elevations increasing during wetter than average periods and decreasing during drier than average periods. PZ02 also shows a general declining trend after 2013 that may relate to the drawdown from mining activities.

Groundwater elevations within Fort Cooper Coal Measures monitoring bore MB01P_HY_01 in the southwestern DNM Area have remained relatively stable throughout monitoring at ~173.5 mAHD.

PZ01 and PZ03 were both mined through in June 2013. **Figure 4-7** shows that groundwater elevations in monitoring bore PZ01 increases from 199.7 mAHD to 201.9 mAHD over the monitoring period, with groundwater elevations within PZ03 remaining stable at around 179 mAHD. Review of groundwater elevations for both monitoring bores does not indicate a clear response to mining activities, even immediately prior to being mined through.

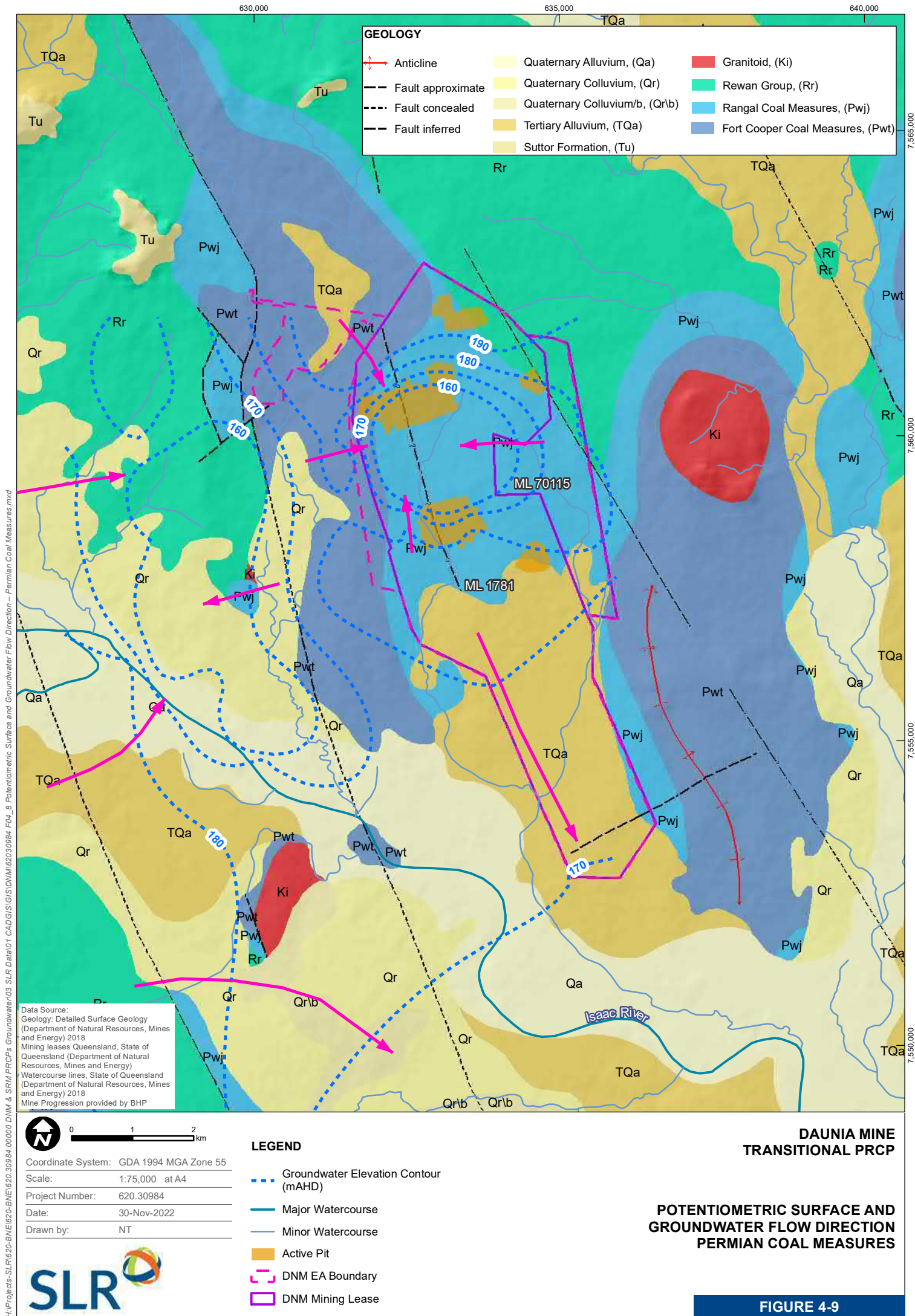
The general lack of clear response to mining activities observed within all monitoring bores suggests low hydraulic conductivity, and/or compartmentalisation of the groundwater system as a result of structural controls (i.e. faulting), which are known to be somewhat significant at DNM (**Section 4.3.3**).

A potentiometric surface for the bulk Permian Coal Measures in the vicinity of DNM was developed by SLR (2020) using a combination of water levels obtained in the Winchester South Project's Permian Coal Measures monitoring bores and from water level observations collected during the earlier Moorvale South Project (SLR, 2019) and Olive Downs Project (HydroSimulations, 2018) groundwater assessments. The hydrograph analysis above shows there is little evidence of difference in groundwater hydraulic response between the various units that comprise the Permian Coal Measures. This validated the earlier study (i.e. SLR, 2020) that mapped the Permian Coal Measures potentiometric surface in a bulk (combined) fashion. This methodology is also considered appropriate given the DNM mining pits access multiple Permian units (e.g. Leichardt Seam, Vermont Seams, and interburden) subject to groundwater monitoring. The SLR (2020) potentiometric surface has therefore been updated using data derived from the Poitrel and DNM monitoring bores discussed above, as well as mine pit void elevation data and is shown as **Figure 4-9**. Groundwater levels in the Permian Coal Measures are shown to follow a general northwest to southeast trend, with local modification in the 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. The effect of structural (i.e. faulting) control on the groundwater system is evident, particularly for the northwest-southeast trending New Chum Fault that separates the DNM Area from Poitrel to the west, and that forms the western boundary of DNM.

4.4.2.2 Recharge and Discharge

Recharge to the Permian coal measures occurs where the unit occurs at subcrop. Due to the low hydraulic conductivity of the interburden material (**Section 4.3**), groundwater largely flows horizontally within the coal measures, along the bedding plane of the coal seams.

Groundwater discharge occurs via evaporation from pit void faces in mining operations, with some discharge captured within the mine water management system for reuse (**Section 4.7**).



4.5 Baseline Water Quality

This section reports on the chemical characteristics and the resulting possible beneficial uses of groundwater within the various hydrogeological units at DNM.

4.5.1 Water Type

The proportions of the major anions and cations were used to determine the hydrochemical facies of groundwaters sampled. The anion-cation balance from the DNM monitoring bores is shown on the Durov plot in **Figure 4-10**. The results for these monitoring bores generally indicate that Na and Cl are the dominant major ions in groundwater across DNM.

Within the Rangal Coal Measures the Leichhardt Seam monitoring bores consistently recorded a Na-Cl water type. Water types of the Vermont Seam monitoring bores were more variable with the distribution of the major ions appearing to be associated with the depth of the bore. In general, deeper bores, typically in the north of the DNM Area, displayed Na-Cl water types, with shallower bores showing water types with higher proportions of Mg ions. This is potentially linked to the presence of overlying unconsolidated surficial Cainozoic deposits in the southern parts of the DNM Area through which recharging groundwater must pass; as these surficial deposits are absent in the northern areas of DNM, it provides a potential explanation for the relative absence of Mg ions in groundwater in the north.

Rangal Coal Measures interburden bores showed mixed water types of Na-Cl-HCO₃, i.e. a higher relative abundance of HCO₃ than the Rangal Coal Measures coal seams.

In relation to data from the broader Study Area, studies undertaken in the adjacent Winchester South Project (SLR, 2020) showed results of Isaac River alluvial bore Knob Hill 2 displaying a mixed water type which differs from the two nearby alluvial monitoring bores that are both Na-Cl type; this suggests some degree of compartmentalisation in the alluvial aquifer. The Rangal Coal Measures were classified as a Na-Cl water type, which is consistent with other samples in the Study Area.

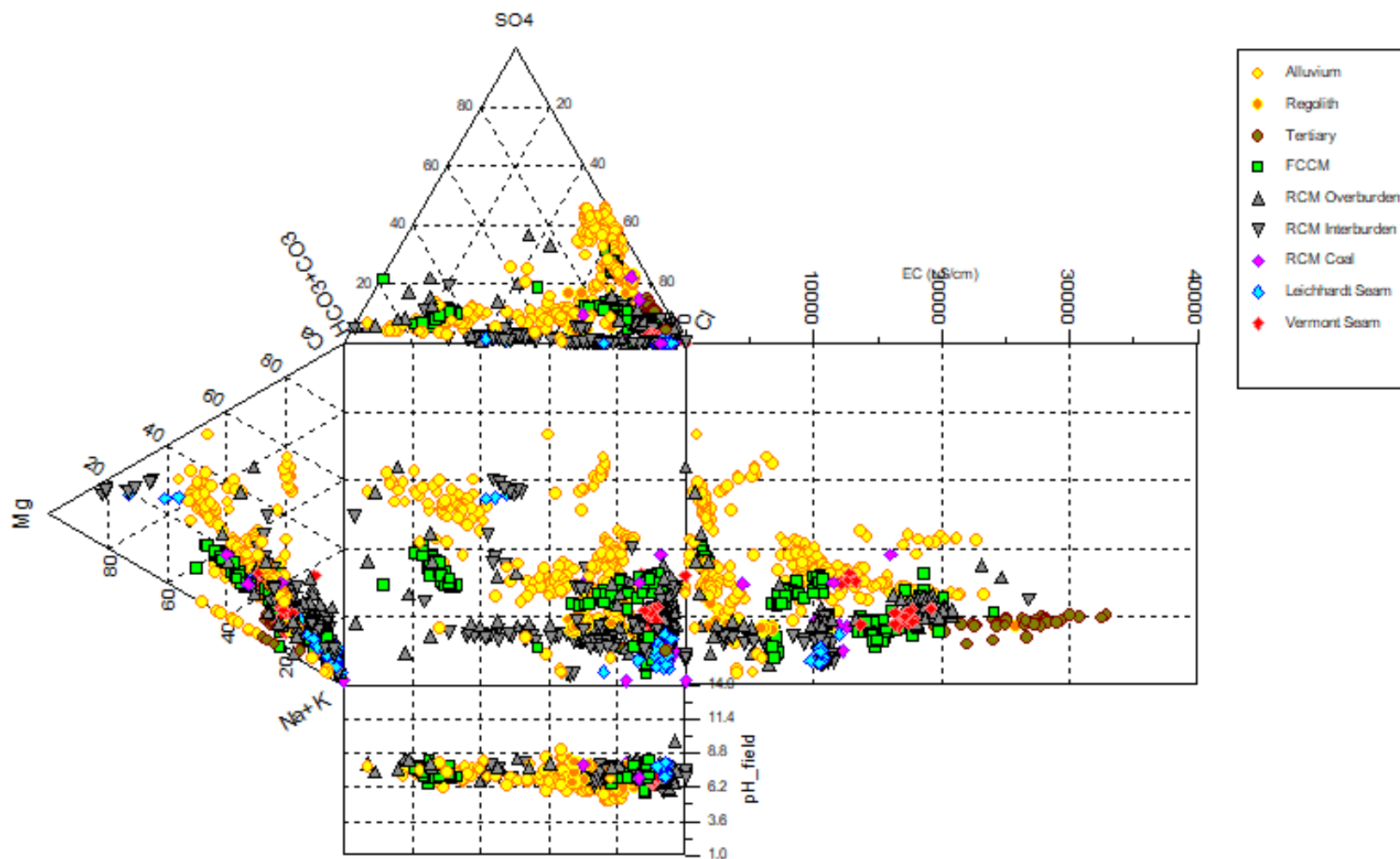


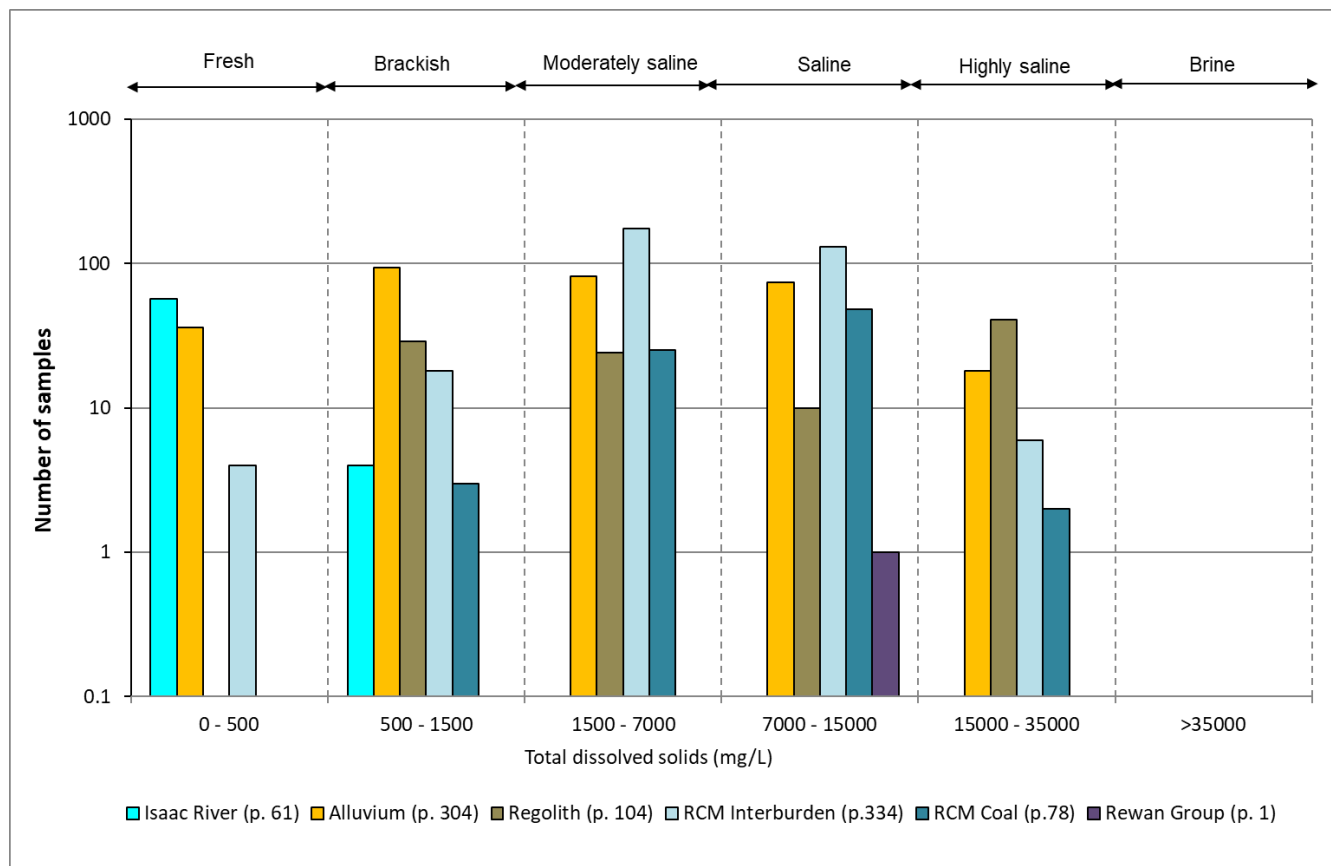
Figure 4-10 Durov Plot of DNM Bores

4.5.2 Salinity

Salinity is a key constraint to water management and groundwater use by receptors, and can be described by total dissolved solid (TDS) concentrations. **Figure 4-11** presents the TDS data associated with waters screened in the various geological horizons for DNM monitoring bores, as well as registered bores and publicly available data for context. Salinity ranges represented on **Figure 4-11** are defined by the Food and Agriculture Organization of the United Nations (FAO).

The graph shows that water within the alluvium is fresh to saline with an average TDS of 556 milligrams per litre (mg/L) (marginal) and ranging between 10 mg/L and 5,620 mg/L. Where water is present within the regolith material, it 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. Water present in the Tertiary basalt is generally moderately saline with an average TDS of 3,538 mg/L, but can be fresh to highly saline ranging between 656 mg/L and 16,526 mg/L.

Water within the Rangal Coal Measures is generally saline within the coal seams, and moderately saline to saline interburden units but can range between fresh and highly saline. Coal seam units of the Rangal Coal Measures record an average TDS of 7,598 mg/L, ranging between 720 mg/L and 24,704 mg/L. The interburden units of the Permian coal measures record an average TDS of 5,349 mg/L, ranging between 1,520 mg/L and 9,126 mg/L.



Note: RCM = Rangal Coal Measures

Figure 4-11 FAO (2013) Salinity Ranking by Unit – DNM

4.5.3 Beneficial Groundwater Use (Environmental Values)

DNM lies within the Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the *Water Plan (Fitzroy Basin) 2011*. Within the GMA, alluvial groundwater is managed as Groundwater Unit 1 and water within the hard rock aquifers as Groundwater Unit 2 (sub-artesian aquifers, which includes the Permian coal measures). Volumetric limits apply to extraction of groundwater within the GMA for non-stock and domestic purposes.

Groundwater resources in the DNM Area are also scheduled under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity) as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EVs) for these groundwaters are:

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

The EPP Water and Wetland Biodiversity provides water quality objectives (WQOs) for the scheduled EVs in WQ1310. WQOs are long-term goals for water quality management and the purpose of the WQOs is to support and protect EVs. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural, economic).

Where groundwater quality analysis results exceed a particular WQO for a particular EV, it is considered indicative that the groundwater may be unsuitable for supporting that particular EV.

The WQ1310 WQOs for groundwater at DNM are shown in **Table 4-3**.

Table 4-3 Water Quality Objectives for Isaac River Sub-basin Environmental Values

Water Quality Indicator	Unit	ADWG Guidelines ¹		Isaac River Sub-basin EVs ²		
		Health	Aesthetic	Irrigation	Stock	Aquatic 95% spp ³
pH	-		6.5 to 8.5			6.5 to 8.5
Aluminium	mg/L		0.2		5	0.055
Calcium	mg/L				1000	
Chloride	mg/L		250			
Magnesium	mg/L				2000	
Manganese	mg/L	0.5	0.1	10		1.9
Sodium	mg/L		180			
Sulfate	mg/L				1000	
Zinc	mg/L		3			0.008
Arsenic	mg/L	0.01		2	0.5	0.024
Cadmium	mg/L	0.002			0.01	0.0002
Chromium	mg/L	0.05			1	0.001
Cobalt	mg/L			0.1	1	
Copper	mg/L	2	1		1	0.0014
Lead	mg/L	0.01			0.1	0.0034
Mercury	mg/L	0.001			0.002	0.0006
Nickel	mg/L	0.02			1	0.011
Selenium	mg/L	0.01			0.02	0.005
Silver	mg/L	0.1				0.05

1. Table 4 of Isaac River Sub-basin Environmental Values and Water Quality Objectives: Drinking water EV.

2. Table 2, Table 9, Table 10 and Table 11 of Isaac River Sub-basin Environmental Values and Water Quality Objectives: Aquatic ecosystem – moderately disturbed.

3. Table 3.4.1 of Australian and New Zealand Guidelines for Fresh and Marine Water Quality: trigger values for slightly-moderately disturbed systems (95% level of protection).

The EPP Water and Wetland Biodiversity also provides limited WQOs specifically for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs vary across the Fitzroy Basin and are defined on the basis of groundwater Chemistry Zones. The applicable Chemistry Zone for DNM is Isaac Groundwater (Zone 34; Sodic Sequence - Saline: Na, Cl). These WQOs are classified by groundwater depth ('shallow' being <30 m depth, and 'deep' being >30 m depth) and are summarised in **Table 4-4**. The management intent of Zone 34 WQOs is to "maintain each of 20th, 50th and 80th percentile values", i.e. that there should be no change to existing water quality (no change in the natural range of values) (DES, 2022).

Table 4-4 Isaac River Sub-basin Zone 34 WQOs for Groundwater Resources (aquatic ecosystem protection) (DEHP, 2011)

Water Quality Indicator	Unit	Shallow Groundwater (<30m)			Deep Groundwater (>30m)		
		20 th Percentile	50 th Percentile	80 th Percentile	20 th Percentile	50 th Percentile	80 th Percentile
EC	µS/cm	498	2150	8910	3419	6100	16000
Hardness	mg/L as CaCO ₃	163	674	2228	359	919	3208
pH	-	7.1	7.75	8.1	7.4	7.8	8.03
Alkalinity	mg/L	154	435	752	156	275	536
Ca	mg/L	18	84	215	46	145	442
Mg	mg/L	27	108	389	35	115	491
Na	mg/L	135	747	1500	480	1100	2565
Cl	mg/L	171	1309	3185	753	1900	5905
SO ₄	mg/L	12	140	318	25	138	398
HCO ₃	mg/L	187	536	878	188	330	650
NO ₃	mg/L	0	0.95	5.3	0.01	2.15	14.92
SiO ₂	mg/L	21	36	52	16	25	36
F	mg/L	0.1	0.28	0.5	0.02	0.155	0.4
Fe	mg/L	0	0.03	0.14	0	0.05	0.246
Mn	mg/L	0	0.01	0.16	0	0.05	0.291
Zn	mg/L	0	0.015	0.06	0.01	0.025	0.317
Cu	mg/L	0	0.01	0.03	0.017	0.03	0.03
SAR	-	4.37	10.85	18.21	10.5	15.6	24.65
RAH	meq/L	0	0	2.3	0	0.24	6.25

In order to understand the groundwater resources within the DNM Area, available water quality data have been compared to the:

- Fitzroy Basin Zone 34 groundwater quality objectives for deep and shallow water;
- Australian Drinking Water Guidelines (ADWG) (NHMRC, 2011);
- ANZECC (2000) guidelines for aquatic ecosystems (95% level of protection), irrigation (long-term and short-term) and stock water supply.

Due to the alluvial monitoring bores being consistently dry since installation no site monitoring data is available for review for the alluvium at DNM. Results from the Winchester South Project groundwater assessment showed that groundwater within the alluvium meets stock water supply and short-term irrigation criteria (SLR, 2020). However, the alluvial groundwater was generally found to exceed guideline levels for drinking water, freshwater aquatic systems, and long-term irrigation. The alluvial groundwater was also found to record concentrations of total and dissolved iron and manganese above the Fitzroy Plan WQOs for Zone 34 (shallow). Results from the Moorvale South Project (SLR, 2019) and Olive Downs Project (HydroSimulations, 2018) groundwater assessments show that, where water is present within the Tertiary sediments, it exhibits poorer quality compared to the alluvium and exceeds guideline criteria for livestock, irrigation, drinking water or aquatic ecosystems. Given the 'dry' nature of the Tertiary Sediments (**Section 4.4.1**) water quality data for DNM Tertiary monitoring bores is limited to a single sample collected at DNMBMB08_01 following installation in December 2020. The sample was found to exceed the Fitzroy Plan WQO (Zone 34 –shallow) for multiple parameters.

Comparing the Permian coal measures data to relevant guideline levels, the summary results indicate that, where present, water within the interburden of the Permian Coal Measures in the north of the DNM Area does not meet guideline criteria for stock water supply. Results show that water within the interburden of the Permian Coal Measures in the south and to the west of the DNM Area meets guideline criteria for stock water supply.

Metal concentrations for all parameters analysed in DNM bores were either below the laboratory detection limit or below the relevant guideline level. Total petroleum hydrocarbon concentrations and aromatic (BTEX) hydrocarbons were mostly below the laboratory detection limits in all DNM monitoring bores.

Groundwater within the Rangal Coal Measures coal seams generally exhibit a high salinity, which is on average higher than the stock watering guideline levels. Comparison of water quality results for DNM monitoring bores to the guideline levels indicates the Rangal Coal Measures (interburden and coal) exceed the guideline criteria for stock water, irrigation, drinking water or aquatic ecosystems. Groundwater within the Rangal Coal Measures (coal and interburden) record concentrations of several parameters above the Fitzroy Plan WQO (Zone 34 – shallow and deep 80th percentile) for aquatic ecosystem protection. Groundwater within the coal seams recorded concentrations of:

- Sodium (Vermont Seams) above the Fitzroy Plan WQO (Zone 34 – deep);
- EC levels (Leichhardt Seam), concentrations of chloride (Leichhardt Seam), calcium (Vermont Seams) and magnesium (Vermont Seams), above the Fitzroy Plan WQO (Zone 34 – shallow); and
- EC levels (Vermont Seams), concentrations of alkalinity (Vermont Seam), sodium (Vermont Seams), chloride (Vermont Seams), dissolved iron (Vermont Seams) and bicarbonate (Vermont Seams) above the Fitzroy Plan WQO (Zone 34 – shallow and deep).

4.6 Groundwater Receptors

4.6.1 Anthropogenic

A search of the Queensland Government's Groundwater Bore Database (GWBD) and the Bureau of Meteorology's National Groundwater Information System (NGIS) 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 bores (81%) are recorded as being for groundwater monitoring and investigations, and only 4 bores (6%) are recorded as being used for water supply. The remainder of bores have an unknown use (13%). A summary of the bore uses identified by the search is presented in **Table 4-5** below, with bore locations presented in **Figure 4-12**.

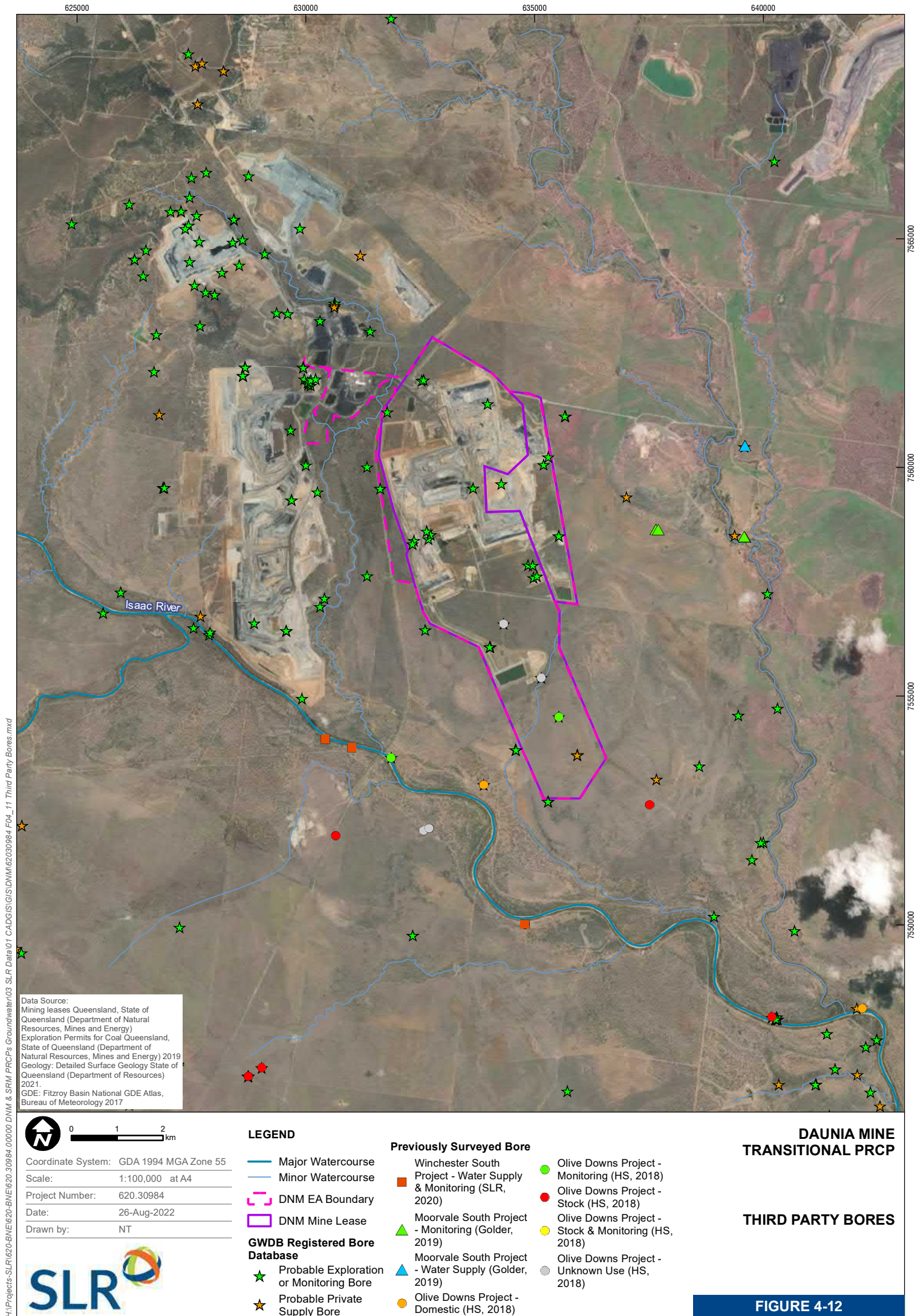


Table 4-5 Use of Registered Groundwater Bores within 5km of DNM

GWDB Use	Count	Percent of Total
Groundwater monitoring (mine monitoring, water resource investigation etc)	57	81
Water Supply	4	6
Unknown	9	13
Total	70	100

4.6.1.1 Field Bore Censuses

No field surveys have been completed at DNM to identify surrounding groundwater users.

A field survey was undertaken at the neighbouring Poitrel site during development of the Poitrel Mine Environmental Impact Statement (EIS; SKM, 2008). The survey identified 12 private groundwater bores in and near to the DNM Area prior to the commencement of DNM mining activities. Bore construction details for these bores were not available for the survey. Whilst target formations of these bores are unknown, three bores were located close to the Isaac River and its tributaries and were interpreted by SKM (2008) to be screened in the perched alluvial aquifer, and the remaining nine bores screened in the coal seams of the Blackwater Group. At the time of the survey, prior to the commencement of mining at DNM, only nine bores were in use, and the closest active water supply bore in use to DNM was located some 14 km northwest of the DNM Area.

More recent bore surveys in the DNM area have been completed between 2017 and 2020 for the Olive Downs Project (HydroSimulations, 2018), Moorvale South Project (Golder, 2019), and the Winchester South Project (SLR, 2020) (**Figure 4-12**). These bore surveys identified six alluvium bores near the Isaac River between approximately 1.1 km and 6.3 km south/southwest of the DNM Area. Away from the vicinity of the Isaac River, the closest active water supply bore was found to be located 4.2 km east of the northern part of the DNM Area, installed into the Permian coal measures. The density of third-party supply bores was found to increase towards the Isaac River suggesting they access shallow non-Permian groundwater; an inactive stock watering bore was identified 1.3 km southeast of the southern DNM Area; whilst an active domestic supply bore was identified adjacent the Isaac River 1.2 km west of the southern DNM Area. Three active water supply bores were found to be located on the southern bank of the Isaac River between 2.8 and 3.7 km south and west of the southern DNM Area, with all interpreted to be installed into the Isaac River alluvium.

4.6.2 Environmental

4.6.2.1 Groundwater Dependent Ecosystems

A groundwater dependant ecosystem (GDE) is a natural ecosystem that requires “access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services” (Richardson, S., et al., 2011).

National Atlas of Groundwater Dependent Ecosystems

The BoM’s National Atlas of Groundwater Dependant Ecosystems (GDE Atlas) classifies ecosystems based on the potential for dependence on groundwater through multiple lines of scientific evidence. Ecosystems have been mapped as either:

- High potential for groundwater dependence (indicating a strong possibility the ecosystem is interacting with groundwater);

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

Desktop mapping of potential aquatic and terrestrial GDEs in the GDE Atlas indicates that areas with possible high, moderate and low potential for groundwater interaction occur in the vicinity of DNM (BoM, 2017; **Figure 4-13**). Isolated areas of low potential GDE's occur within the DNM Area on the northwestern boundary, with moderate to high potential GDE's identified predominantly to the southwest of DNM in alignment with the Isaac River and New Chum Creek.

Surface ecosystems on and adjacent DNM that may be reliant on the surface expression of groundwater are shown in **Figure 4-13**. The desktop GDE mapping indicates:

- Terrestrial vegetation associated with the Isaac River and adjacent unnamed minor water course mapped as having a moderate potential to be dependent on subsurface expression of groundwater;
- Aquatic habitat associated with the Isaac River and adjacent unnamed minor water course is mapped as having a high potential to be dependent surface expression of groundwater; and
- All other terrestrial vegetation and aquatic habitat in proximity to DNM is broadly mapped as having a low to moderate potential of being associated with the presence of groundwater (BoM, 2021).

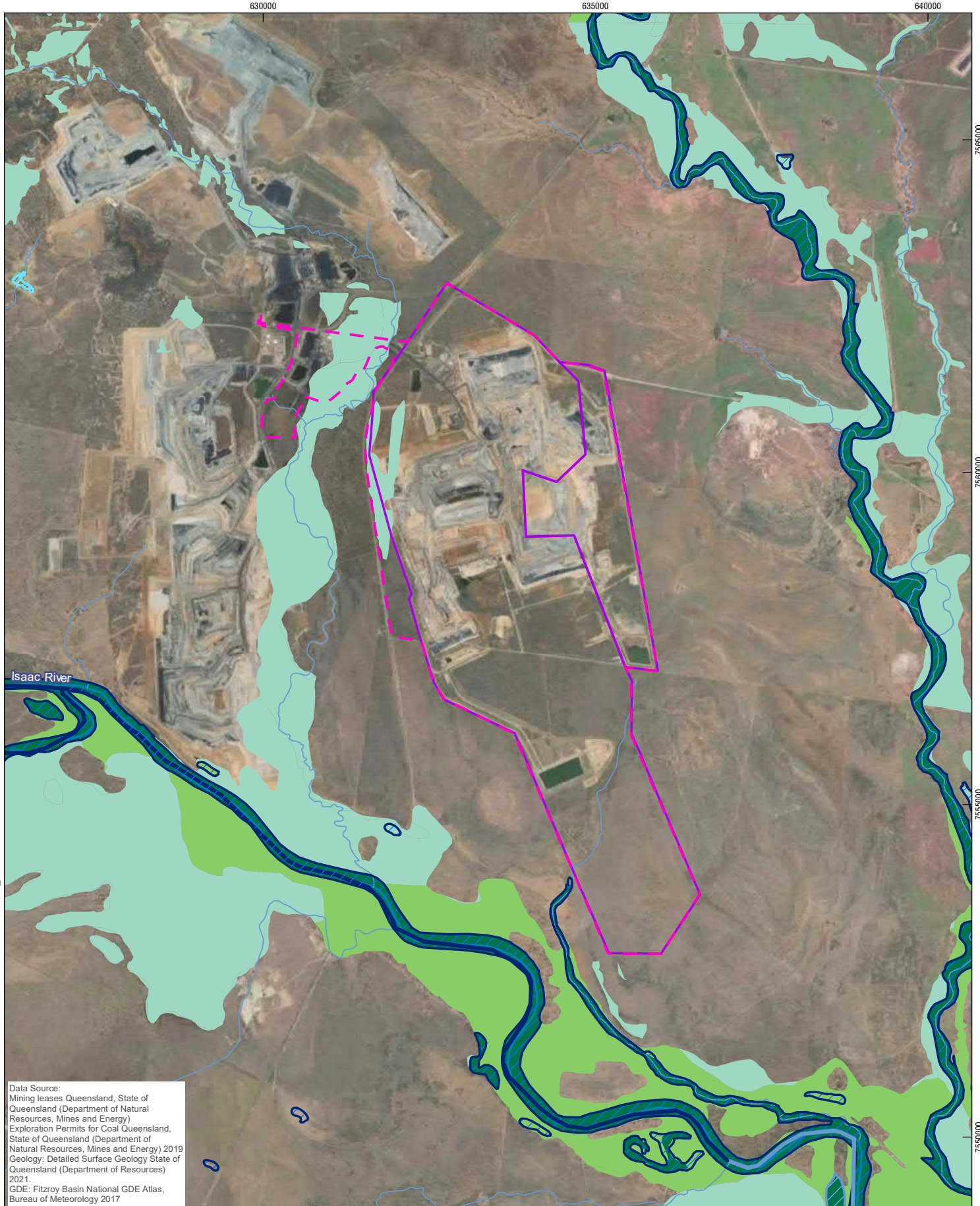
Local GDE Studies

A remote sensing terrestrial GDE assessment was undertaken by Zrog (2021) as part of broader GDE assessments across BHP tenements within the region. Using the Australian Government Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) recommended remote sensing approach, Landsat ETM imagery was selected following relatively wet and dry seasons and was analysed to identify areas of vegetation that were shown to be persistently wetter and greener than the surrounding areas. No potential terrestrial GDEs were identified in the immediate vicinity of DNM using the remote sensing method, with the closest potential terrestrial GDE mapped using the IESC approach located approximately 7.3 km to the southeast of DNM at the confluence of North Creek and the Isaac River.

Of relevance to DNM, a recent survey of local GDEs for the neighbouring Poitrel was undertaken to validate the GDE Atlas mapping (Advisian, 2018). The survey results indicated a low confidence terrestrial GDE located to the northwest of the DNM Area, associated with New Chum Creek. The GDE Atlas mapped high confidence aquatic GDE associated with Isaac River, to the west of DNM, is inferred not to interact with groundwater due to the depth to groundwater in the vicinity of Isaac River (Advisian, 2018).

Recent GDE studies undertaken for the nearby Winchester South Project just to the south of the DNM Area include ecological and groundwater assessments using desktop and field-based methods (SLR, 2020). These studies are particularly relevant to DNM since the area covered in the Winchester South Project assessment extends along the southern boundary of DNM (i.e. the Isaac River and associated floodplain). Those studies did not seek to map actual GDEs but instead draw general conclusions on the potential for GDEs near to Winchester South, with the results indicating:

- The aquatic in-stream ecosystems associated with the Isaac River are largely not dependent on the surface expression of groundwater, but may be for a short period after rainfall events when baseflow to the Isaac River from the underlying alluvium may occur. However, these waterways are ephemeral and inevitably dry out.



Data Source:
Mining leases Queensland, State of
Queensland (Department of Natural
Resources, Mines and Energy)
Exploration Permits for Coal Queensland,
State of Queensland (Department of
Natural Resources, Mines and Energy) 2019
Geology: Detailed Surface Geology State of
Queensland (Department of Resources)
2021
GDE: Fitzroy Basin National GDE Atlas,
Bureau of Meteorology 2017



0 1 2
km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 30-Nov-2022

Drawn by: NT



LEGEND

- Major Watercourse
- Minor Watercourse
- DNM EA Boundary
- DNM Mine Lease

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

DAUNIA MINE TRANSITIONAL PRCP

POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS (GDE ATLAS)

FIGURE 4-13

- The riparian vegetation along the Isaac River may access the surface expression of groundwater for short periods of time after rainfall events, however monitoring data within the Isaac River indicates that these events would occur infrequently. The riparian vegetation therefore has a moderate to high potential to meet the definition of a terrestrial GDE, but any dependency on groundwater in the Quaternary alluvium is likely to be facultative, during dry times (i.e. not only dependant on groundwater).
- The depth to groundwater beneath the palustrine wetlands adjacent the Isaac River ranges from 10 m to 20 m, meaning that the aquatic ecosystem associated with the wetlands do not receive groundwater discharge, and therefore are not aquatic GDEs. Rather, the clay-rich substrates of these wetlands are likely to hold surface water run-off for extended periods creating the above ground conditions for the aquatic ecosystem. This includes the mapped high potential aquatic GDE to the west of DNM. The terrestrial vegetation associated with wetlands on the Isaac River floodplain and its tributaries does however have a moderate potential to meet the definition of a terrestrial GDE, but any dependency on groundwater is likely to be facultative, during dry times.
- Terrestrial vegetation on the Isaac River floodplains (outside of wetlands) has a moderate potential to meet the definition of a terrestrial GDE, but any dependency on groundwater is likely to be facultative, during dry times. It is unlikely that these would be highly dependent on the groundwater due to the poor quality (high salinity) of the groundwater source.
- No stygofauna species were recorded from bores sampled during field surveys. The generally high EC of groundwater throughout the broader region suggests that the groundwater environment is not ideal for stygofauna.

A recent GDE study was completed for the Isaac Downs Project 9 km to the west of DNM (3D Environmental, 2019). This study focussed on the Isaac River and associated floodplain environment local to the Isaac Downs Project that is also present just south of DNM. The study results indicated:

- There is no evidence that terrestrial vegetation is utilising groundwater from deeper confined aquifers associated with Permian coal seams.
- Two areas were identified where terrestrial vegetation is likely interacting with shallow unconfined alluvial groundwater, both associated with riparian ecosystem analogous to RE11.3.25 (*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines). One of the identified GDE areas (denoted GDEA Area 2 in the study) extended over much of the extent of the modern Isaac River stream channel and fringing vegetation, whilst the second GDE area (denoted GDE Area 2) was much more localised to a particular area of the River where the channel is broader.
- In the smaller GDE Area 2, the majority of trees were inferred to be permanently interacting with shallow groundwater in the alluvial aquifer. This was surmised to be due to the geomorphic characteristics of the river channel in this location, with a broad inner bench and flood overflow facilitating rapid recharge of the shallow aquifer. It was also found that there is also the likelihood that Permian basement rock subcrop is elevated in this location relative to other areas on the river, providing a physical control on aquifer depth that facilitates a greater degree of interaction between the tree root zone and groundwater.
- In the larger GDE Area 1, vegetation on the riparian fringe was found to be variably interacting with groundwater dependent on position on the riverbank, with trees fringing the river channel generally demonstrating a greater degree of groundwater interaction than those higher up the bank. There is also likely to be a significant proportion of trees in GDE Area 2 that have no, or limited dependence on groundwater.

- In both GDE Areas, outside the modern Isaac River stream channel, moving up the inner bank onto higher river terraces, the dependence of vegetation on groundwater decreases significantly to the point that there is no interaction between trees and groundwater on the higher, older alluvial terraces.
- Providing volumetric changes to the alluvial aquifer are not rapid and otherwise normal hydrological function of the River system is maintained, the study found that mining related impacts to the identified GDEs are likely to be minor.

4.7 Mine Pit Inflows

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

Groundwater inflow estimates for DNM are available from numerical modelling completed in support of the Daunia Water Licence Performance Review Report (SLR, 2021a). The simulated inflows for future approved mining at DNM between 2021 and 2042 were predicted to reach a maximum peak in year 2023 at 588.4 ML/year (1.6 ML/day) but relatively consistent between 2024 and 2035 at between approximately 400 and 500 ML/year (1.1 to 1.4 ML/day), and declining significantly after 2035 (**Figure 4-14**). The predicted average DNM inflow rate over the duration of mining was 397.3 ML/year (1.1 ML/day) (SLR, 2021a).

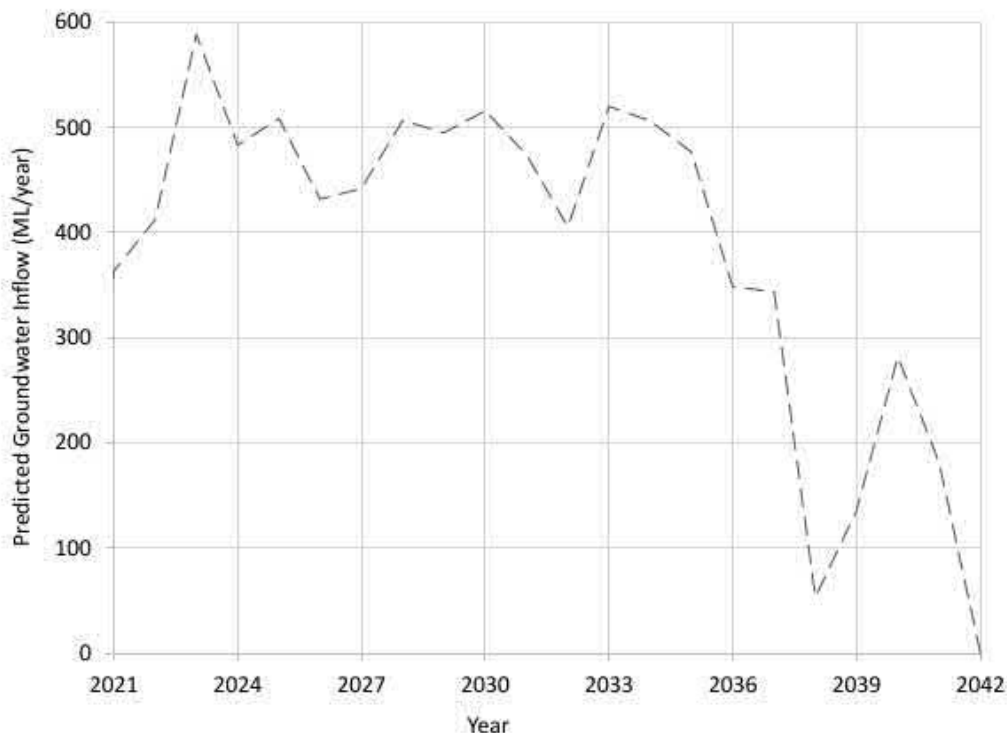


Figure 4-14 Predicted Future Mine Pit Groundwater Inflow at DNM (SLR, 2021a)

5 Conceptual Site Model – End of Mining

A conceptual site model (CSM) of the groundwater regime have been developed based on the review of the hydrogeological information for DNM presented in the above report sections. The CSM is based on the hydrogeological data review presented above and the DNM CSM presented in SLR (2022), and as well as the results of previous DNM groundwater modelling reported in SLR (2021).

5.1 General

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

The main hydrogeological features at DNM include:

- Cainozoic sediments:
 - Quaternary alluvium – unconfined aquifer (sporadically water-bearing strata of permeable unconsolidated sand or gravel) localised in close proximity to the west of the DNM Area along the Isaac River and to the east along North Creek. Quaternary alluvium is located regionally along the Isaac River where it is particularly well developed;
 - Quaternary to Tertiary colluvium and weathered units (regolith) – unconfined and largely unsaturated unit at DNM and in the Study Area.
- Permian coal measures with:
 - Low permeability interburden units with aquitard properties; and
 - Coal seams that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

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

Alluvium associated with the creeklines at DNM is poorly developed and sporadically saturated. However, the Isaac River alluvium, that occurs 500 m southwest of the DNM Area at its closest, is considered a significant regional aquifer from a natural environmental receptor perspective and there is some evidence that it supports facultative GDEs fringing the modern River channel. Where it occurs, groundwater within the alluvium is recorded at depths of between 10 mbgl to 17 mbgl, typically significantly disconnected from the streambed elevation. Regionally, groundwater flow within the alluvium is a subdued reflection of topography, with groundwater flowing in a southeasterly direction consistent with the alignment of the Isaac River. Losing conditions from the Isaac River to the underlying alluvium are evident during flow periods and recharge to the alluvium is considered to be primarily from stream flow or flooding, with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub-surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding.

Water quality data for the alluvium within the broader Study Area indicates it can be fresh to saline and highly spatially and temporally variable. The alluvium across the Study Area is mostly suitable for stock water supply and irrigation but is not suitable for drinking water and freshwater aquatic ecosystems. Based on previous ecological studies, it was identified that riparian vegetation along the Isaac River has a low likelihood of dependence on alluvial groundwater. There are currently only one (dry) alluvial bore within the DNM monitoring network, however monitoring data for alluvial bores associated with the neighbouring Poitrel show that, where saturation is found, groundwater is not suitable for long-term irrigation, with concentrations of iron, chromium, and manganese exceeding guideline levels. 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.

Across the southern part of the DNM Area, Tertiary-Quaternary aged sediments and weathered Permian units (collectively termed 'regolith') form the base of the unconfined shallow groundwater system. The groundwater flow processes are similar to those of the alluvium, however the fluxes are expected to be significantly lower due to the dominance of clay within the sediments. Within the Study Area, near the Isaac River and creeks, water has been detected within the unconsolidated surficial material at depths of around 8 mbgl to 19 mbgl. Outside of these areas the regolith material was found to be largely unsaturated. Water quality data for the regolith indicates it is generally highly saline but can be brackish to moderately saline. Water within the regolith is generally of poor quality and not considered suitable for stock, irrigation, aquatic ecosystems or drinking water.

In the Permian strata, groundwater is encountered mainly in the coal seams, and occasionally in the sandstone/siltstone units of lower hydraulic conductivity. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences, with low hydraulic conductivity interburden generally confining the individual seams. The coal seams are dual porosity in nature with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats). Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at subcrop.

Review of fault behaviour within the Study Area and from external studies 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 increases in vertical hydraulic conductivity is limited to small vertical horizons (<20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. Hydraulic testing of faults within the Study Area indicate that faulting zones intercepted are not pathways for preferential flow, and instead act as hydraulic barriers and lead to groundwater system compartmentalisation.

Regionally, groundwater within the Permian coal measures flows in a southeasterly direction, but the flow system is significantly modified by mining activities in the region with ongoing discharge to mine workings, including at DNM. Groundwater discharge to mine workings (including but not limited to DNM) is a significant component of the regional Permian coal measures groundwater system outflow. Review of water quality data indicates water within the Permian coal measures is generally saline at DNM but can range between fresh to highly saline. Groundwater within the coal measures at DNM is only considered suitable for some stock, with the type of stock dependent on the TDS range (i.e. beef cattle or sheep). Some bores screened within the interburden and the coal seams display highly variable concentrations of aluminium and nickel, exceeding the guidelines for stock watering.

5.2 End of Mining

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

A visual representation of the end mining CSM is provided as **Figure 5-1**, noting the features discussed above. Based on previous DNM groundwater modelling presented in SLR (2021a), key hydrogeological features present at the end of mining that are relevant to the discussion of potential groundwater impacts post-mining are likely to be:

- Groundwater drawdown within the Rangal Coal Measures, associated with passive dewatering into the DNM mine pit voids, results in inwards hydraulic flow gradients in the coal measures.
- Fault displacement of Permian sequences has potentially formed hydraulic barriers, resulting in compartmentalisation within hydrostratigraphic units.
- Mine pit voids capture seepage from spoil emplacements.
- Little to no impact on surficial aquifers including the Isaac River alluvium.
- Little to no impact on environmental receptors.
- No likely impact on anthropogenic receptors.

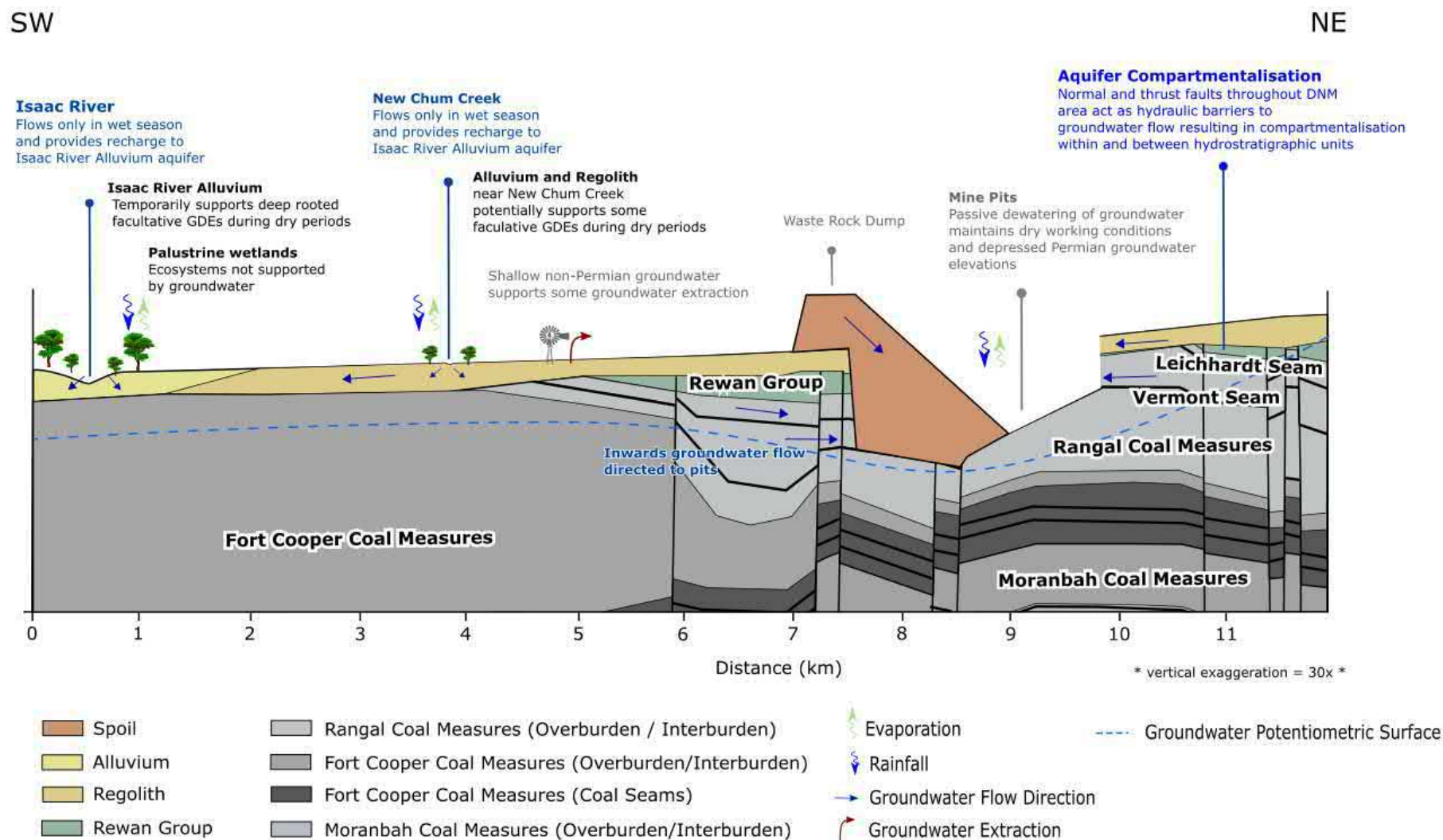


Figure 5-1 Conceptual Model of the Groundwater System – End of Mining

6 Potential Impacts

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

6.1 Groundwater System at End of Mining

The potential impacts to the groundwater system post-closure, as relevant to the hydrogeology assessment for the PRC Plan, are relative to how the groundwater system recovers from active mining. Therefore, it is important to understand the nature of the groundwater system at the conclusion of mining immediately prior to the closure period. The SLR (2021a) work has been interrogated to provide an indication of the predicted nature of the DNM groundwater system at the end of mining, and potential groundwater system impacts that may have arisen at the end of mining. These can be summarised as:

- Groundwater level drawdown of the Permian coal measures, associated with passive dewatering into the active DNM mine pit voids. The magnitude of this drawdown will be most significant in the immediate vicinity of the pit voids, but extend northwards, eastwards and southwards of DNM by several kilometres and interact with drawdown from nearby mines such as Poitrel, Millennium, Winchester South and Olive Downs.
- No groundwater level drawdown of the alluvium.
- No groundwater-related effect on surface water flows of the Isaac River.
- Limited potential for groundwater level drawdown impacts to potential GDE's along the Isaac River and New Chum Creek to the west of the DNM Area, where the water table in the regolith material may be accessed by deeper rooted riparian species and may be subject to relatively small drawdowns.
- No potential for groundwater quality impacts outside of DNM associated with spoil dumps, due to the inward groundwater flow gradients towards the pit voids capturing all potential seepage.

6.2 Groundwater System Post-Mining

Potential impacts to the groundwater system in the post-closure period as relevant to this hydrogeology assessment are summarised below. These have been investigated further in this hydrogeology assessment by adopting the updated final landform for the final voids consistent with the PRC Plan.

- Void water level recovery (i.e. lake formation) significantly below the pre-mining groundwater levels, and significantly below the base of weathering or any shallow Cainozoic aquifers.
- Partial groundwater system recovery outside the voids, particularly in the Permian coal measures.
- Ongoing groundwater discharge to the final voids driven by the inwards hydraulic gradient between the void lakes and the surrounding groundwater system, and maintained by ongoing evaporative discharge from the void.
- Potential for ongoing salinisation of the void lakes.

No potential for groundwater quality impacts outside of DNM associated with spoil dumps, due to the inward groundwater flow gradients towards the voids continuing to capture all potential seepage.

7 Groundwater Modelling

7.1 Model Details

BMA's Bowen Basin regional numerical groundwater model was adopted for the PRC Plan's hydrogeological assessment. This section provides a summary of the design and development of the numerical groundwater model (the model). Full details of the numerical groundwater model adopted in this hydrogeological assessment are included within SLR (2022b). The version of the BMA model adopted for this hydrogeological assessment is an update to the earlier model version developed specifically for DNM (SLR, 2021a).

BMA's regional numerical groundwater model was deemed appropriate for the purposes of the PRC Plan for the following reasons:

- Adoption of the MODFLOW-USG code in the existing model allows for sufficient refinement of the model grid around the DNM operations such that the limitations of a regional model in terms of the grid design are mitigated.
- The model incorporates the DNM geologic model with model layer representation consistent with the geologic model.
- The model is robustly calibrated to DNM specific monitoring data as well as an extensive regional dataset including that collected at neighbouring mines.
- The model incorporates regional influences that may interact with the groundwater system (and model predictions) post-closure at DNM, including operations at the neighbouring mines Poitrel and Moorvale South that are considered likely to interact with the DNM voids given their proximity.
- The model has previously been used at DNM to support Water License compliance reporting to the State.
- The version of the model adopted for the DNM PRC Plan is the latest update to the existing BMA regional numerical model that has been subject to multiple independent peer reviews, as well as State and Commonwealth regulator reviews, and has found widespread acceptance as a result of those reviews. In particular, the independent peer reviewer of the previous SLR (2021b) Caval Ridge Mine version of the model found that "the documented groundwater assessment is best practice" and that the "groundwater modelling has been conducted to a very high standard" (HydroAlgorithmics, 2021).

7.1.1 Model Objectives

Numerical modelling was undertaken in support of this hydrogeology assessment for the PRC Plan to evaluate the potential impacts of Landform #2 (refer **Section 1.2**) on the groundwater regime. The objectives of the predictive modelling were to:

- Assess groundwater inflow to the final landform's voids;
- Simulate the level and rate of recovery of the void lakes, and the level and rate of mining-related groundwater drawdown recovery in the groundwater system surrounding the voids; and
- Identify areas of potential risk, such as private supply bores (**Section 4.6.1**) or GDEs (**Section 4.6.2**), where groundwater impact mitigation/control measures may be necessary post-closure.

7.1.2 Model Design

The most recently updated version of the BMA regional numerical groundwater model, adopted for the DNM PRC Plan, was developed primarily to support the Saraji East Mining Lease Project approvals (SLR, 2022b). The model is regional in nature, designed primarily to predict regional scale mining impacts in a cumulative impact framework. That is, mines such as DNM are represented within the regional cumulative hydrogeological impact framework in which they sit.

The BMA regional numerical groundwater model builds on the Olive Downs Project EIS model (the foundational regional Bowen Basin model) (HydroSimulations, 2018). The foundational model was subsequently updated for the Moorvale South Project in 2019 (SLR, 2019), for the Winchester South Project EIS in 2020 (SLR, 2020), for the Lake Vermont North Project and Caval Ridge Mine Horse Pit Extension Project in 2021 (SLR, 2021b), DNM Water License reporting in 2021 (SLR, 2021a), and most recently for the Saraji East Mining Lease Project in 2022 (SLR, 2022b).

The numerical model was developed using a Geographic Information System (GIS) in conjunction with MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the USGS. MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard.

Model layering is based on a simplified regional scale representation of the central Bowen Basin hydrogeological framework. The model layer structure is presented in **Table 7-1**. Those layers identified in the table as not present at DNM are 'pinched out' at DNM within the MODFLOW-USG code.

Table 7-1 Model Layering

Model Layer	Geologic Formation	Hydrogeologic Unit	Present in the DNM Area
1	Alluvium, colluvium, Tertiary basalt	Alluvium, surface cover	Yes
2	Tertiary sediments, Tertiary basalt	Tertiary sediments, weathered Permian, Tertiary basalt	Yes
3	Rewan Group	Triassic	Yes (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

7.1.3 Model Calibration

A detailed description of the calibration procedure is provided in SLR (2022b). The numerical model includes a steady state and a transient calibration (2008 to 2021). In all, calibration used 3,449 target heads for 282 bores, including 9 observation sites at DNM. Both the steady-state and transient calibrations capture historical mining at DNM, Saraji, Peak Downs, Caval Ridge, Lake Vermont, Poitrel, Millennium, Isaac Plains, Olive Downs and Grosvenor mines. Mining was represented in the model using the MODFLOW drain package, with the drain cells set to the base of the target coal seam for each pit, and within the target coal seam for underground mines. Calibration of the model was carried out with the objective being to replicate the groundwater levels measured in the DNM, Saraji, Caval Ridge, Lake Vermont, Winchester South Project, Olive Downs, Moranbah South Project, Moorvale South Project, Millennium, and Poitrel monitoring networks, as well as some registered bores, in accordance with Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Calibration for the model achieved an 8.9 m root mean square (RMS) error, equating to a 5.9% scaled root mean square (SRMS) error, which is within the recommended range (i.e. 10%) in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). Observations from the DNM monitoring bores achieved an RMS error of 8.5 m, which is lower than the RMS error for the entire model, reflecting slightly better calibration performance at DNM when compared to the entire model calibration dataset. Calibrated hydraulic parameters were shown to be all within the range of available field data (SLR, 2022b).

7.1.4 Model Performance and Limitations

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), the Murray Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2001) and the IESC Explanatory Note for Uncertainty Analysis (IESC, 2018). These are mostly generic guides and do not include specific guidelines on special applications, such as underground coal mine modelling.

The 2012 Australian Groundwater Modelling Guidelines has replaced the model complexity classification of the previous MDBC guideline by a "model confidence level" (Class 1, Class 2 or Class 3 in order of increasing confidence) typically depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design and construction.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

It is generally expected that a model confidence level of Class 2 is required for mining environmental impact assessment; the 2012 Australian Groundwater Modelling Guidelines state that a Class 2 model may be used for assessing impacts associated with mine dewatering (Barnett et al. 2012).

Table 7-2 summarises the subjective qualitative criteria allowing model classification, per Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines. The classification of the latest iteration of the BMA model as presented in **Table 7-2** has been assessed subjectively by a Principal level groundwater modeller and reviewed by a Technical Director level hydrogeologist/modeller, whereby:

1. The classification table was subjectively reviewed and the specialists mutually decided, in their professional opinion, which box most appropriately describes the various characteristics of the model.
2. Thereafter, the assessors assigned an overall classification class for the model based on the characteristics selected, i.e. which class has the most selected characteristics.

The assessment shown in **Table 7-2** indicates that, overall, the latest iteration of the groundwater model can be classified as primarily Class 3 using the 2012 Australian Groundwater Modelling Guidelines classification system (effectively "high confidence"), with some aspects meeting the lower Class 2 criteria. This is considered an appropriate level for this PRC Plan context. The classification of the previous iteration of the model as at least Class 2 has been validated by an independent expert hydrogeologist/modeller (HydroAlgorithmics, 2021), with that independent reviewer noting that "*all models are in fact mixtures of Class 1, Class 2 and Class 3*".

Table 7-2 Groundwater Model Classification Table^{1,2}

Class	Model Characteristics				
	Data		Calibration		Prediction
1		Few or poorly distributed data points		Not possible	Predictive timeframe >> calibration timeframe
		Unavailable or sparse data in areas of greatest interest		Unacceptable levels of error	Temporal discretisation is different to calibration
	✓	No metered groundwater extraction data		Inadequate distribution of data	Transient prediction but steady state calibration
		Remote climate data		Targets incompatible with model purpose	Unacceptable validation
		Little or no useful data on land-use, soils, or river flows and stage elevations			
2		Some data but may not be adequate throughout domain	✓	Reasonable calibration statistics with errors in parts of the model	✓ Predictive timeframe > calibration timeframe
		Some metered groundwater extraction data		Long-term trends not replicated in all parts of domain	Long stress periods compared to calibration
	✓	Streamflow and stage measurements are available at some points		Transient calibration not extending to present day	New stresses not in calibration
		Reliable irrigation application data available in part	✓	Weak seasonal replication	Poor validation
				No use of calibration targets compatible with model purpose	
			✓	Validation not undertaken	
3	✓	Spatial and temporal distribution of data adequate	✓	Scaled RMS error or other calibration statistics are acceptable	Predictive timeframe ~ calibration timeframe
		Clearly defined aquifer geometry	✓	Long-term trends adequately replicated where important	✓ Temporal discretisation in predictive model consistent with transient calibration
		Reliable metered groundwater extraction data		Seasonal fluctuations adequately replicated	✓ Similar stresses to those in calibration
	✓	Rainfall and evaporation data is available	✓	Transient calibration is current	Steady state prediction consistent with steady state calibration
	✓	Aquifer testing data to define key parameters	✓	Model is calibrated to heads and fluxes	Model validation suggests calibration is appropriate
	✓	Good quality and adequate spatial coverage of DEM	✓	Key modelling outcomes dataset used in calibration	Steady-state predictions when the model is calibrated in steady-state
		Streamflow and stage measurements are available at many points			
		Reliable land-use and soil-mapping data available			
		Reliable irrigation application data available			

1. Refer Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines (Barnett et al. 2012)

2. Green highlighted cells = model has been subjectively assessed to meet the classification criteria for that Class

7.2 PRC Plan Landform #2 Model

Post-mining groundwater impacts at DNM were investigated for the purposes of the PRC Plan's hydrogeology assessment with a numerical groundwater recovery model for Landform #2 (i.e. three residual voids; refer **Section 1.2**).

7.2.1 Model Setup

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

The recovery stress periods of the overall model setup commence from the end of mining at DNM (end of the year 2050) and were run for 2,000 years over 67 model stress periods. The recovery stress period setup is shown in **Table 7-3**. Note the stress period setup also accounts for simulated recovery at other mine voids within the model domain, i.e. is not designed only for the recovery simulation at DNM.

Table 7-3 Recovery Model Stress Periods

Recovery Stress Periods	Recovery Stress Period Duration (Years)	Starting Year (Post-Mining at DNM)	Ending Year (Post-Mining at DNM)
1 – 5	1	1	5
6 – 13	5	6	45
14 – 33	1	46	65
34 – 43	2	66	85
44 – 48	5	86	110
49 – 62	10	111	250
63 – 66	50	251	500
67	1500	501	2000

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

Climate related boundary conditions (i.e. recharge and ET) in the recovery model were set constant for the duration of the recovery model, at their values consistent with the latest version of the predictive model (SLR, 2022). Recharge and ET were not applied to the final voids themselves in the groundwater model, since the Golder (2022) water balance model used iteratively with the groundwater model (see **Section 7.2.2**) accounts for these boundary conditions.

The properties of the residual void cells were converted to values representative of void values consistent with the methodology adopted in the latest version of the model (SLR, 2022b). That is, the void cells were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of $5.0 \times 10^{-6} \text{ m}^{-1}$), to simulate free water movement within the residual void. This approach is often referred to as a 'high-K' lake.

The simulation of mines adjacent to DNM (refer **Figure 1-1**) in the groundwater model, such as Poitrel to the west of the DNM Area, Millennium to the northwest of the DNM Area, and Moorvale South to the southeast of the DNM Area, has the potential to influence the model results. The simulation of Poitrel and Millennium within the groundwater model is unchanged from the latest version of the groundwater model (SLR, 2022b), i.e. mining at both Poitrel and Millennium ceases in the model in the year 2027 (i.e. prior to the DNM recovery model simulation) and the mined out pits are parameterised as being wholly backfilled with spoil. The simulation of Moorvale South within the groundwater model is consistent with the PRC Plan being developed for that site concurrently with the DNM PRC Plan, i.e. using the same numerical model and incorporating the Moorvale South final landform (including its residual voids) available at the time of the DNM PRC Plan hydrogeology assessment development.

7.2.2 Residual Void Lake Recovery

The residual voids will accumulate water over time due to rainfall, surface water runoff and groundwater inflows from recovered groundwater levels. Void water levels were not predicted by the groundwater model but were estimated by the balance between groundwater inflow and the direct rainfall and rainfall runoff from the surrounding catchment against the evaporation loss from the lake surface through iterative surface water balance modelling (Golder, 2022). The Golder (2022) surface water balance modelling included climate sensitivity and three climate scenarios reported therein were adopted for the groundwater model as instructed by BMA and shown in **Table 7-4**. That is, three sets of groundwater model predictions were generated for this hydrogeology assessment based on the three climate scenarios.

Table 7-4 Climate Scenarios Modelled

Climate Scenario	Climate Model	IPCC RCP Scenario ¹	Golder (2022) Realisation
Wetter	ACCESS1-0Q	4.5	R#1
Mid	ACCESS1-0Q	8.5	R#4
Drier	MPI-ESM-LRQ	8.5	R#6

1. Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP), refer https://sedac.ciesin.columbia.edu/ddc/ar5_scenario_process/RCPs.html

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

1. Initial predicted groundwater inflows with time to the DNM residual voids were estimated by Golder (2022) using analytical inflow calculations that were incorporated in the Golder (2022) water balance model.
2. The pit lake levels with time were then predicted by the Golder (2022) water balance model for the range of climate scenarios, incorporating groundwater (Step 1) and surface water fluxes and processes.
3. To refine the Step 1 estimation of residual void groundwater inflows, the daily residual void water elevations derived from the Golder (2022) water balance modelling (Step 2) were then replicated by SLR within the numerical groundwater model for the final landform using the time variant constant head boundary (CHD) condition, adopting a simplified average of the Golder (2022) daily results over the relevant groundwater model stress period length.
4. Refined predicted groundwater inflows with time to the residual voids from the numerical groundwater model (Step 3) were then incorporated into an update of the Step 2 water balance model prepared by Golder (2022).

5. To further refine the Step 3 estimation of residual void groundwater inflows, the daily residual void water elevations derived from the updated Golder (2022) water balance modelling (Step 4) were then replicated by SLR within the numerical groundwater recovery model for the final landform.
6. Since the refined groundwater model predictions for fluxes to the residual voids from Step 5 were still in agreement with what was used as input to the water balance modelling (i.e. the predicted groundwater inflows with time to the voids per Step 4), it was considered by Golder (2022) and BMA that further iterations between the two models were not required and therefore the Step 5 groundwater model results were adopted for reporting in this hydrogeology assessment.

Figure 7-1 through **Figure 7-3** provide a graphical representation of the final simulated recovery of water levels in the residual voids, based on the iterative groundwater and surface water balance modelling. Of note, there is only an approximate 2 to 3 m range in equilibrium lake elevations between the three climate scenarios.

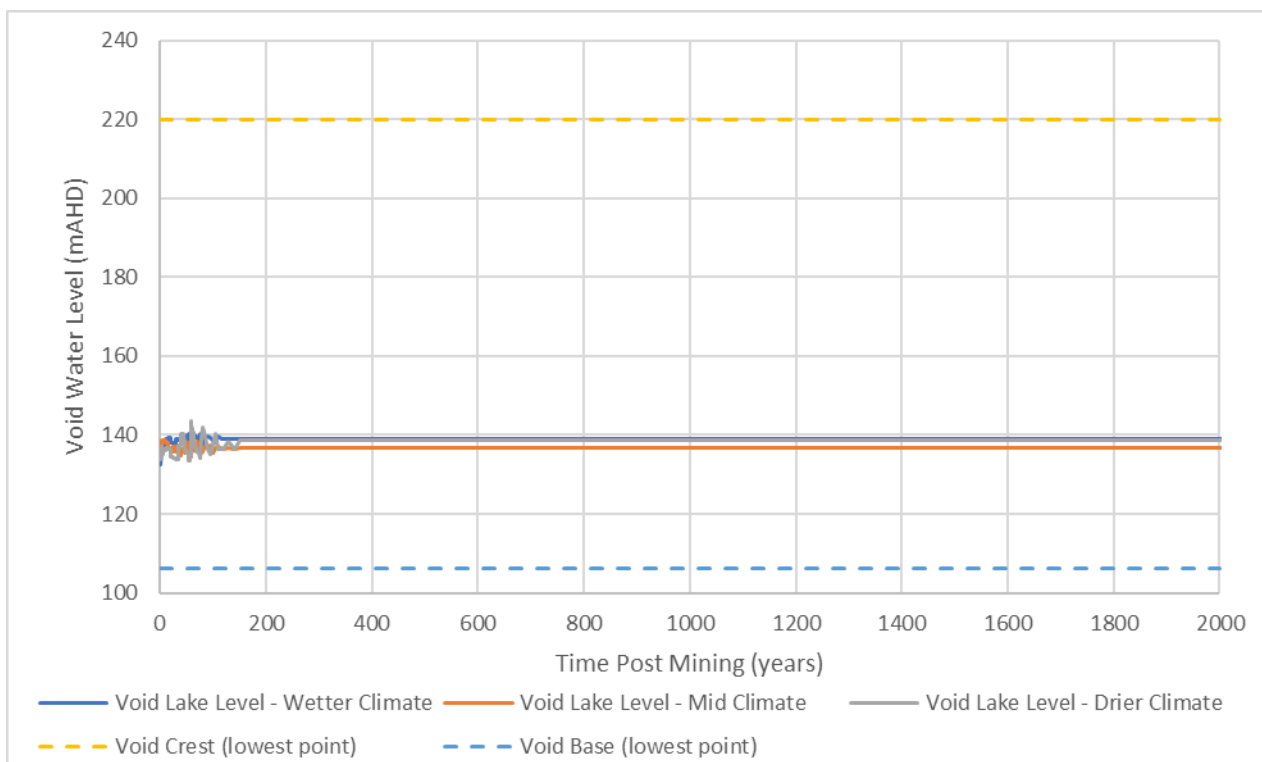


Figure 7-1 Simulated Void Water Level Recovery over Time – Titan North/Central Void (based on Golder, 2022)

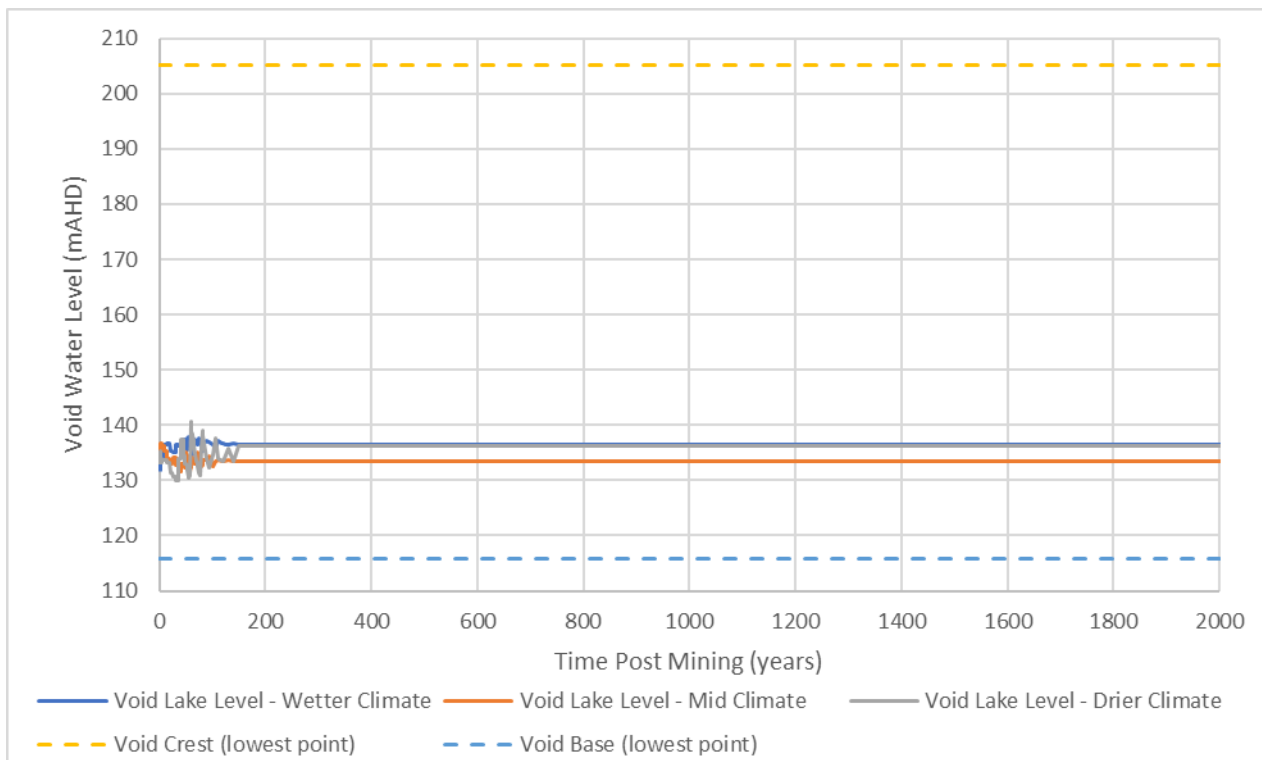


Figure 7-2 Simulated Void Water Level Recovery over Time – Titan East Void (based on Golder, 2022)

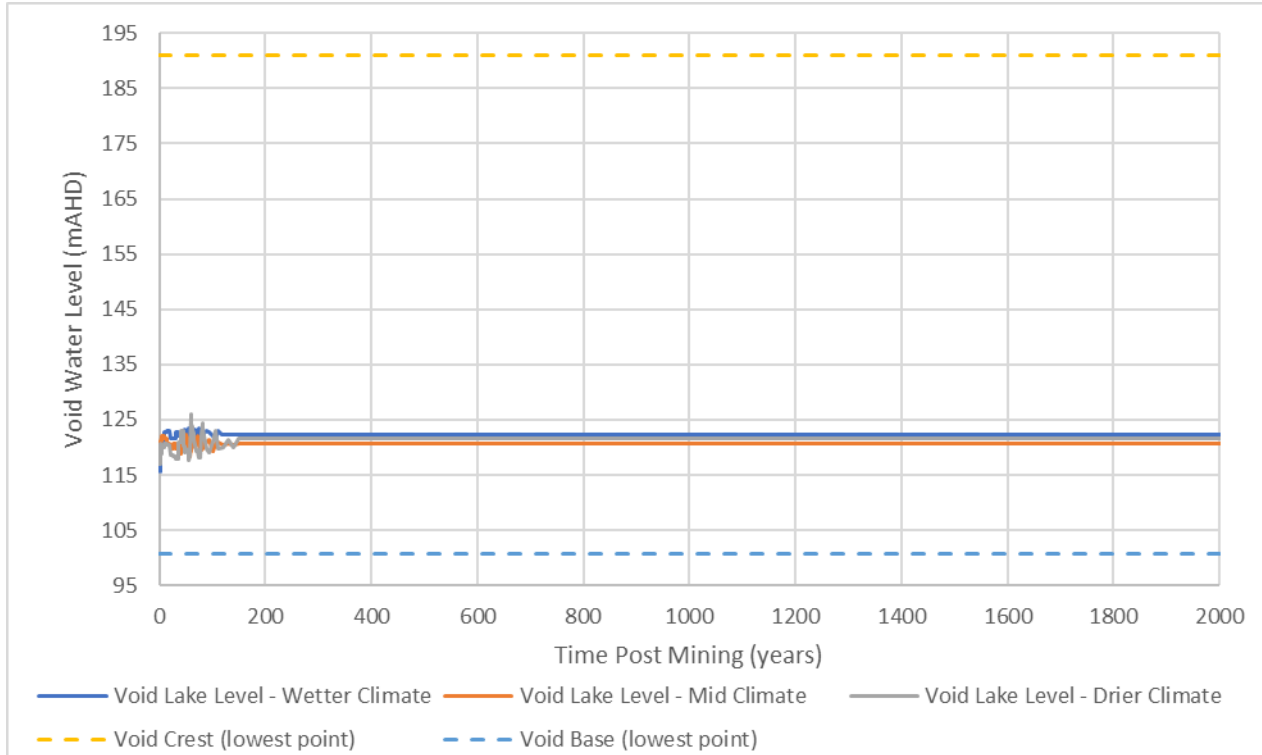


Figure 7-3 Simulated Void Water Level Recovery over Time – Pandora Void (based on Golder, 2022)

Figure 7-1 through **Figure 7-3** show that the residual void water level recovery is a slow process with the recovery rate declining as the lakes reach equilibrium conditions. The majority of recovery in the voids is achieved within the first 50 years and equilibrium water level conditions are reached after approximately 50 to 150 years for all climate scenarios represented in the groundwater model. Equilibrium is achieved while there are still stress periods of a maximum 10 year duration occurring the in the groundwater model (see **Table 7-3**) thus the groundwater model setup allows for capturing the predicted lake level variability until stabilisation. The predicted equilibrated water levels in the residual voids are shown in **Table 7-5**.

Table 7-5 Equilibrated Water Levels in the Residual Voids (based on Golder, 2022)

Climate Scenario	Residual Void	Initial water level (mAHD)	Approximate time to equilibrium (years)	Equilibrium water level (mAHD)
Wetter	Titan North/Central	133.0	50	138.8
	Titan East	132.8	80	136.5
	Pandora	116.0	100	122.3
Mid	Titan North/Central	135.0	50	136.6
	Titan East	134.1	100	133.4
	Pandora	118.2	120	120.6
Drier	Titan North/Central	133.7	100	138.6
	Titan East	133.2	150	136.1
	Pandora	116.9	150	121.6

The freeboard for each of the residual voids (i.e. the difference in elevation between the long-term water levels in the residual voids and the landform crest elevation) is as shown in **Table 7-6**. Predicted void lake levels remain significantly below the surface ‘spill’ level for each of the residual voids.

Table 7-6 Predicted Freeboard in the Residual Voids at Equilibrium

Climate Scenario	Residual Void	Freeboard (m)
Wetter	Titan North/Central	81.1
	Titan East	68.6
	Pandora	68.7
Mid	Titan North/Central	83.3
	Titan East	71.7
	Pandora	70.4
Drier	Titan North/Central	81.3
	Titan East	69.0
	Pandora	69.4

The difference in elevation between the long-term water levels in the residual voids and the lowest point of the base of the shallow geologic formations (weathered regolith; model Layer 2) adjacent the voids is as shown in **Table 7-7**. Predicted residual void lake levels remain significantly below the base of the shallow geologic formations for each of the residual voids, even with the temporal fluctuations in void water levels predicted by the Golder (2022) water balance model. That is, there is never the potential for a flux of water to leave the residual voids and enter the shallow geologic formations.

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

Climate Scenario	Residual Void	Lowest Elevation of base of Model Layer 2 adjacent Void (mAHD)	Difference between void lake level and lowest elevation of base of Model Layer 2 adjacent Void (m) ¹	
Wetter	Titan North/Central	197.7	64.7	58.9
	Titan East	198.0	65.2	61.5
	Pandora	163.9	47.9	41.6
Mid	Titan North/Central	197.7	62.7	61.1
	Titan East	198.0	63.9	64.6
	Pandora	163.9	45.7	43.3
Drier	Titan North/Central	197.7	64.0	59.1
	Titan East	198.0	64.8	61.9
	Pandora	163.9	47.0	42.3

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

7.2.3 Residual Void Groundwater Inflow

The final predicted groundwater inflows to the residual voids from the groundwater model are shown on **Figure 7-4** through **Figure 7-6**, with inflows partitioned between that which flows into the residual voids through spoil, and that which flows into the residual voids through surrounding natural geological formations.

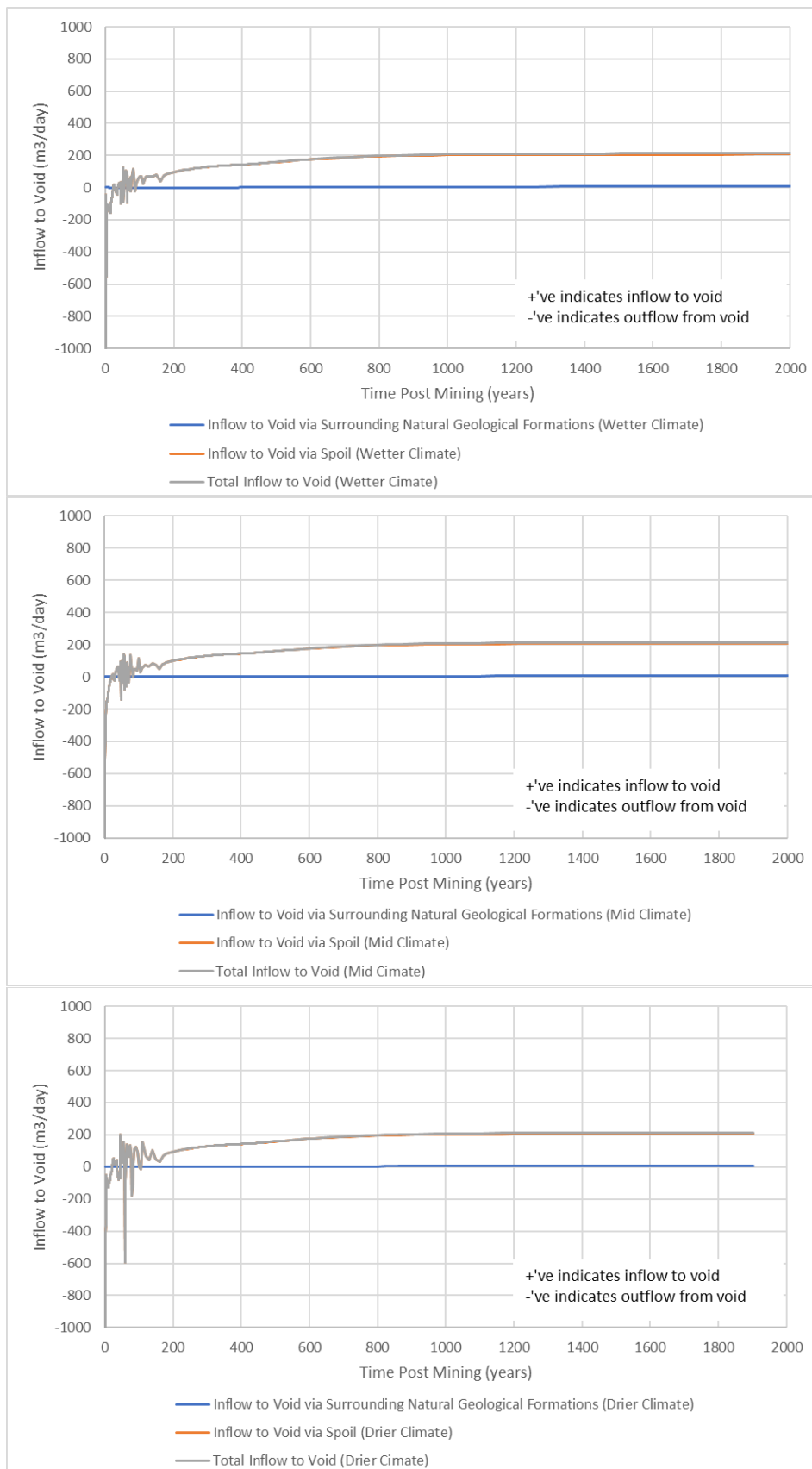


Figure 7-4 Predicted Residual Void Groundwater Inflows – Titan North/Central Void

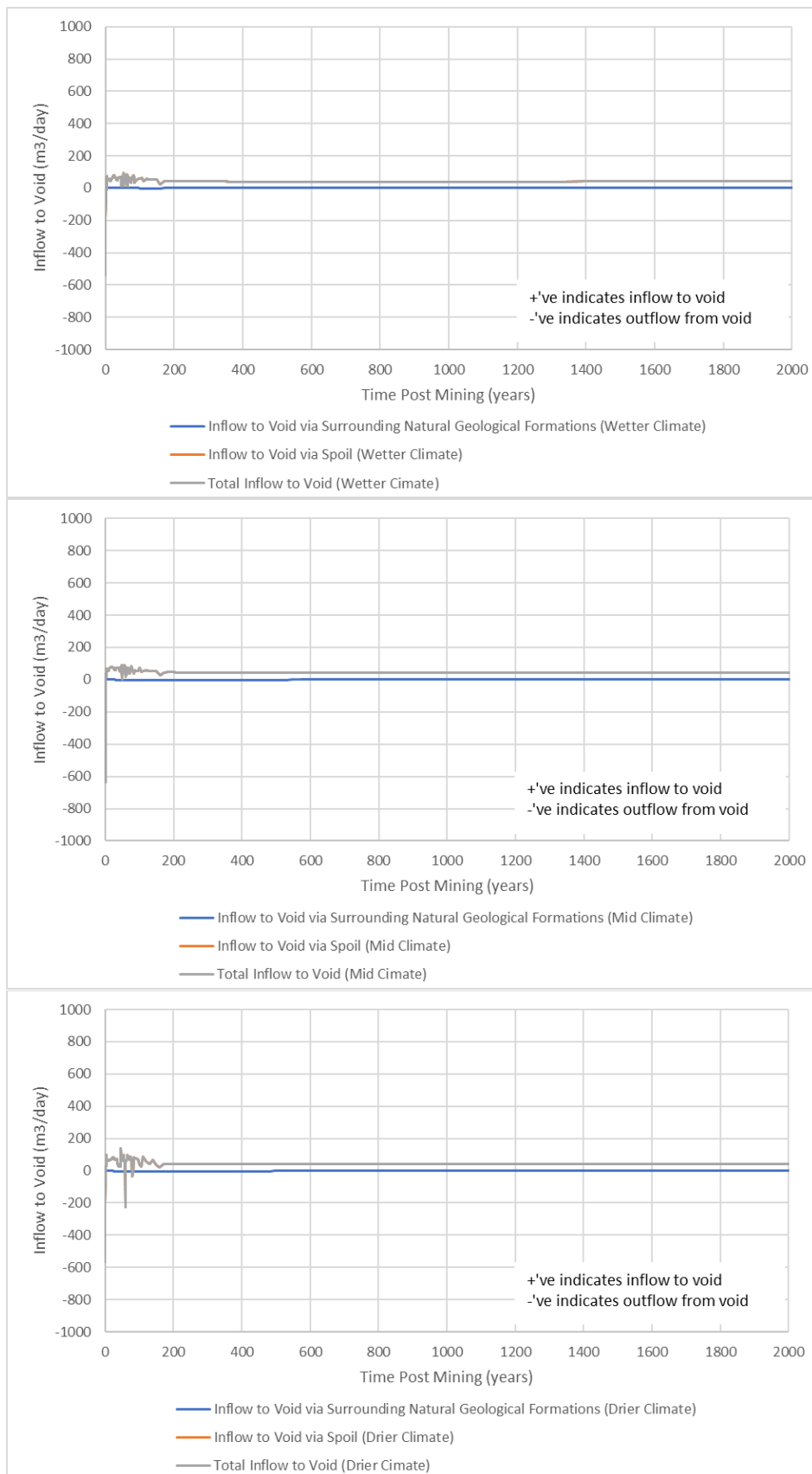


Figure 7-5 Predicted Residual Void Groundwater Inflows – Titan East Void

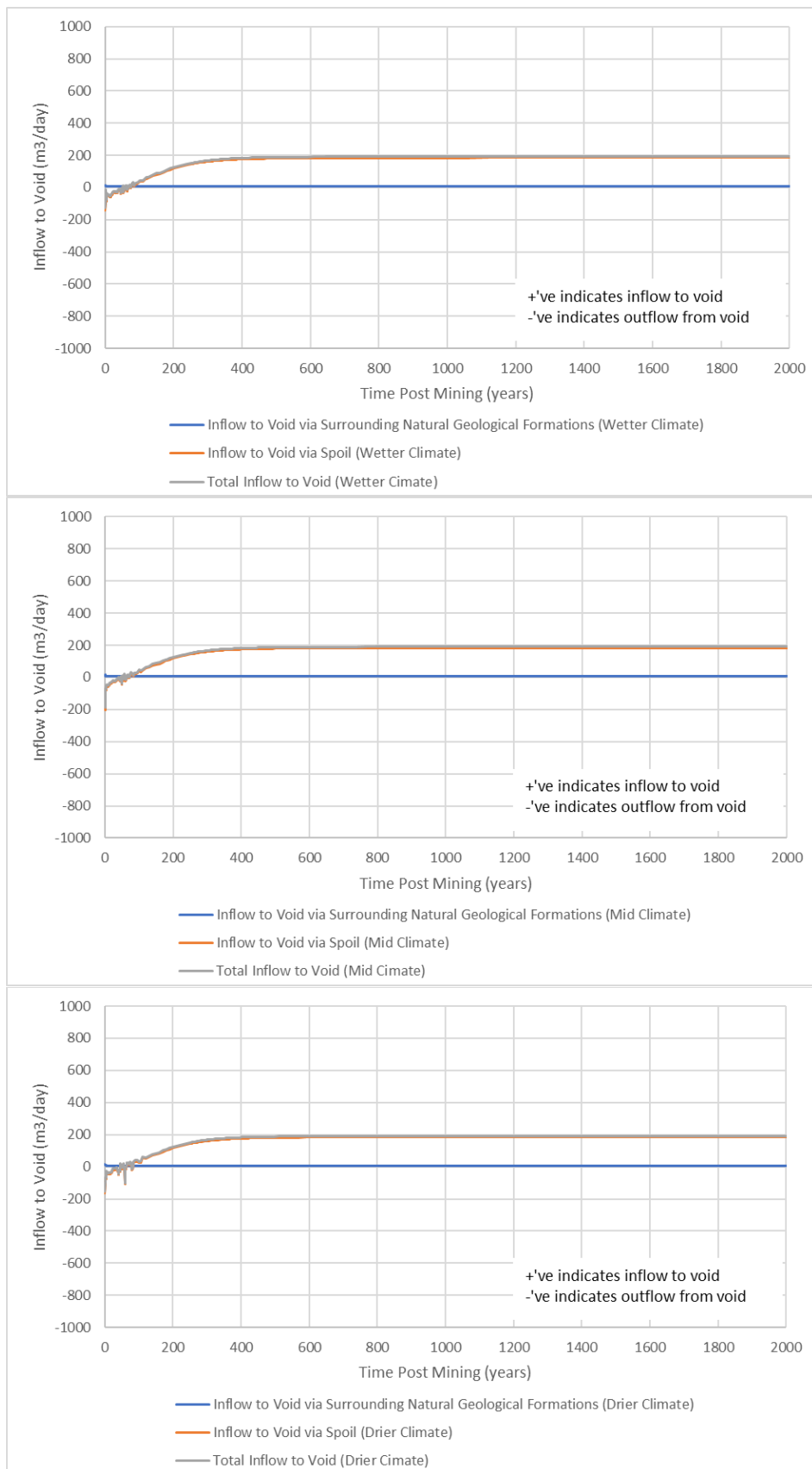


Figure 7-6 Predicted Residual Void Groundwater Inflows – Pandora Void

In the first 70 to 80 years post-mining for the Titan North/Central and Pandora voids, and the first 2 years post-mining for the Titan East Void, groundwater levels remain suppressed. During this time, groundwater fluxes to the voids are largely controlled by the predicted Golder (2022) residual void lake levels that rise and fall periodically (refer **Figure 7-1** through **Figure 7-3**) according to:

- the day-on-day climatic simulation within the Golder (2022) water balance model, and
- how the daily timestep water balance results are translated to the groundwater model's more simplified stress period setup.

Accordingly, there are periods of variable groundwater inflow and outflow predicted by the groundwater model for the Titan North/Central and Pandora voids in the first 70 to 80 years post-mining, and some variability in the predicted inflow magnitudes over approximately the first 150 years post-mining for all voids.

Model results show an initial outflow of rainfall derived surface water captured in the voids (per the Golder water balance model) to the surrounding groundwater system (to the spoil) in the first 2 years post-mining at Titan East Void, 30 years post-mining at Titan North/Central Void, and 40 years post-mining at Pandora Void, as the groundwater levels in the surrounding in-pit spoil backfill (and natural geological formations) slowly recover from mining activities. All predicted outflows occur to the spoil, that is, there is no predicted outflow from any of the voids to the natural geological formations. Potential impacts associated with these early predicted outflows are evaluated with particle tracking in **Section 7.2.5**. However, as groundwater levels in the spoil and natural geology recover to elevations above the void lakes and lake levels stabilise, the direction of flow out of the void lakes is reversed and long-term groundwater inflow to the lakes is established. Inflow only conditions post-mining prevail after approximately 2 years at Titan East Void, 70 years at Pandora Void, and 80 years at Titan North/Central Void, with that inflow coming mostly via the spoil (and originating mainly as local rainfall recharge applied to the spoil). It is noted that any form of further backfilling of residual voids to above the groundwater level as a means to attempt to limit void water discharge will likely result in poorer environmental outcomes, as any water in the backfilled voids will have a hydraulic head gradient toward the surrounding groundwater system. This will facilitate discharge outwards to the surrounding environment, in the absence of the hydraulic control (sink) caused by a relatively deep void lake that is maintained by evaporation in the long term (SLR, 2022c).

At Titan North/Central Void, groundwater inflows are predicted to marginally but steadily increase up to approximately 800 years post closure, despite stable lake levels represented in the groundwater model after 150 years (refer **Figure 7-1**). This is considered to be reflective of the general recovery of the regional groundwater system relative to the DNM residual void lake levels, as the groundwater system recovers following cessation of all mining activity represented in the regional scale groundwater model. A similar situation is predicted to occur at Pandora Void, albeit with inflows stabilising over a much shorter time period (by approximately 400 years post-closure). At Pandora Void, this is considered to be somewhat reflective of the simulated post-mining influence of the adjacent mining operations to the west (Poitrel) and east (Moorvale South), and possibly to the south (Winchester South).

Model results indicate that between 96% and 100% of the long-term groundwater inflow to the voids comes via the spoil, originating mainly as local recharge applied to the spoil. Predicted equilibrium groundwater inflows to each of the voids for the three climate scenarios are presented in **Table 7-8**. These volumes are only approximately 41% of the 397.3 ML/year (1,088 m³/day) estimate of long-term average associated water take from mining activities at DNM (refer **Section 4.7**). The equilibrium groundwater inflows to each of the voids shown in **Table 7-8** represent approximately 20% to 30% of the total volumetric inflow to each residual void's water balance (Golder, 2022), that is, groundwater volumetric contribution the residual voids is relatively small in comparison to surface water (rainfall and runoff) contribution.

Table 7-8 Equilibrium Groundwater Inflow to the Residual Voids

Climate Scenario	Residual Void	Equilibrium Inflow Rate – Spoil (m ³ /day)	Equilibrium Inflow Rate – Natural Geological Formations (m ³ /day)	Equilibrium Inflow Rate – Total (m ³ /day)
Wetter	Titan North/Central	206.7	5.9	212.6
	Titan East	40.8	0.0	40.8
	Pandora	185.3	7.0	192.3
Mid	Titan North/Central	208.1	5.9	214.0
	Titan East	41.8	0.0	41.8
	Pandora	183.5	7.0	190.5
Drier	Titan North/Central	206.5	5.9	212.4
	Titan East	41.0	0.0	41.0
	Pandora	185.4	7.0	192.4

7.2.4 Predicted Groundwater Levels

Groundwater level predictions and associated discussion presented herein is focussed primarily on the Mid Climate scenario with the Drier and Wetter scenario's reported as sensitivities. This is deemed appropriate given the relatively small difference in predicted residual void lake elevations (that drive groundwater levels) between the scenarios with respect to void lake levels that might pose a risk to the groundwater environment (refer **Section 7.2.2**).

7.2.4.1 Mid Climate Scenario

Groundwater Levels – General

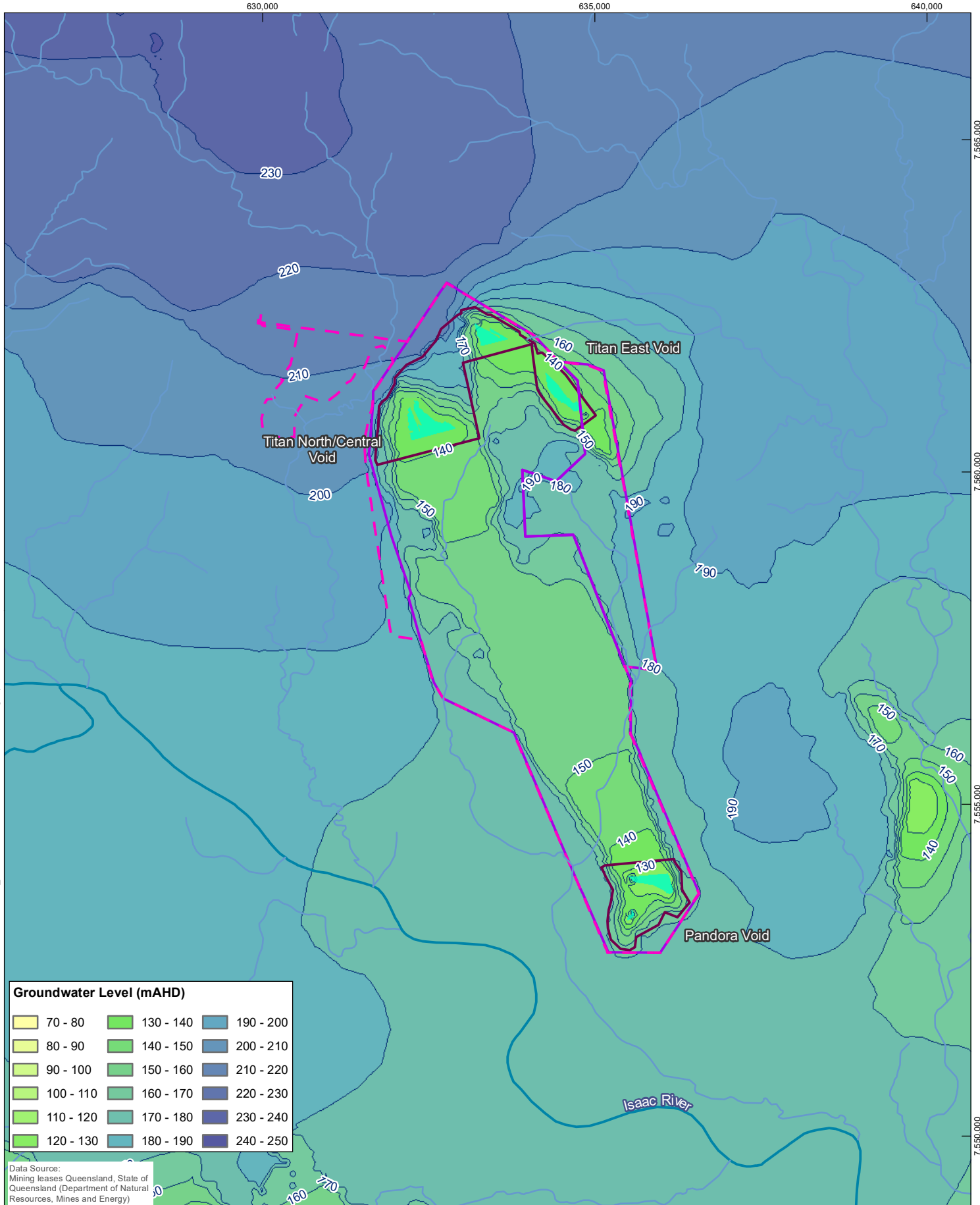
The predicted equilibrium water table elevation adjacent the residual voids is shown on **Figure 7-7** for the Mid Climate scenario. Predicted groundwater levels for the Leichhardt and Vermont Seams of the Rangal Coal Measures (model layers 5 and 7, respectively) outside of the residual voids are shown on **Figure 7-8** and **Figure 7-9**, again at equilibrium for the Mid Climate scenario. Note that the simulated influence of the Moorvale South Project residual voids to the west-southwest of the DNM Area is clearly evident in **Figure 7-7** through **Figure 7-9**.

As shown on **Figure 7-7**, within the DNM Area (including areas of spoil backfill in the DNM Area) and up to 2 km from Titan East Void away from the DNM Area the water table is predicted to remain depressed in the long term, driven by the ongoing groundwater discharge to the residual void lakes and governed by the lake elevations themselves. That is, long term inwards groundwater flow gradients to the residual voids are maintained post-mining. Steepest water table gradients outside the voids themselves occur northeast of the DNM Area adjacent the Titan East Void, whereas gradients north and west of Titan North/Central Void and surrounding the Pandora Void are generally somewhat shallower. Water table depression east of the DNM Area extends up to 1 km from the edge of the DNM Area, however water table depression west of the DNM Area is comparatively limited in what is considered to be a result of the simulated influence of Poitrel. The water table remains close to pre-mining groundwater elevations in the area along the Isaac River where potential GDEs are mapped (refer **Section 4.6.2**).

Predicted groundwater levels for the Leichhardt and Vermont Seams of the Permian Coal Measures indicate again that groundwater levels in the Permian sequence are predicted to remain depressed in the long term, driven by the ongoing evaporation-driven groundwater discharge to the residual void lakes and governed by the lake elevations themselves. Generally, predicted groundwater levels are very similar between the Leichhardt and Vermont seams. The effect of the significant structural geology (see **Sections 3.2.4** and **4.3.3**) can be seen in **Figure 7-8** and **Figure 7-9** as broad areas to the west, east and south of DNM where the seams are geologically absent. There are also fringing areas where the seams are predicted to be 'dry' (unsaturated) in the long-term post-mining, particularly on and immediately adjacent to the DNM Area.

Predictive hydrographs showing the change in groundwater levels over time for the Leichhardt and Vermont Seams of the Permian Coal Measures just outside the residual voids (within approximately 150 m of the residual void crests) are shown as **Figure 7-10** through **Figure 7-12**, with the hydrograph locations shown on **Figure 7-8** and **Figure 7-9**. The hydrographs demonstrate that the vast majority of groundwater level drawdown in the Permian Coal Measures occurs during mining operations, with post-closure groundwater levels in the Permian coal seams adjacent Titan North/Central and Titan East voids recovering from their lowest point that occurred during mining. Both the Leichhardt and Vermont seams adjacent the Titan North/Central Void are predicted to recover significantly in the long-term post-closure. Post-closure groundwater levels in the Permian coal seams adjacent Titan East Void are predicted to have only a relatively small magnitude of recovery. Post-closure groundwater levels adjacent Pandora Void are not predicted to recover from the lowest point predicted to occur shortly after the cessation of mining, with the Leichhardt Seam to the southwest of Pandora Void predicted to remain 'dry' in the long term. The hydrographs also demonstrate very little effect on groundwater levels from the residual void inflow flux variability in the early post-closure period as shown and discussed in **Section 1**. Predicted residual void lake levels remain significantly below predicted groundwater levels at all times, indicating no potential for outwards movement of void water to the Leichhardt or Vermont Seams outside the residual voids.

H:\Projects-SLR\620-BNE\620-BNE\620-30984-00000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\GIS\DNM\62030984_F07_7_Predicted Water Table Elevation PostMining Equilibrium Mid Climate.mxd



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 15-Mar-2023

Drawn by: NT



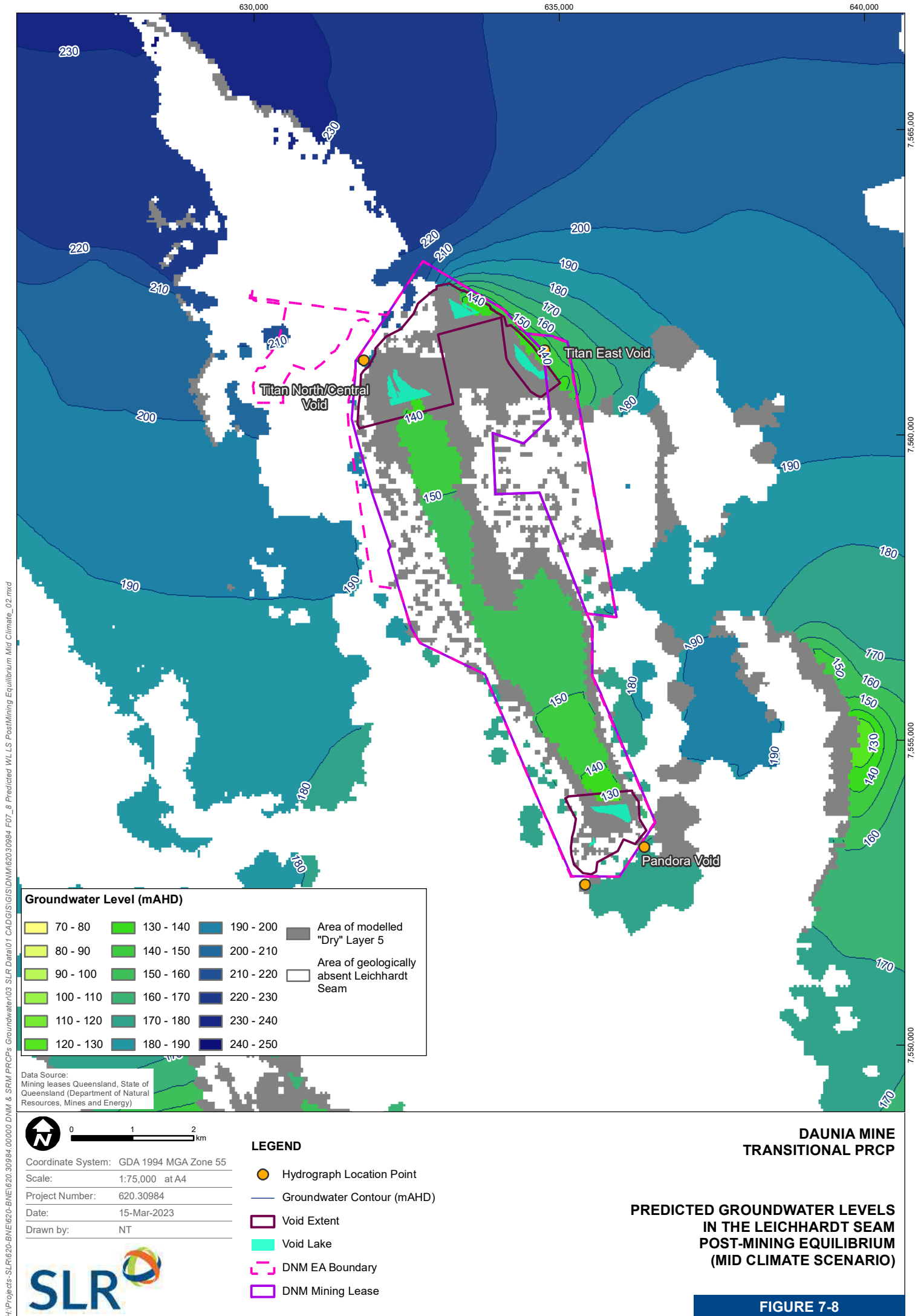
LEGEND

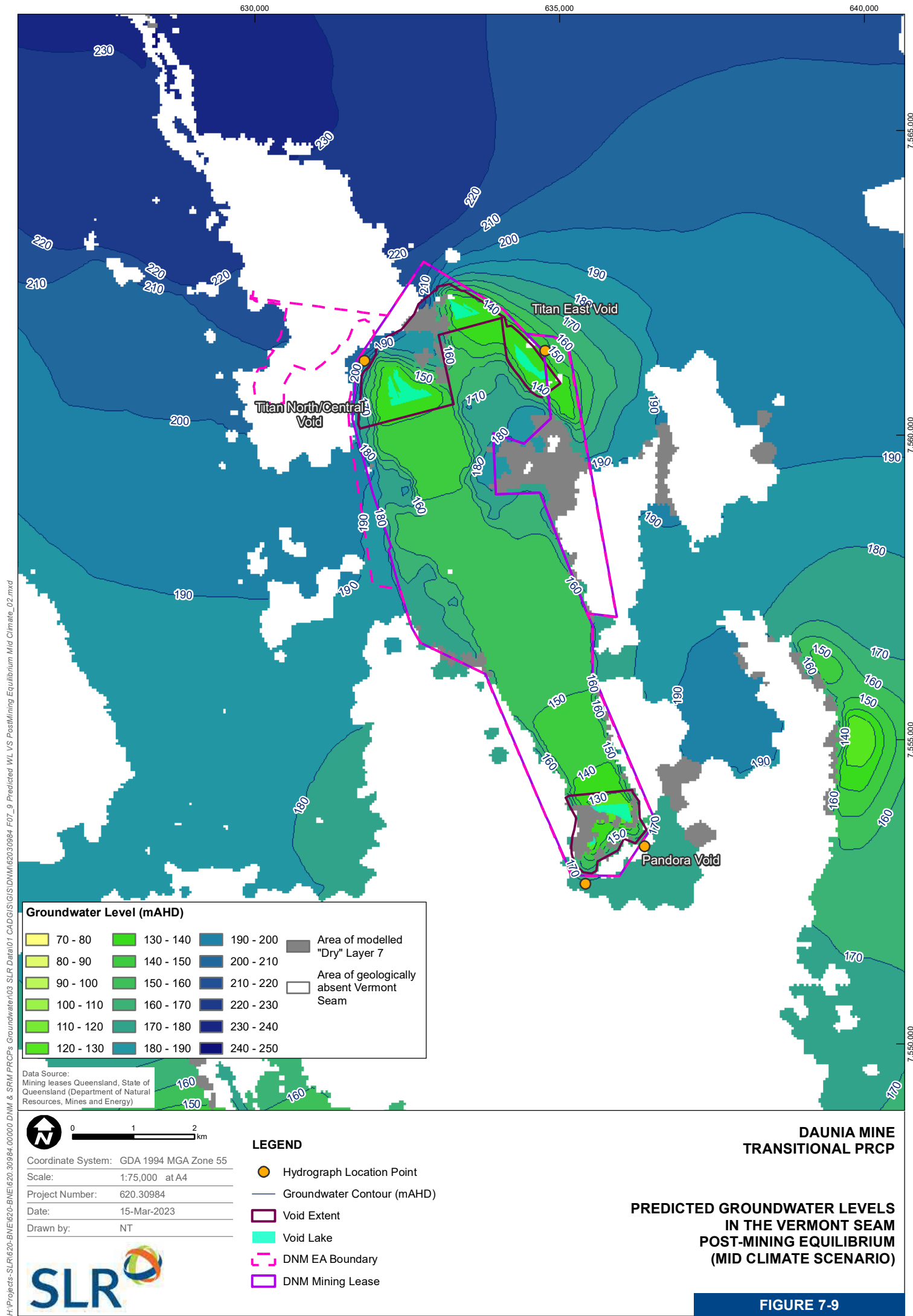
- Groundwater Contour (mAHd)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake
- DNM EA Boundary
- DNM Mining Lease

DAUNIA MINE TRANSITIONAL PRCP

**PREDICTED WATER TABLE
ELEVATION – POST-MINING
EQUILIBRIUM
(MID CLIMATE SCENARIO)**

FIGURE 7-7





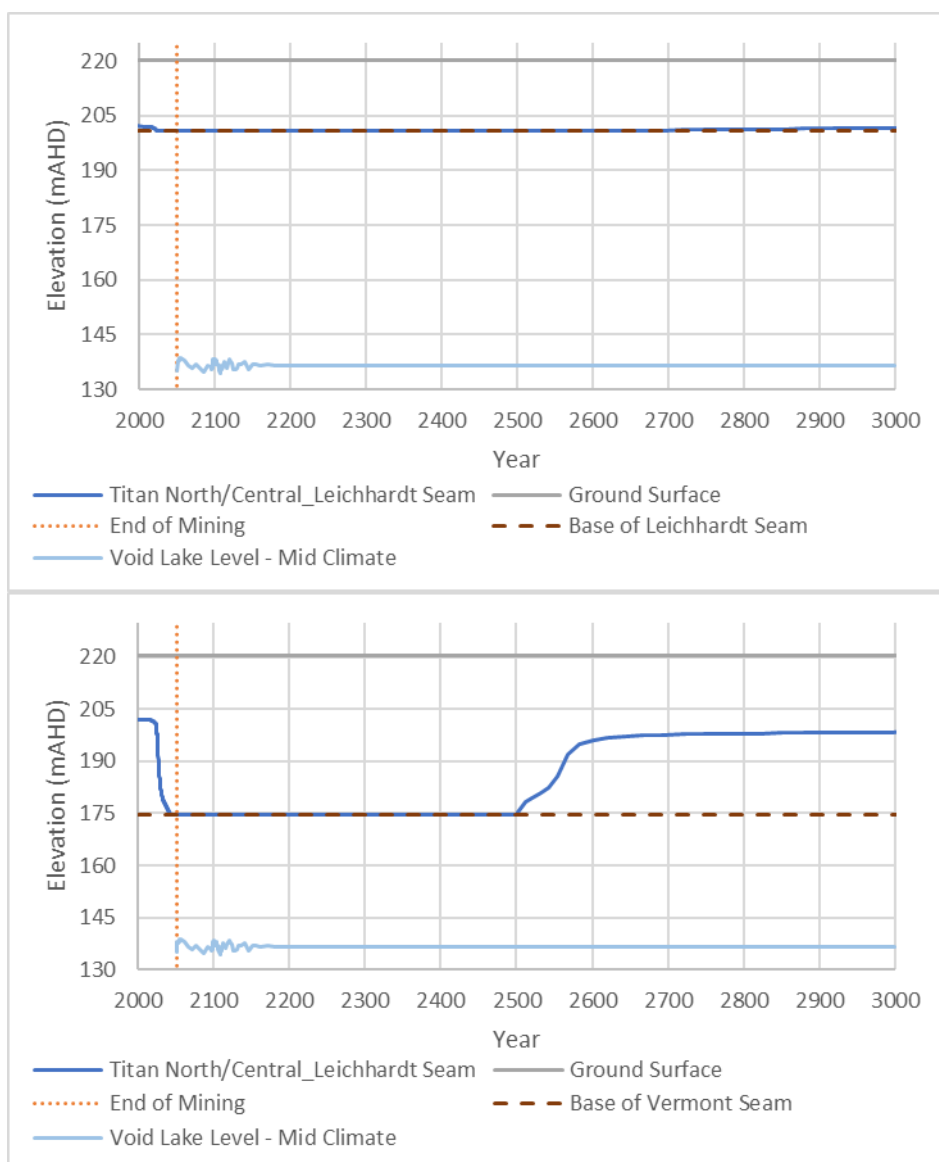


Figure 7-10 Permian Coal Measures Predictive Hydrographs adjacent Titan North/Central Void

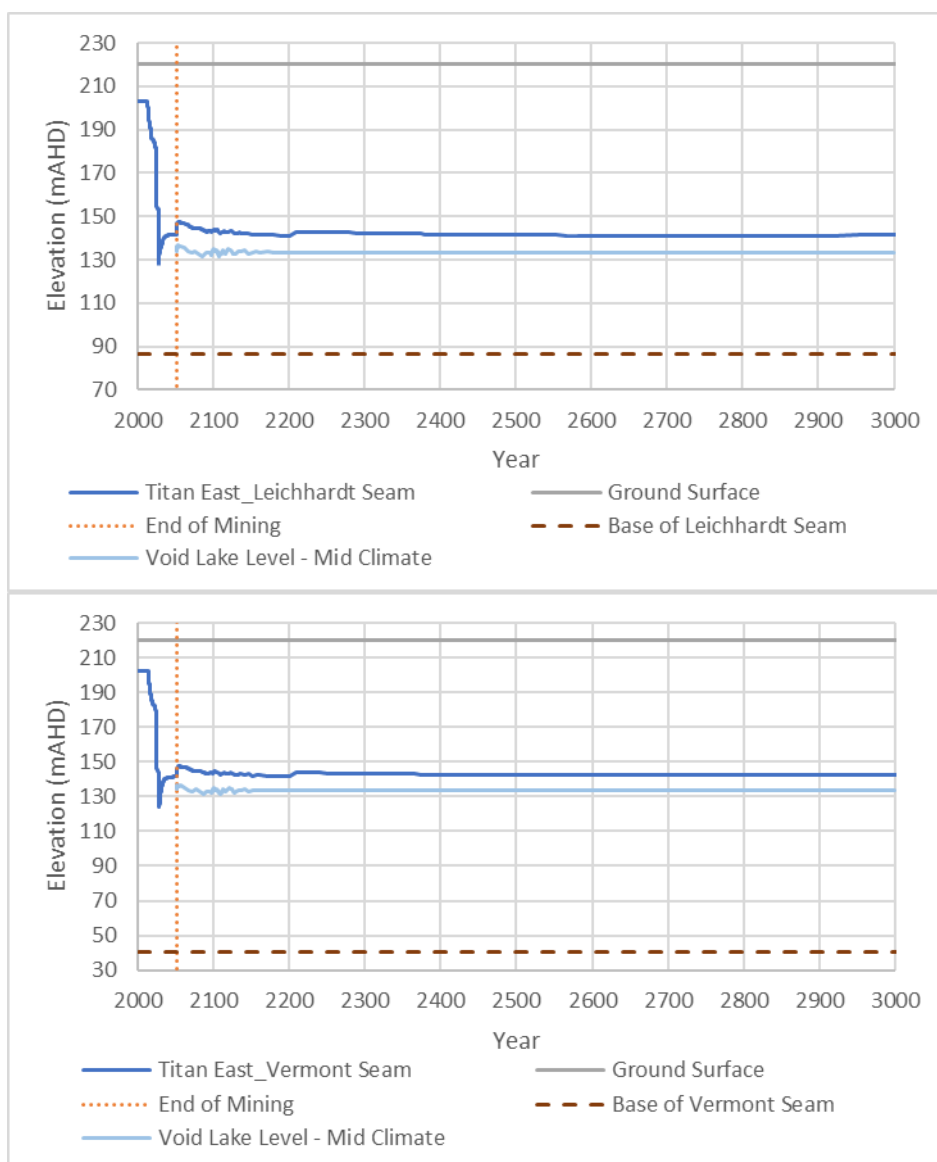


Figure 7-11 Permian Coal Measures Predictive Hydrographs adjacent Titan East Void

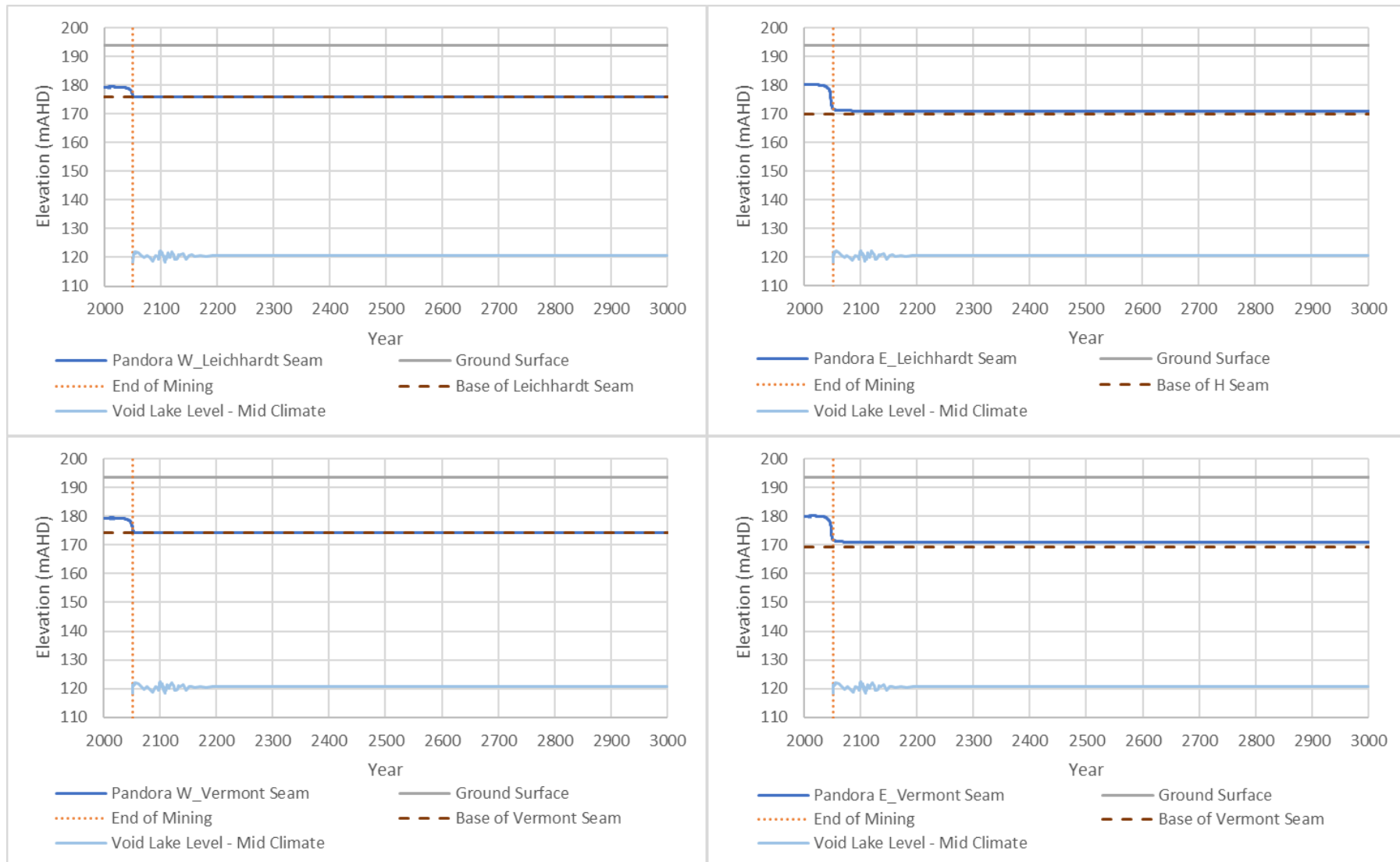


Figure 7-12 Permian Coal Measures Predictive Hydrographs adjacent Pandora Void

Groundwater Level Impacts to Potential Receptors

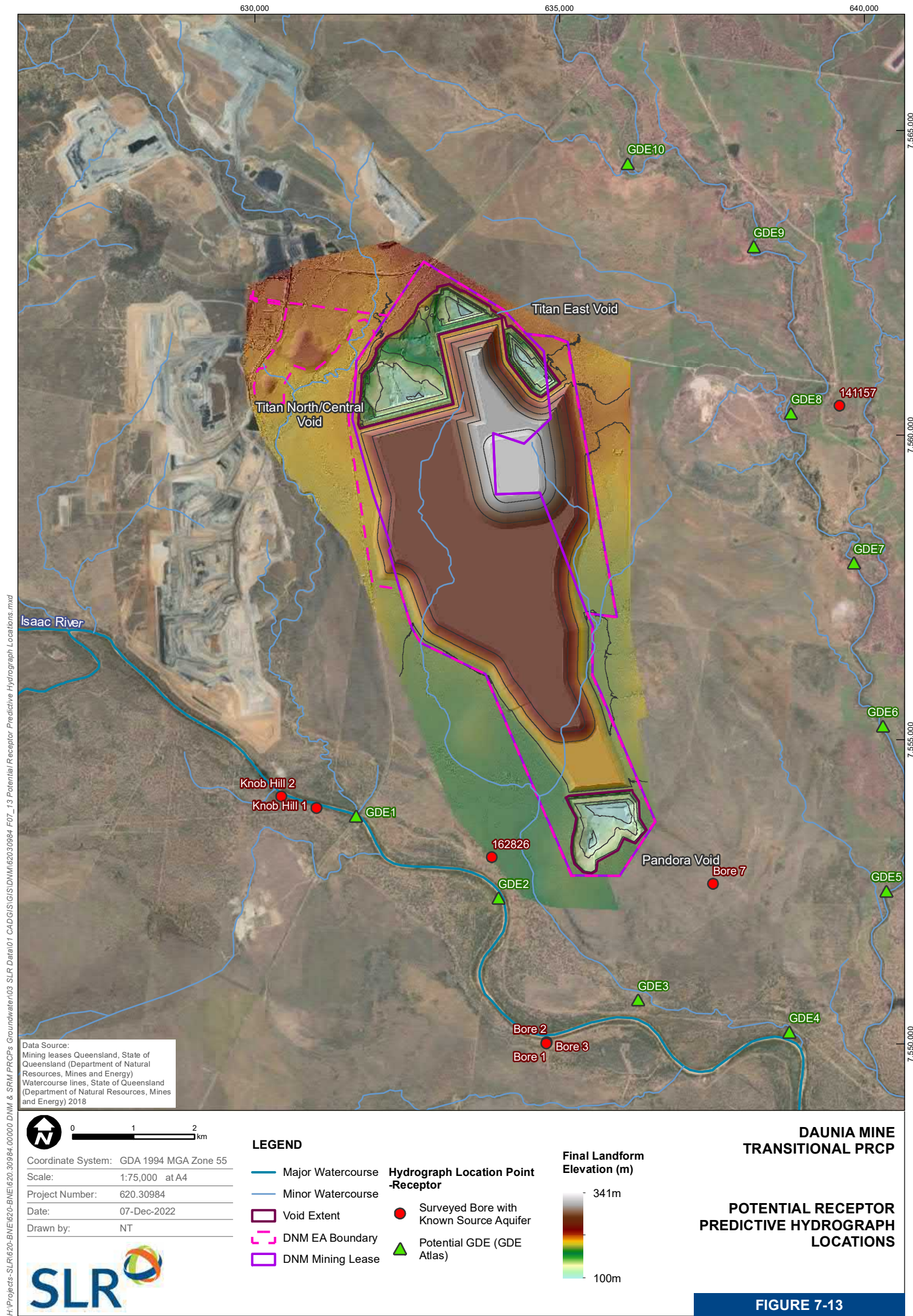
Predictive hydrographs have been derived from the groundwater model to understand the nature of likely groundwater level change in the interpreted source aquifer for identified potential natural and anthropogenic groundwater receptors in the vicinity of the DNM Area (refer **Section 4.6**). The aim of the hydrographs is to assess the potential for additional impacts to these potential receptors in the period post-mining, i.e. identify additional potential impacts beyond those that have occurred during already approved mining operations that may be attributable to the PRC Plan's proposed final landform. **Figure 7-13** provides the hydrograph locations.

Predictive hydrographs for the water table at the potential GDE sites identified near to the DNM Area (refer **Section 4.6.2**) are provided **Figure 7-14** for the mid climate scenario. The end of DNM mining / start of the DNM post-mining period is identified on the hydrographs. Note there is no difference in the hydrographs for the drier or wetter climate scenarios. Since there is evidence from previous studies that much of the deeper rooted terrestrial vegetation immediately fringing the Isaac River may in part access shallow alluvial groundwater (**Section 4.6.2.1**), predictive hydrographs have been generated at equally spaced intervals along the GDE Atlas mapped extent of potential GDEs at the River. Predictive hydrographs have also been generated at equally spaced intervals along the GDE Atlas mapped extent of potential GDEs along North Creek east of DNM.

The water table hydrographs indicate that for potential GDE sites along the Isaac River (GDE1 through GDE4), no additional water table drawdown is predicted to occur over the post-mining period, with between zero and 1.5 m of water table drawdown in the vicinity of the potential GDEs predicted to occur prior to the end of mining (i.e. associated with approved DNM mining operations plus other nearby operations including Poitrel, Winchester South, Moorvale South and Olive Downs). Most predicted water table drawdown prior to the end of DNM mining occurs at site GDE4, which is the furthest hydrograph site to the southwest, however it should be noted that the predicted depth to water table at this site (and at the GDE3 site immediately west) is nearly 10 m prior to the commencement of DNM mining and therefore likely beyond the rooting depth of all but the deepest rooted large terrestrial vegetation species and therefore total plant groundwater use would likely be negligible. Some recovery of the water table is evident post-mining, particularly for the GDE4 site.

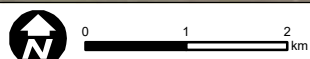
Hydrographs sites GDE5, GDE6 and GDE7 on North Creek are located in significantly closer proximity to the Moorvale South Project than DNM. It is expected therefore that the Moorvale South final landform represented in the groundwater model is controlling the water table responses seen at those hydrographs. The GDE5 and GDE6 hydrographs also show that peak water table drawdown is predicted to occur prior to the end of DNM mining, whereas GDE7 shows additional water table drawdown over the DNM post-mining period (likely related to Moorvale South as previously discussed).

Hydrographs sites GDE8, GDE9 and GDE10 on the upper reaches of North Creek show 0.1 to 0.4 m water table drawdown over the DNM post-mining period. It is considered that, given the shape of these drawdown curves and proximity to other mining operations represented in the model such as Millennium, these hydrographs are representative of longer term regional scale effects from a number of sites including DNM. The magnitude of predicted water table drawdown at these sites (0.1 to 0.4 m) is relatively small and the predicted water table remains within approximately 3 m of the ground surface at all three sites, and therefore significant impacts to any GDEs located there would not be anticipated.



H:\Projects-SLR\620-BNE\620-BNE\620-30984-000000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\SDM\62030984_F07_13 Potential Receptor Predictive Hydrograph Locations.mxd

Data Source:
Mining leases Queensland, State of Queensland (Department of Natural Resources, Mines and Energy)
Watercourse lines, State of Queensland (Department of Natural Resources, Mines and Energy) 2018



Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:75,000 at A4
Project Number: 620.30984
Date: 07-Dec-2022
Drawn by: NT



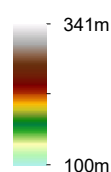
LEGEND

- Major Watercourse
- Minor Watercourse
- Void Extent
- DNM EA Boundary
- DNM Mining Lease

Hydrograph Location Point -Receptor

- Surveyed Bore with Known Source Aquifer
- ▲ Potential GDE (GDE Atlas)

Final Landform Elevation (m)



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POTENTIAL RECEPTOR PREDICTIVE HYDROGRAPH LOCATIONS

FIGURE 7-13

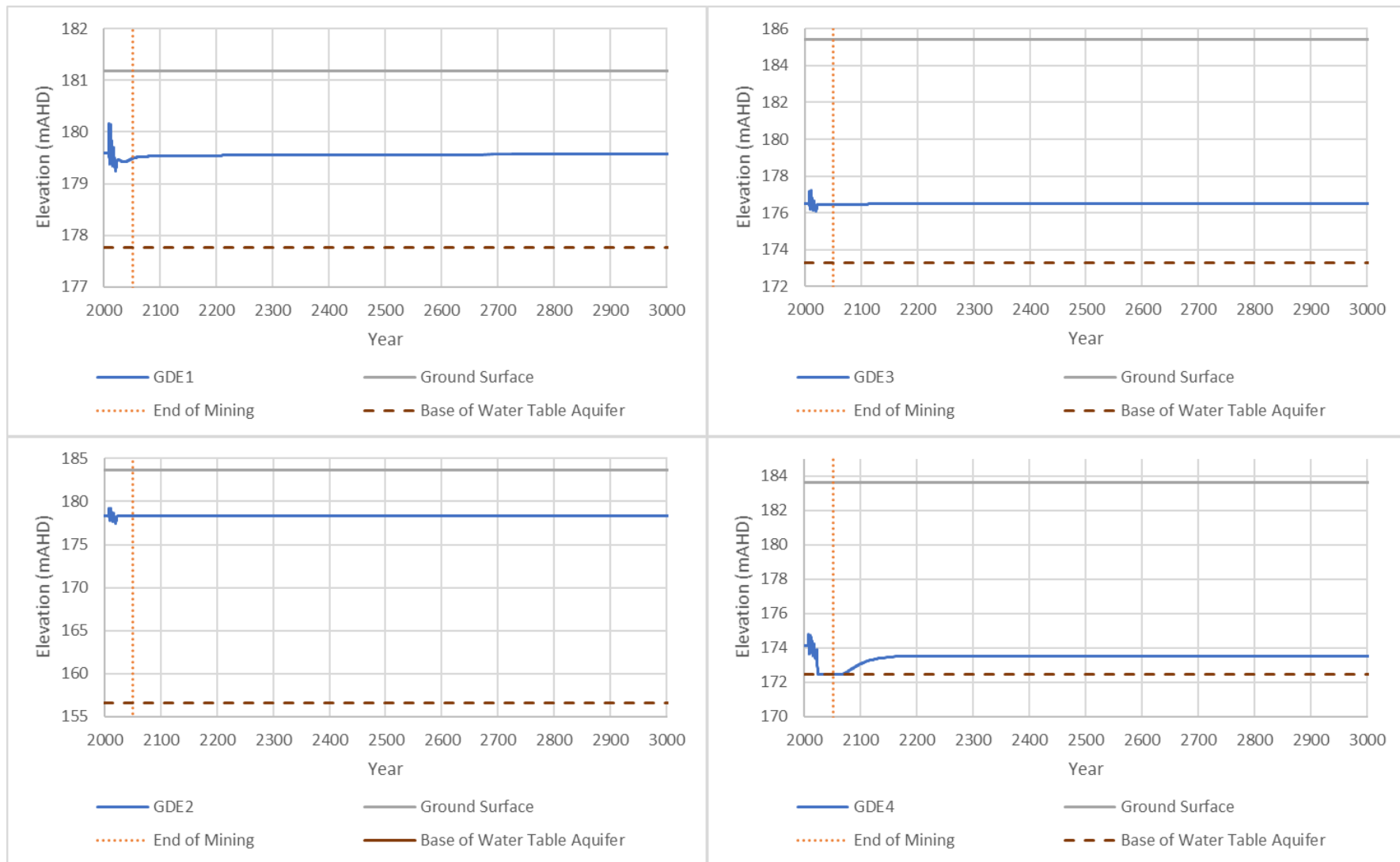


Figure 7-14 Water Table Hydrographs at Potential GDEs

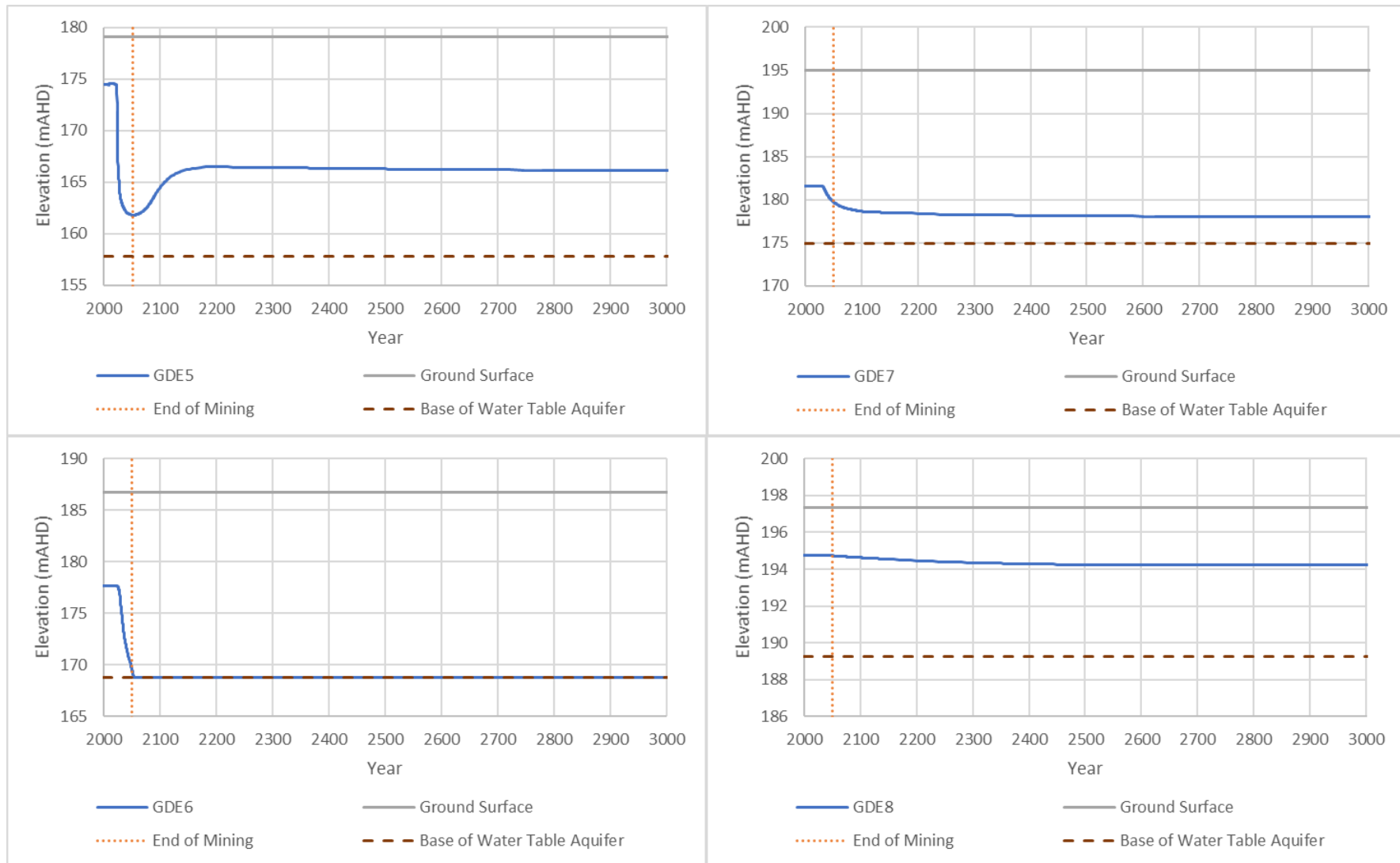


Figure 7-14 Water Table Hydrographs at Potential GDEs (cont.)

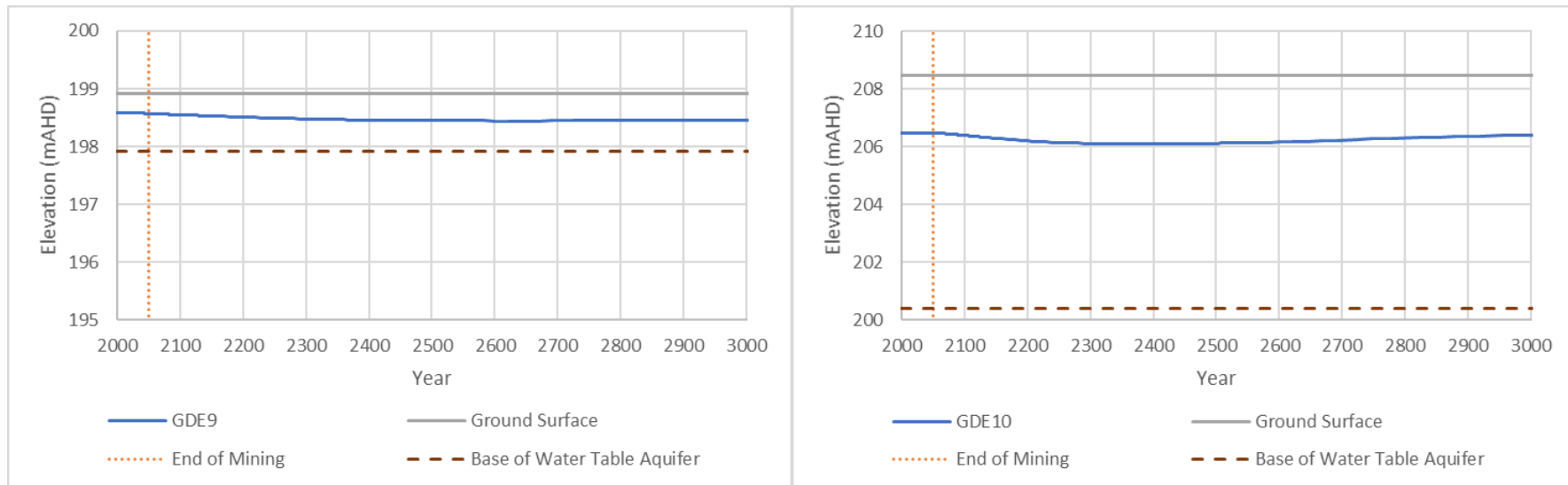


Figure 7-14 Water Table Hydrographs at Potential GDEs (cont.)

Predictive hydrographs for the ten identified third party water supply bores in recent bore census' with sufficient information to attribute a source aquifer (refer **Section 4.6.1.1**) are provided as **Figure 7-15** for the mid climate scenario. The end of DNM mining / start of the DNM post-mining period is identified on the hydrographs. Note there is no difference in the hydrographs for the drier or wetter climate scenarios. Negligible additional groundwater drawdown over the DNM post-mining period is predicted at most bores. The most additional drawdown predicted at Bore 3 located 2.7 km south of the Pandora Void, with 0.4 m predicted additional drawdown in the long term post-closure at DNM, which remains less than the relevant 5 m drawdown 'bore trigger threshold' for consolidated aquifers (i.e. the Fort Cooper Coal Measures) identified in Chapter 3 of the *Water Act 2000*, i.e. the threshold at which drawdown impacts may need to be further investigated for the purposes of determining any requirement to 'make good' a bore impairment.

Bores 141677 and 5 Mile Bore are predicted to show relatively significant groundwater level recovery in the DNM post-mining period, with groundwater levels rising between approximately 4 and 6 m from their lowest points that occur during active (approved) DNM mining activities. It is worth noting that the predicted drawdown at these bores during the DNM mining period cannot be only attributed to DNM mining, since other nearby mines are represented in the model during the DNM mining period such as Moorvale South, Winchester South, and Olive Downs. In particular, bores 141677 and 5 Mile Bore are located significantly closer to Moorvale South than to DNM.

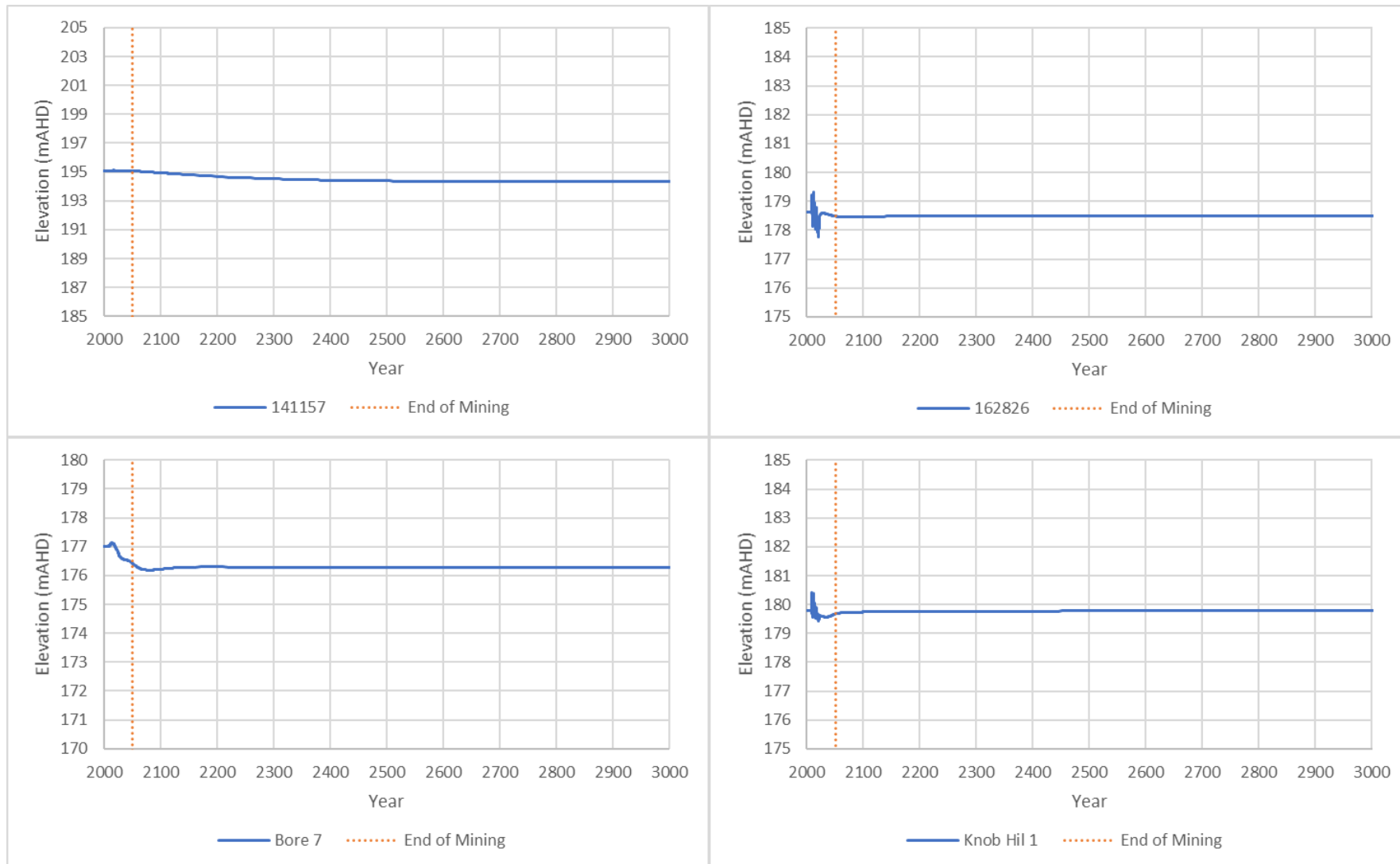


Figure 7-15 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer

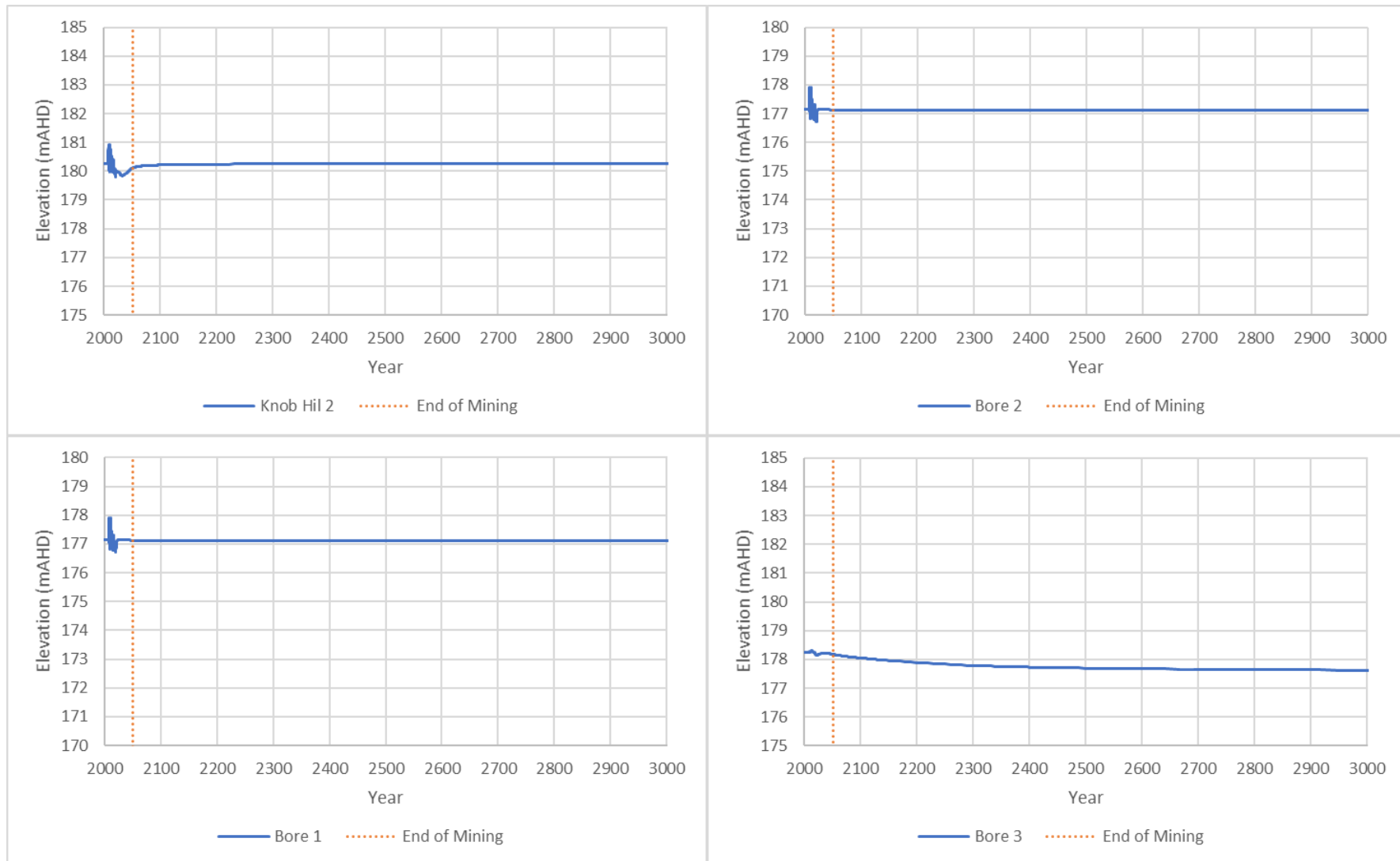


Figure 7-15 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer (cont.)

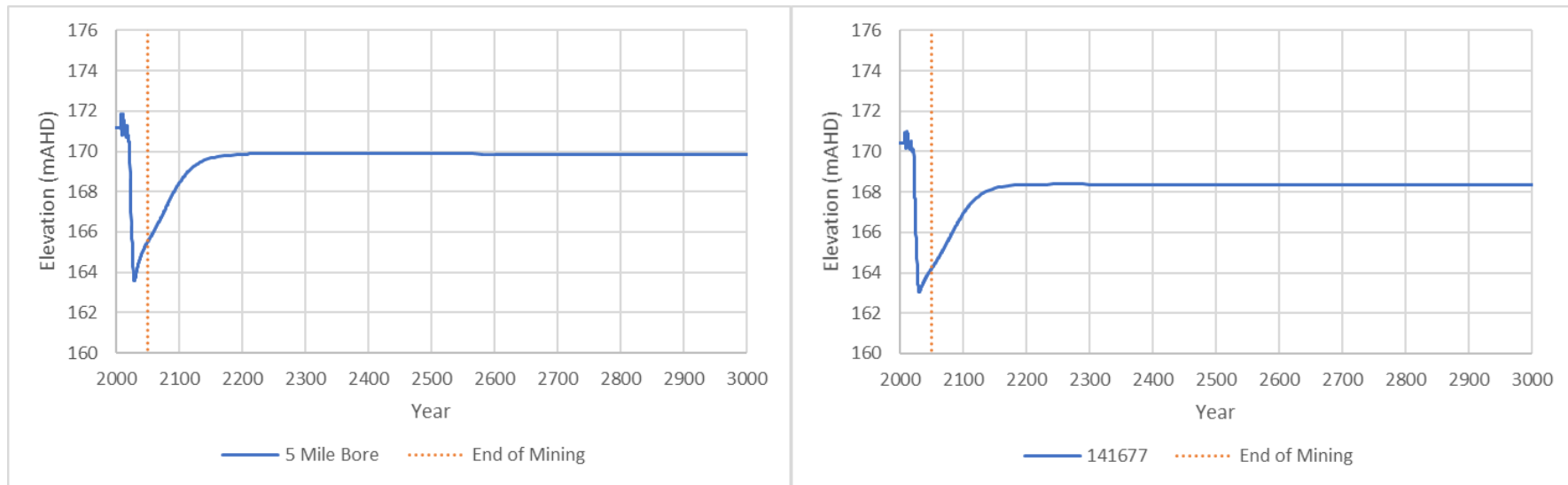


Figure 7-15 Hydrographs for Surveyed Third Party Supply Bores with Attributable Source Aquifer (cont.)

7.2.4.2 Climate Sensitivity

Predicted groundwater levels for the Drier Climate scenario and Wetter Climate scenario are shown in **Appendix B** and **Appendix C**, respectively.

There is very little difference between the predicted groundwater levels outside the voids for the 3 climate scenarios as discussed in **Section 7.2.4.1**.

7.2.5 Flow Path Simulation

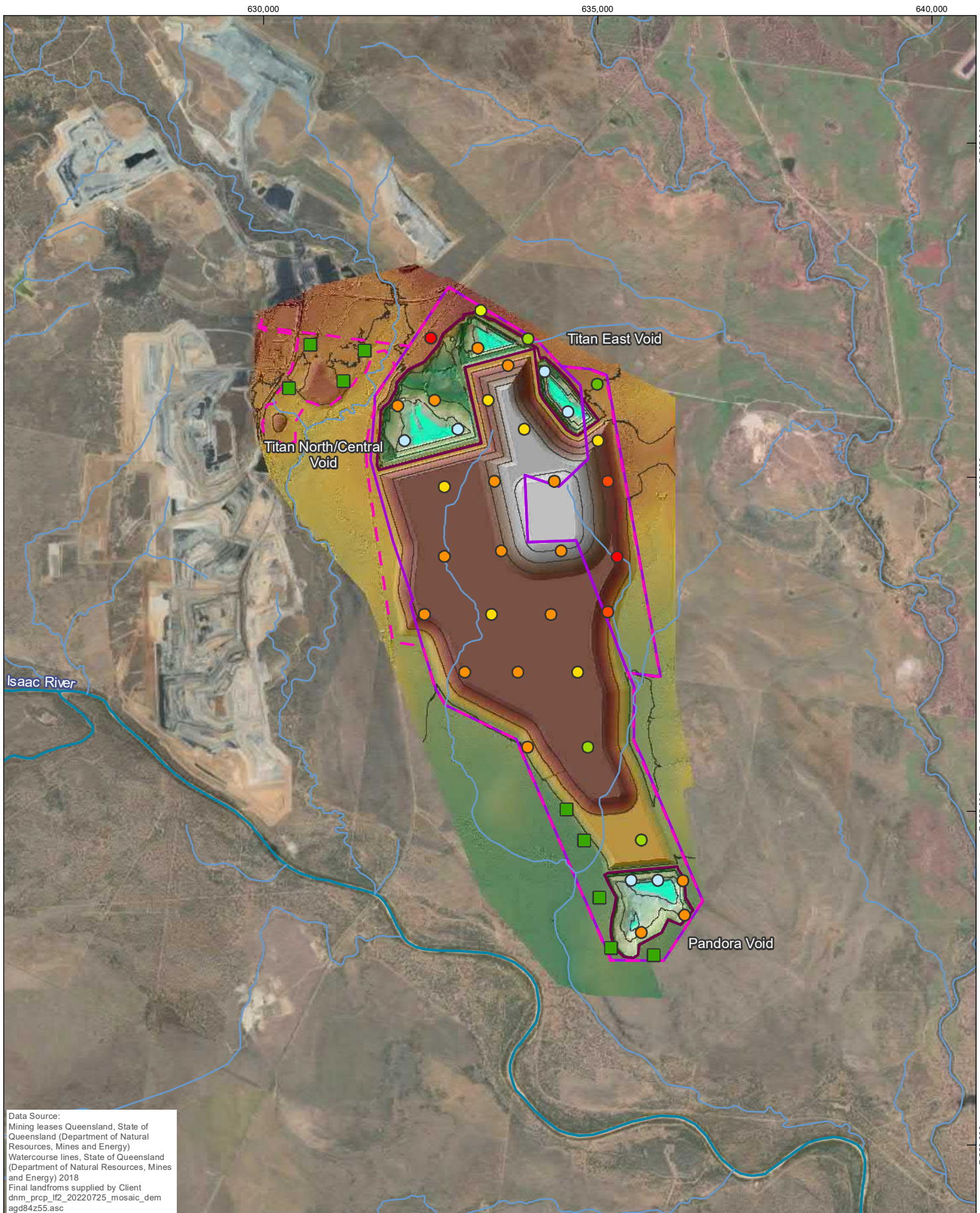
An analysis of the water movement within Landform #2 was undertaken to simulate and assess the movement and fate of water particles through the groundwater system post-mining. A number of particles were placed on the final landform and within the residual voids in the recovery groundwater model and the mod-PATH3DU code (S.S. Papadopoulos & Associates, Inc., 2018) was used to simulate particle pathways along the groundwater flow field during recovery (i.e. 2,000 years). To run the mod-PATH3DU code the transient head outputs from the groundwater flow model were used by mod-PATH3DU to simulate particle flowpath lines.

Figure 7-16 shows the initial location of particles on Landform #2. The particles were placed at the surface of the model and released at the start of the post-mining simulation, with the movement of the particles then recorded during the post-mining simulation. It should be noted that the mod-PATH3DU code automatically moves the particle from the model surface to the shallowest saturated layer at the commencement of the simulation; as shown on **Figure 7-16** for many of the particles this represents the Permian layers (including areas of spoil backfill in model layers that represent Permian units pre-mining) as the shallow layers (Layers 1 and 2) are unsaturated across much of the DNM Area at the commencement of the post-mining simulation. Locations where the model predicts saturation in the shallow groundwater system (i.e. Layer 2) at the end of mining and therefore where particles did commence in shallow groundwater include the MIA on the northwestern side of the DNM Area, and along the southwestern boundary of the SRM Area adjacent Pandora Void (refer **Figure 7-16**).

7.2.5.1 Mid Climate Scenario

Figure 7-17 shows the predicted movement of water particles in the 2,000 year recovery simulation of Landform #2 for the Mid Climate scenario. The colours along the predicted particle flow paths provides the model layer the particle was simulated to be moving through, with the green to red scale classification representing particles moving from shallow to deep model layers.

The colour changes along the paths on **Figure 7-17** indicate that particles situated within the shallower saturated layers at the beginning of the post-mining simulation generally move progressively toward deeper layers representing the Permian coal measures (or backfilled spoil where the coal measures has been mined out) over the post-mining period. The flow path analysis indicates the particles generally move toward the void lakes, with many of the particles remaining in the voids once they have entered the void lakes. Particles that move into the voids during the post-mining simulation remain within the voids for the duration of the simulation. Particles starting in voids themselves remain within the voids for the duration of the simulation.



Data Source:
 Mining leases Queensland, State of
 Queensland (Department of Natural
 Resources, Mines and Energy)
 Watercourse lines, State of Queensland
 (Department of Natural Resources, Mines
 and Energy) 2018
 Final landforms supplied by Client
 dnm_prp_if2_20220725_mosaic_dem
 agd84z55.asc

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:75,000 at A4
 Project Number: 620.30984
 Date: 15-Mar-2023
 Drawn by: NT



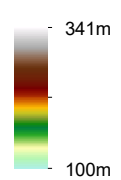
LEGEND

- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake
- DNM EA Boundary
- DNM Mining Lease

Starting Location and Layer of Particle Simulation

- | | |
|---|--|
| Void Lake | 6 |
| 2 | 7 |
| 3 | 8 |
| 4 | 9 |
| 5 | |

Final Landform Elevation (m)

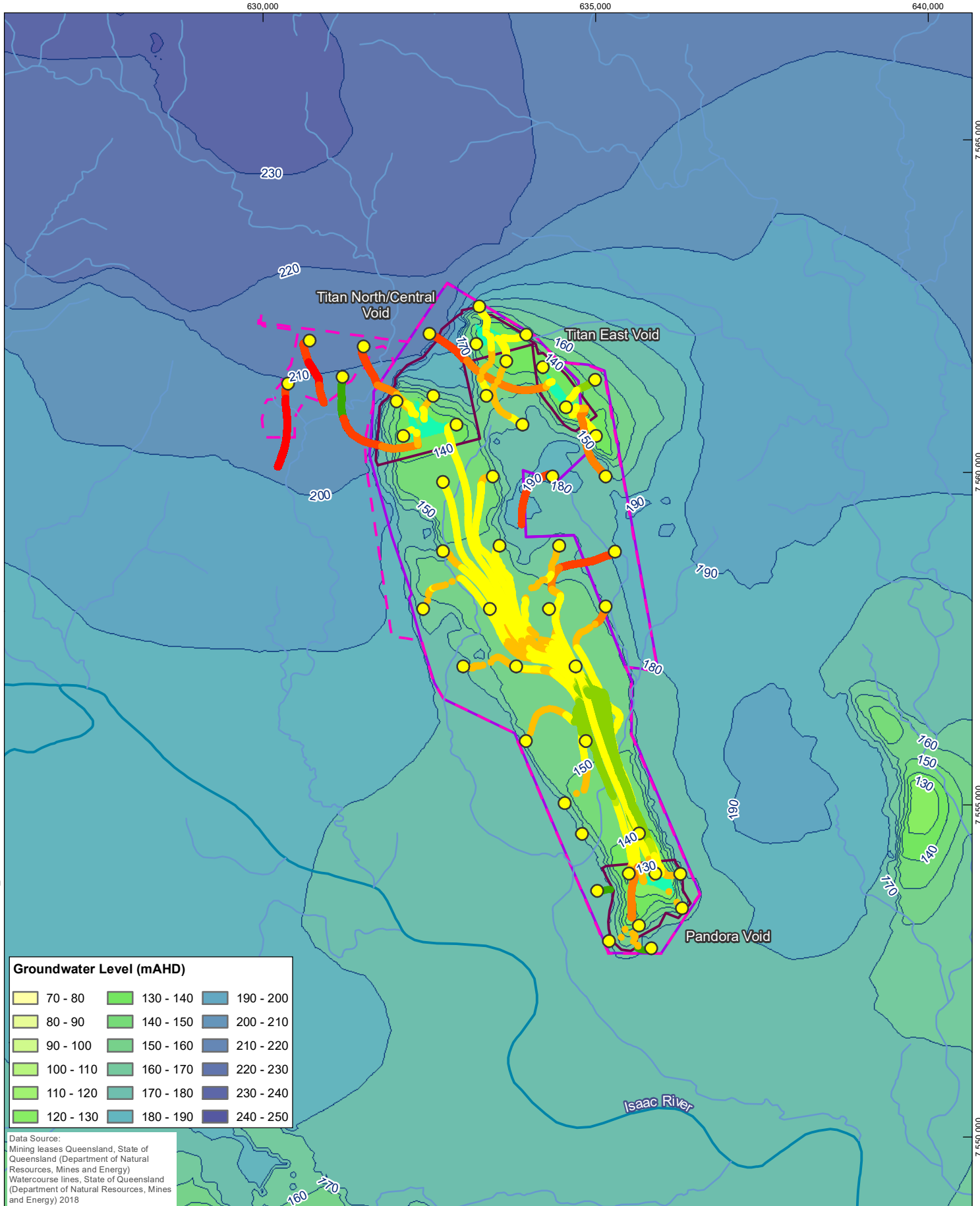


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STARTING LOCATION OF PARTICLES

FIGURE 7-16

H:\Projects-SLR\620-BNE\620-BNE\620.30984_000000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\SDM\62030984_F07_16 Starting Location Particles.mxd



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 15-Mar-2023

Drawn by: NT



LEGEND

- Starting Location of Particle Simulation
- Groundwater Contour (mAHd)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake

- DNM EA Boundary
- DNM Mining Lease

Model Layer Traversed

- | | | |
|--|---|--|
| ● 2 | ● 5 | ● 8 |
| ● 3 | ● 6 | ● 9 |
| ● 4 | ● 7 | ● 10 |

DAUNIA MINE TRANSITIONAL PRCP

PREDICTED MOVEMENT OF PARTICLES (MID CLIMATE SCENARIO)

FIGURE 7-17

Some particles located on the MIA area to the west-northwest of Titan North/Central Void do not become captured within Landform #2 over the 2,000 year simulation, but move southwards approximately 1 km over the 2,000 year simulation and marginally leave the DNM Area. It is considered that this relates to the hydraulic influence of the adjacent Poitrel Mine within the groundwater model over the post-mining simulation. The potential environmental risks associated with groundwater beneath the MIA potentially moving out of the DNM Area will be addressed within the PRC Plan's Contaminated Land Assessment. No particles are shown to move significantly away from the DNM Area to the broader receiving environment.

Given that the particle pathlines are simulated from the start of the post-mining period, they generally follow predicted head gradients shown on **Figure 7-17**. However, the particle directions at times appear to be in opposition to the head contours/gradients shown on **Figure 7-17**, or travel from near to one residual void to another residual void. It should be noted that the head contours shown on **Figure 7-17** only represents the final head pattern when the aquifer has reached an equilibrium and hence does not necessarily show the transient head changes occurring during the 2,000 years post-mining simulation that may result in short term particle movement counter to the long term equilibrium head contours/gradients shown on **Figure 7-17**. **Section 7.2.2** describes the predicted transient nature of residual void lake levels controlling groundwater movement within the DNM Area, and **Figure 7-10** through **Figure 7-12** in **Section 7.2.4** present the predicted transient nature of groundwater levels adjacent the voids.

Overall, the particle movement simulation indicates that nearly all groundwater on DNM, including that flowing through spoil of the final landform, would remain within the final landform (e.g. backfilled spoil and voids) in the long-term with no groundwater predicted to flow to the receiving environment, i.e. the voids would remain groundwater sinks and groundwater would not flow from the residual voids off-site.

7.2.5.2 Climate Sensitivity

Flow path simulation results for the Drier Climate scenario and Wetter Climate scenario as shown in **Appendix B** and **Appendix C**, respectively.

As with the groundwater level predictions (**Section 7.2.4**), there is very little difference between the predicted particle movements for the Drier Climate scenario and Wetter Climate scenario, and the Mid Climate scenario discussed in **Section 7.2.5.1**.

8 Conceptual Site Model – Post-Mining

8.1 Overview

A visual representation of the post-mining CSM is provided as **Figure 8-1**, based on the end of mining CSM discussed in **Section 5** and the post-mining groundwater modelling presented in **Section 7**. There is no evidence from a groundwater perspective that the final landform is unsuitable for the proposed PMLUs and NUMAs, given the hydrogeological assessment objectives outlined in **Section 1.3** and the following key features:

- Residual void lake formation, with lake levels stabilising below the pre-mining groundwater elevations and any shallow post-Permian strata regardless of climate scenario modelled, including the base of surficial weathering and shallow hydrostratigraphic units (i.e. alluvium and regolith).
- Residual groundwater drawdown within the Rangal Coal Measures as caused by the approved DNM mining operation, with ongoing evaporative discharge from the residual void lakes, resulting in continued inwards hydraulic flow gradients in the coal measures to the residual voids and no outflow in the long term regardless of climate scenario modelled.
- Residual voids continue to capture any seepage from spoil emplacements.
- Moderate potential for groundwater beneath the MIA to not be captured by the final landform due to the hydraulic influence of the adjacent Poitrel Mine.
- Little to no additional impact on surficial aquifers, including the alluvial aquifers, caused by the PRC Plan's final landform.
- Little to no additional impact on environmental receptors caused by the PRC Plan's final landform.
- Little to no additional impact on anthropogenic receptors caused by the PRC Plan's final landform.

8.2 Source-Pathway-Receptor Analysis

A graphical representation of the CSM in source-pathway-receptor (SPR) format, with particular focus on the post-mining period, is presented as **Figure 8-2**.

SW

NE

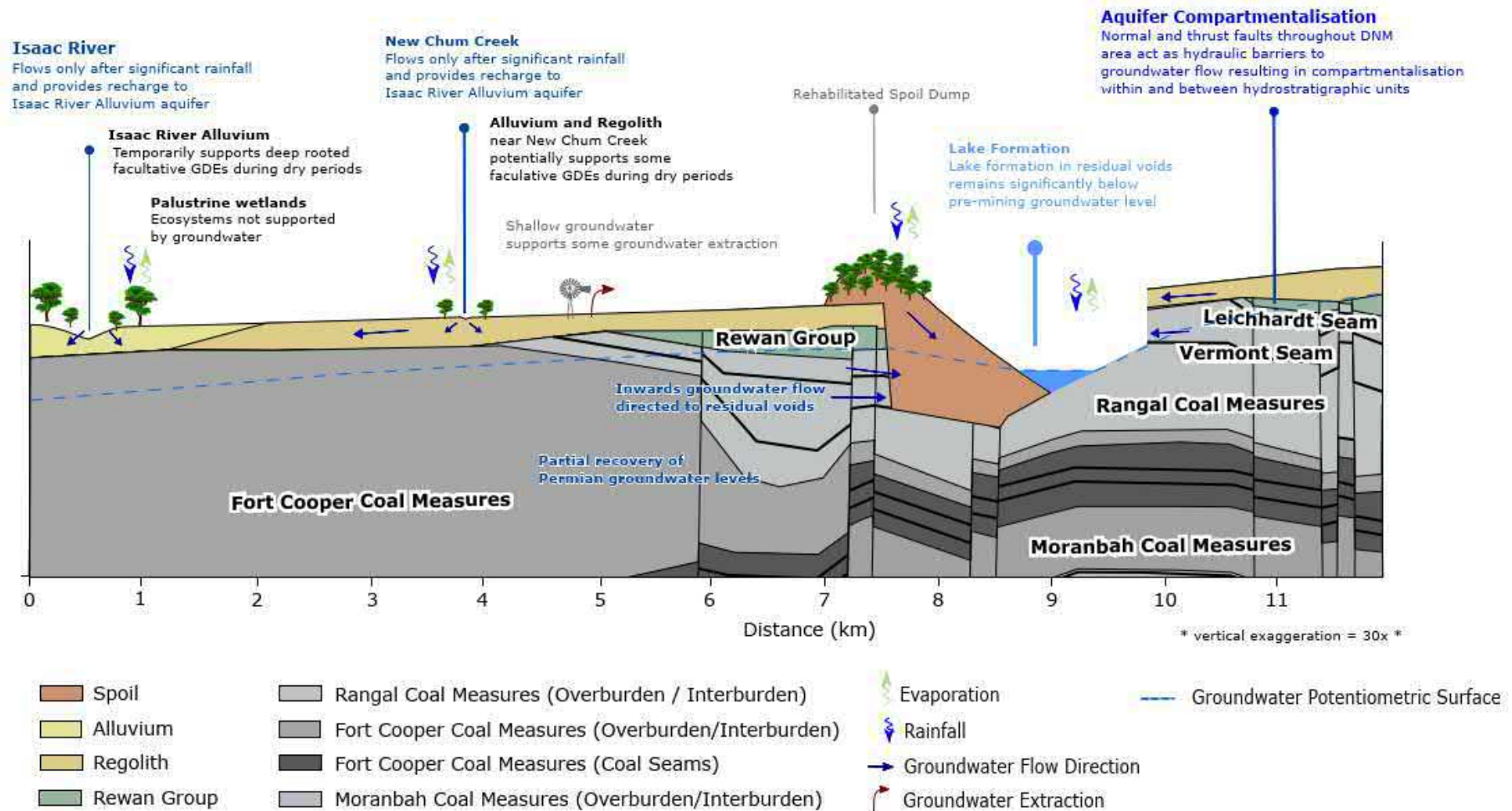


Figure 8-1 Conceptual Model of the Groundwater System – Post-Closure

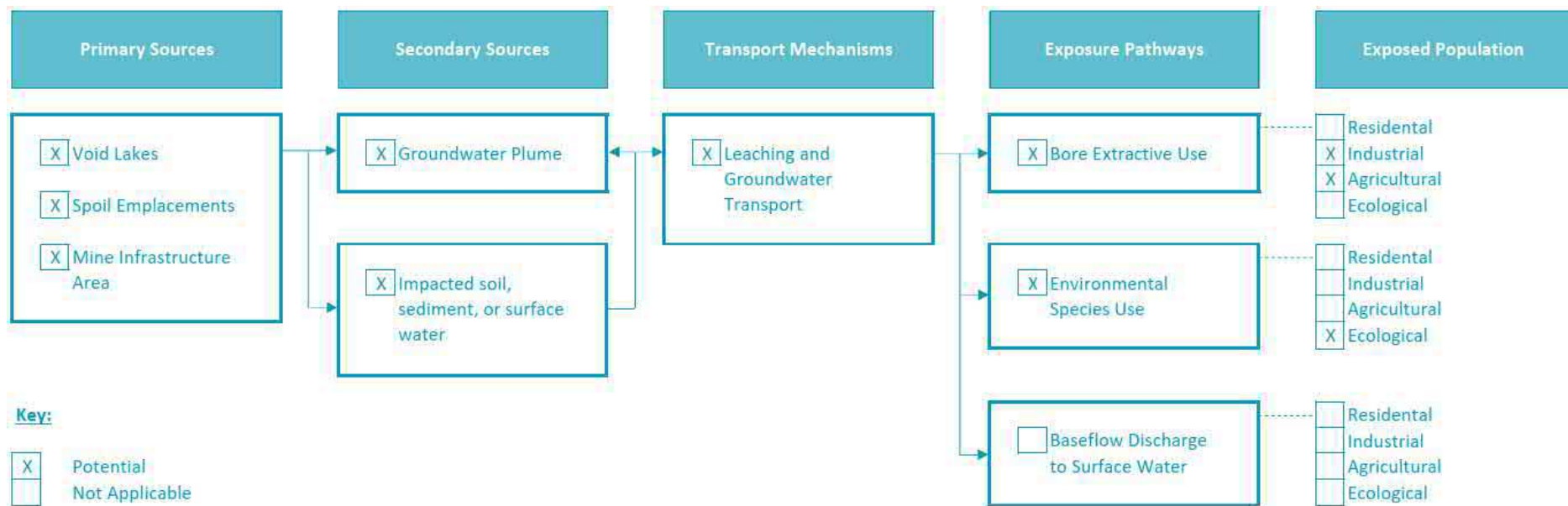


Figure 8-2 Source-Pathway-Receptor Presentation of CSM

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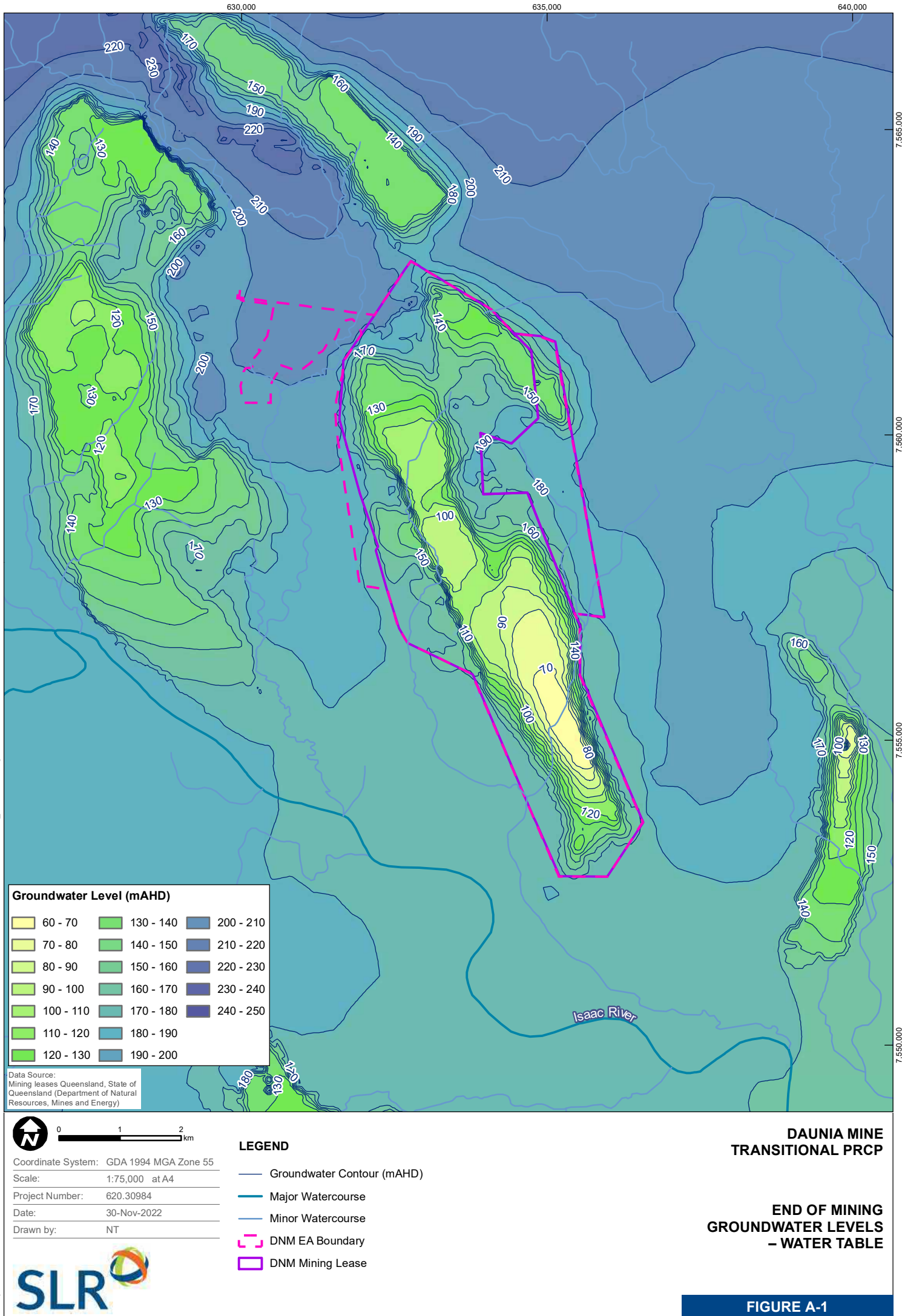
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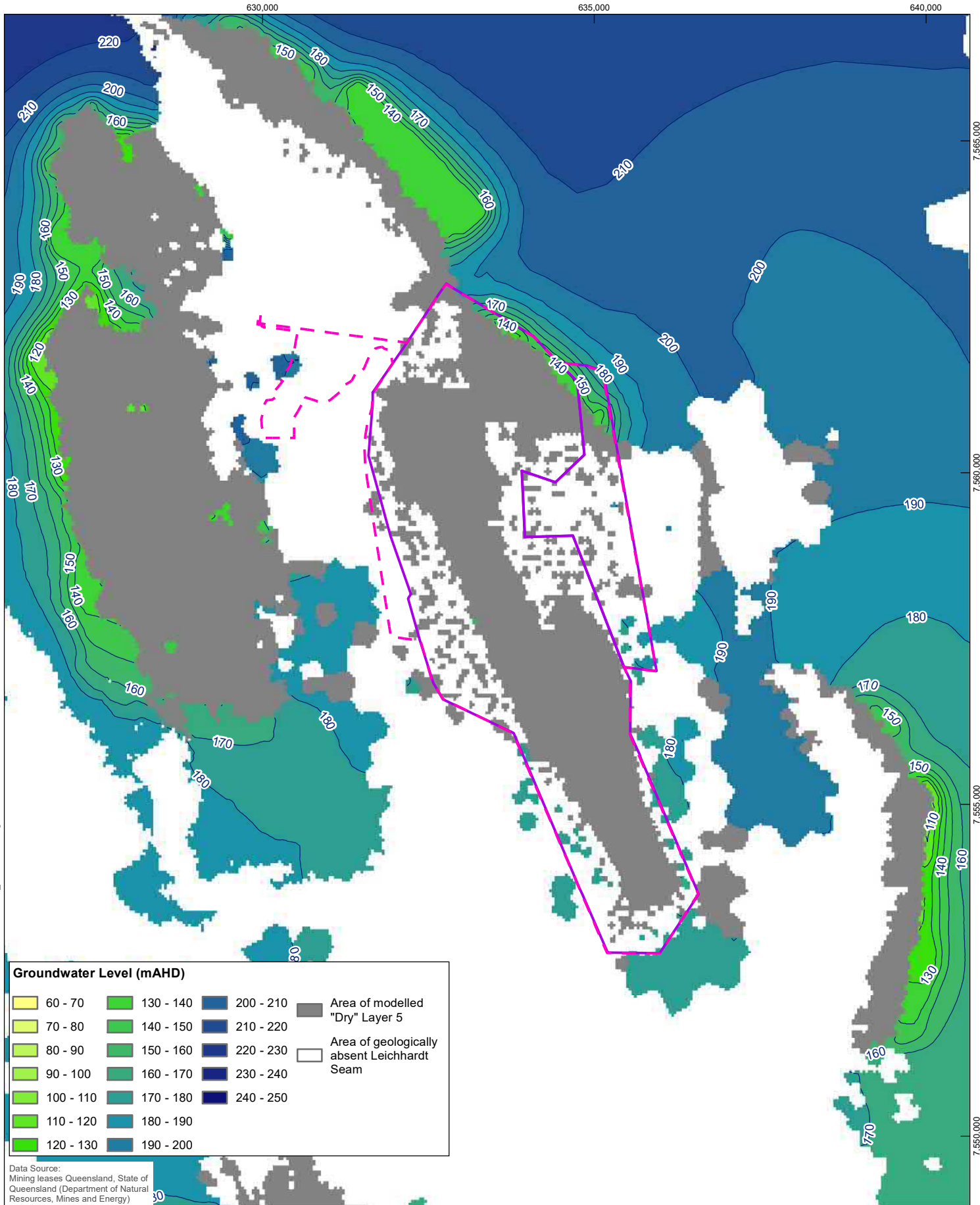
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Appendix A – Recovery Model Starting Heads

H:\Projects-SLR\620-BNE\620-BNE\620-30984-00000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\SDM\62030984_FA_1_End of Mining GWL Water Table.mxd





0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 30-Nov-2022

Drawn by: NT

LEGEND

Groundwater Contour (mAHD)

DNM EA Boundary

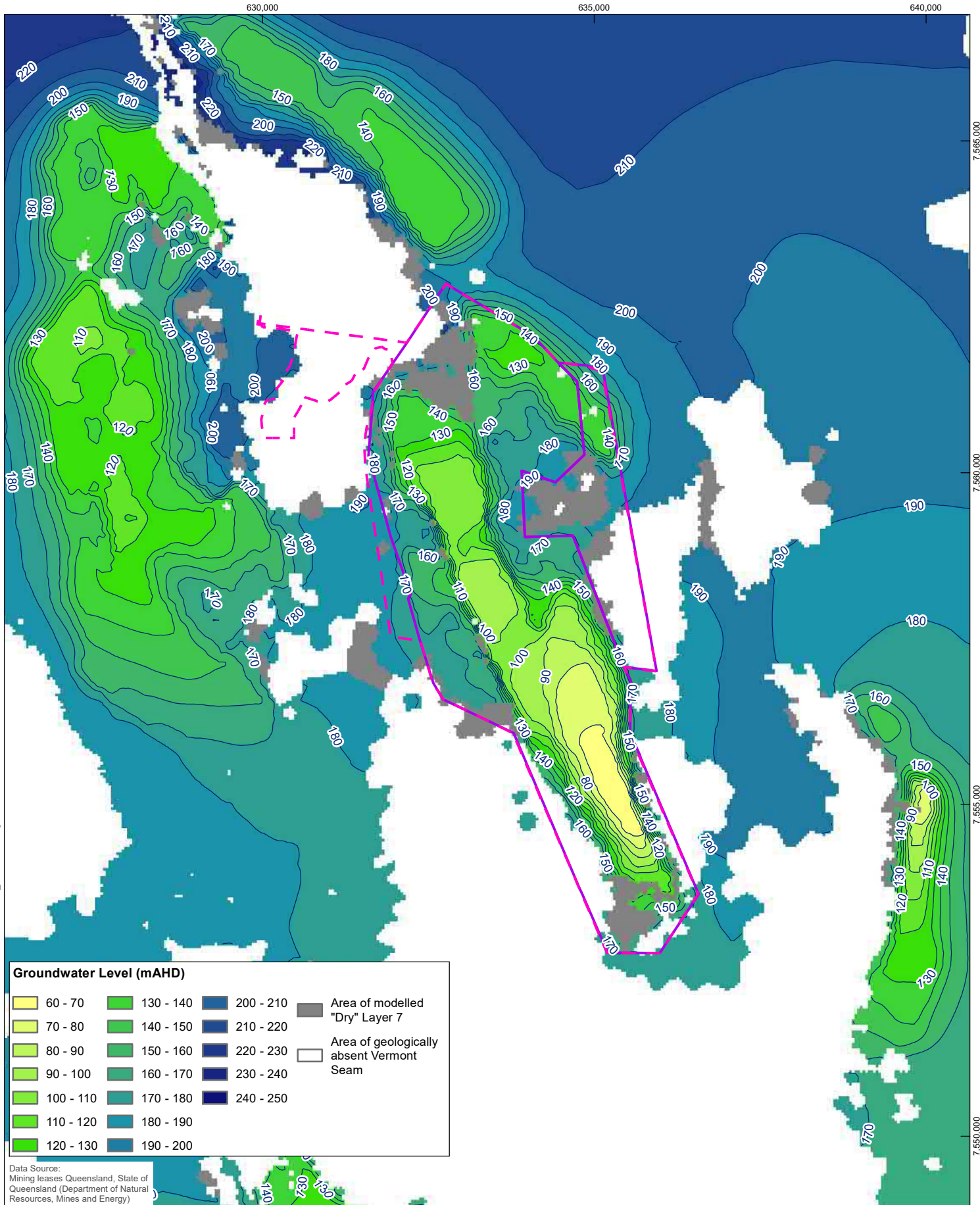
DNM Mining Lease

**DAUNIA MINE
TRANSITIONAL PRCP**

**END OF MINING
GROUNDWATER LEVELS
- LEICHHARDT SEAM**



FIGURE A-2



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 30-Nov-2022

Drawn by: NT

LEGEND

Groundwater Contour (mAHD)

DNM EA Boundary

DNM Mining Lease

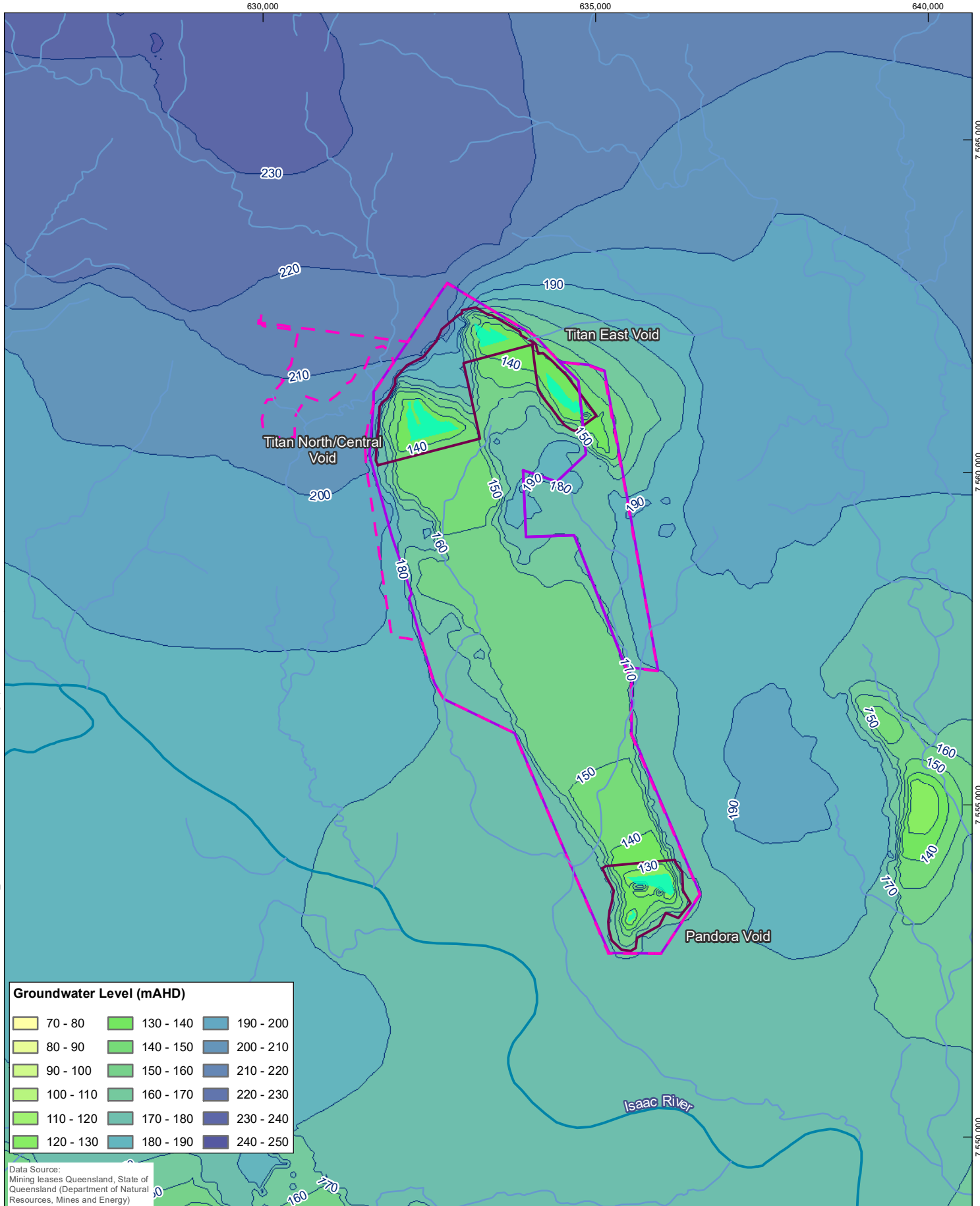
**DAUNIA MINE
TRANSITIONAL PRCP**

**END OF MINING
GROUNDWATER LEVELS
- VERMONT SEAM**



FIGURE A-3

Appendix B – Drier Climate Scenario Model Predictions



0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 15-Mar-2023

Drawn by: NT



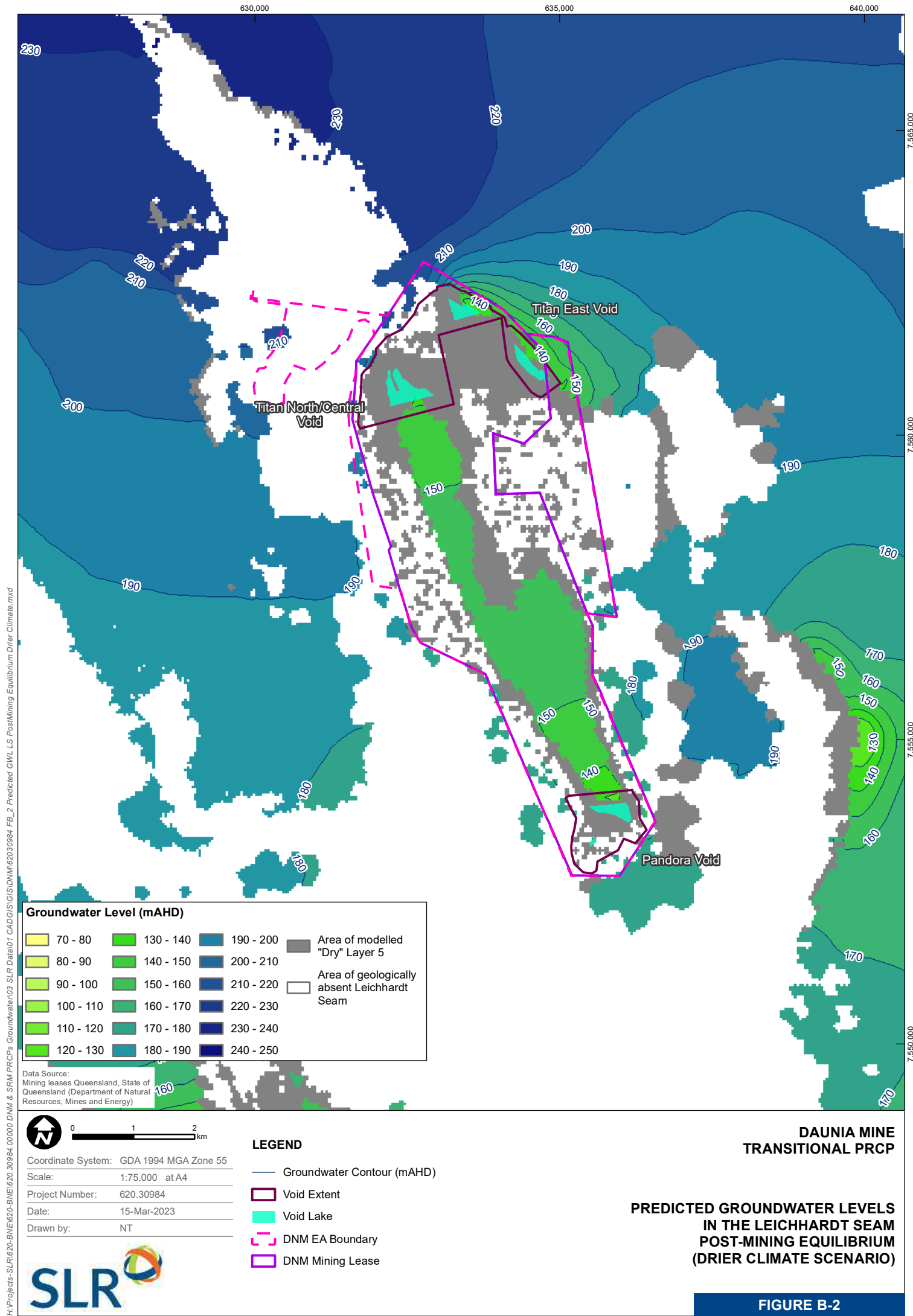
LEGEND

- Groundwater Contour (mAHd)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake
- - - DNM EA Boundary
- DNM Mining Lease

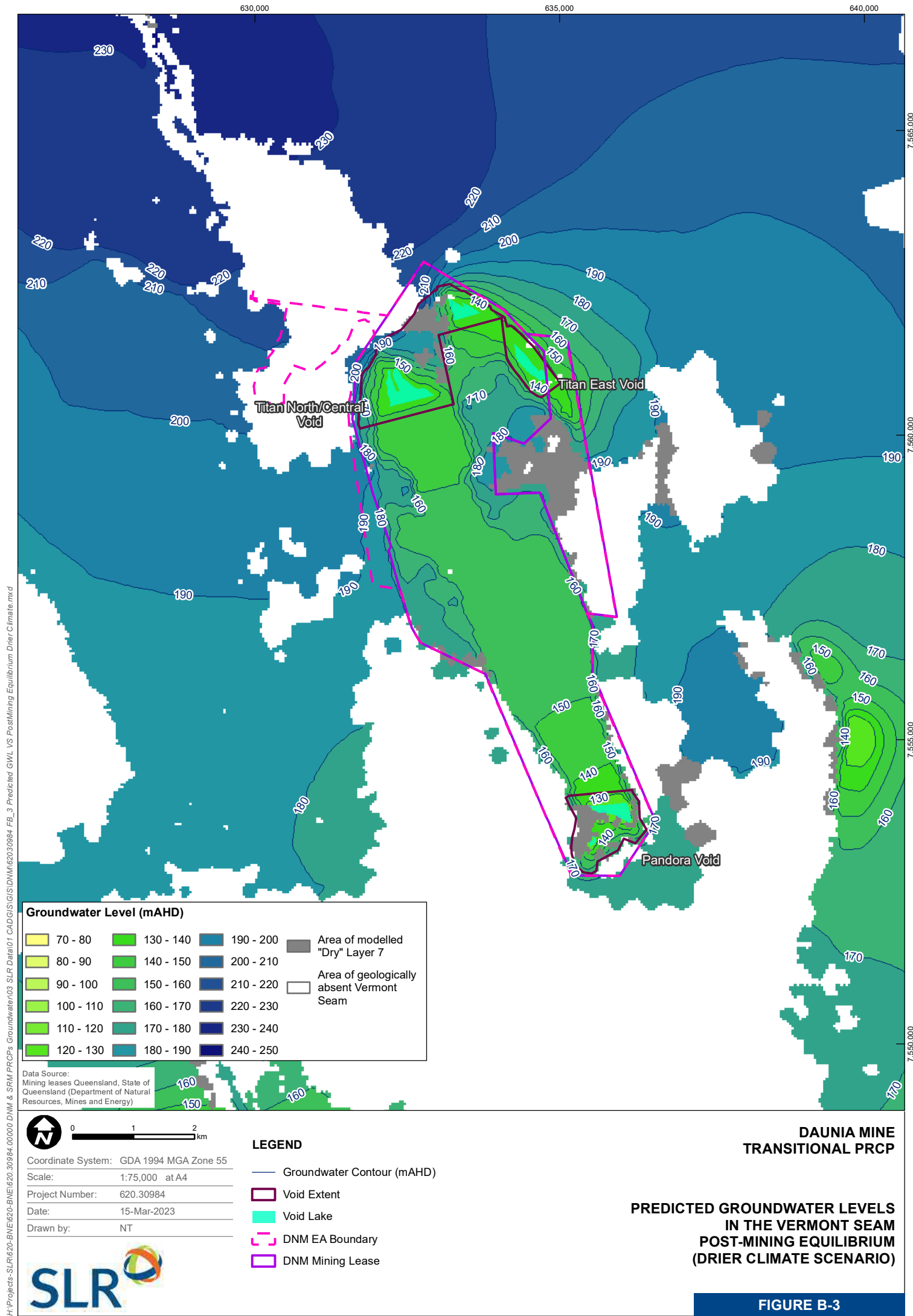
DAUNIA MINE TRANSITIONAL PRCP

**PREDICTED WATER TABLE
ELEVATION – POST-MINING
EQUILIBRIUM
(DRIER CLIMATE SCENARIO)**

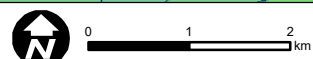
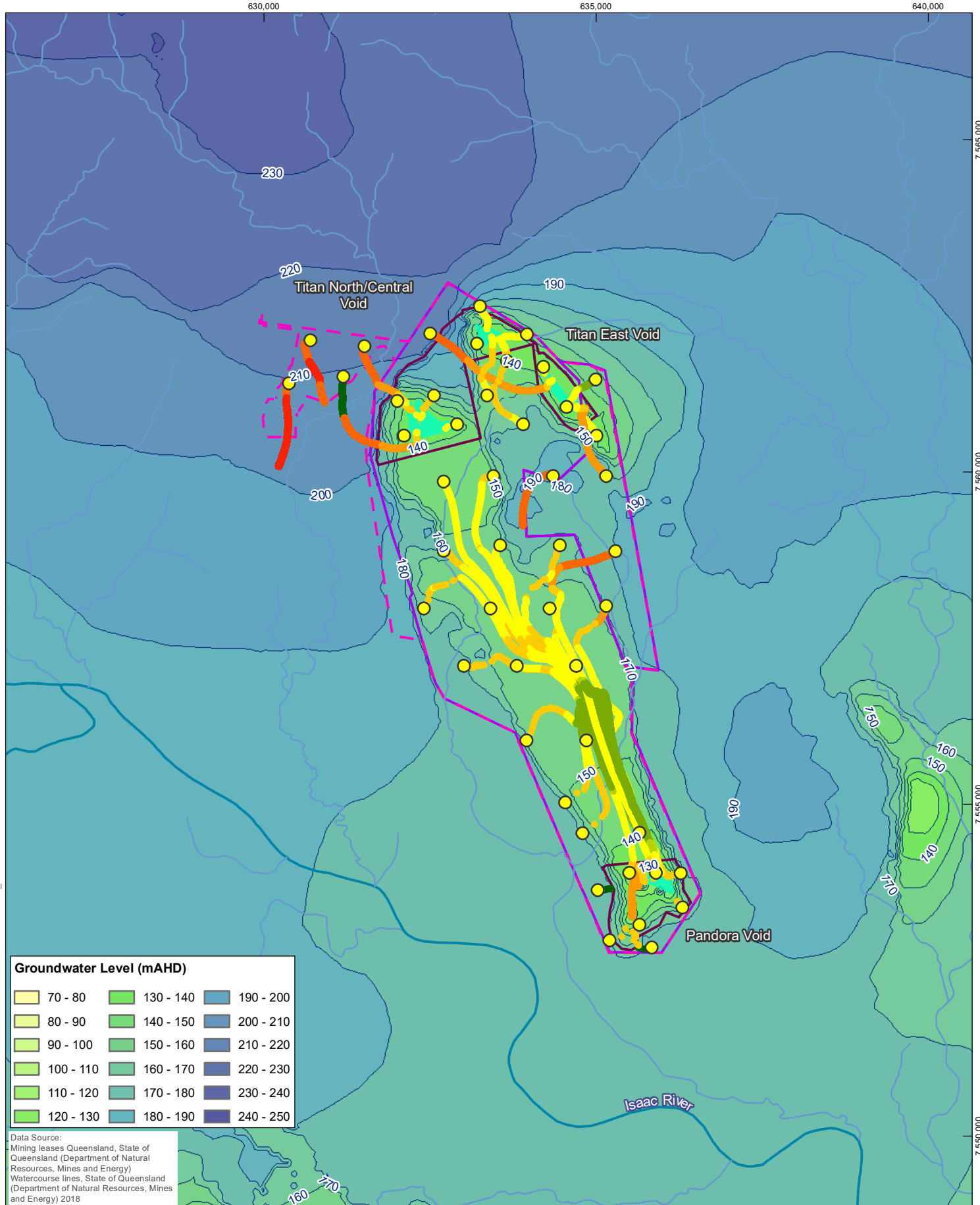
FIGURE B-1



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H:\Projects-SLR\620-BNE\620-BNE\620-30984-00000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\GDMM\62030984_FB_3 Predicted GWL VS PostMining Equilibrium Drier Climate.mxd



Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:75,000 at A4
Project Number: 620.30984
Date: 15-Mar-2023
Drawn by: NT



LEGEND

- Starting Location of Particle Simulation
- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake

- DNM EA Boundary
- DNM Mining Lease

Model Layer Traversed

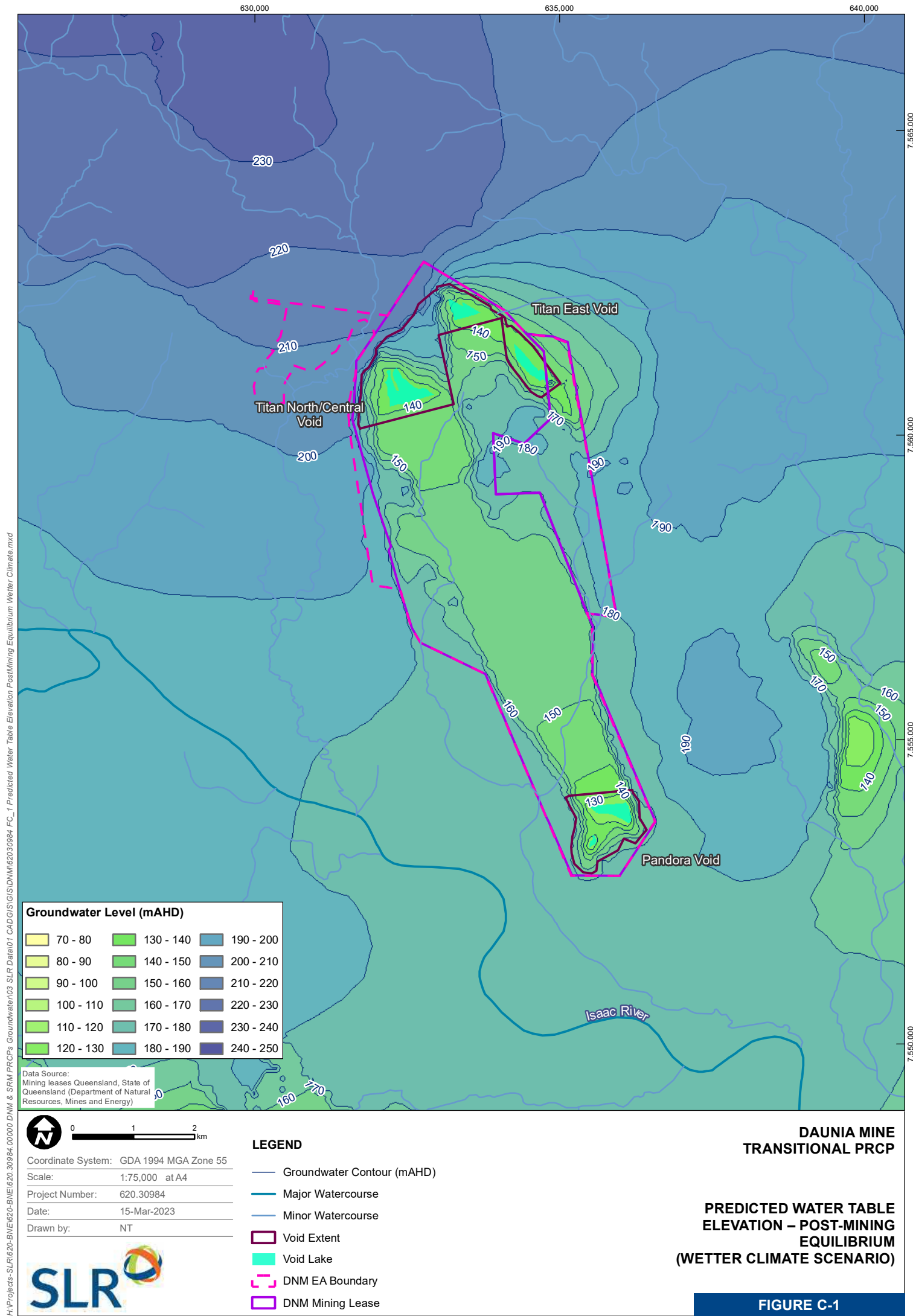
- | | | |
|--|---|---|
| ● 2 | ● 5 | ● 8 |
| ● 3 | ● 6 | ● 9 |
| ● 4 | ● 7 | ● 10 |

DAUNIA MINE TRANSITIONAL PRCP

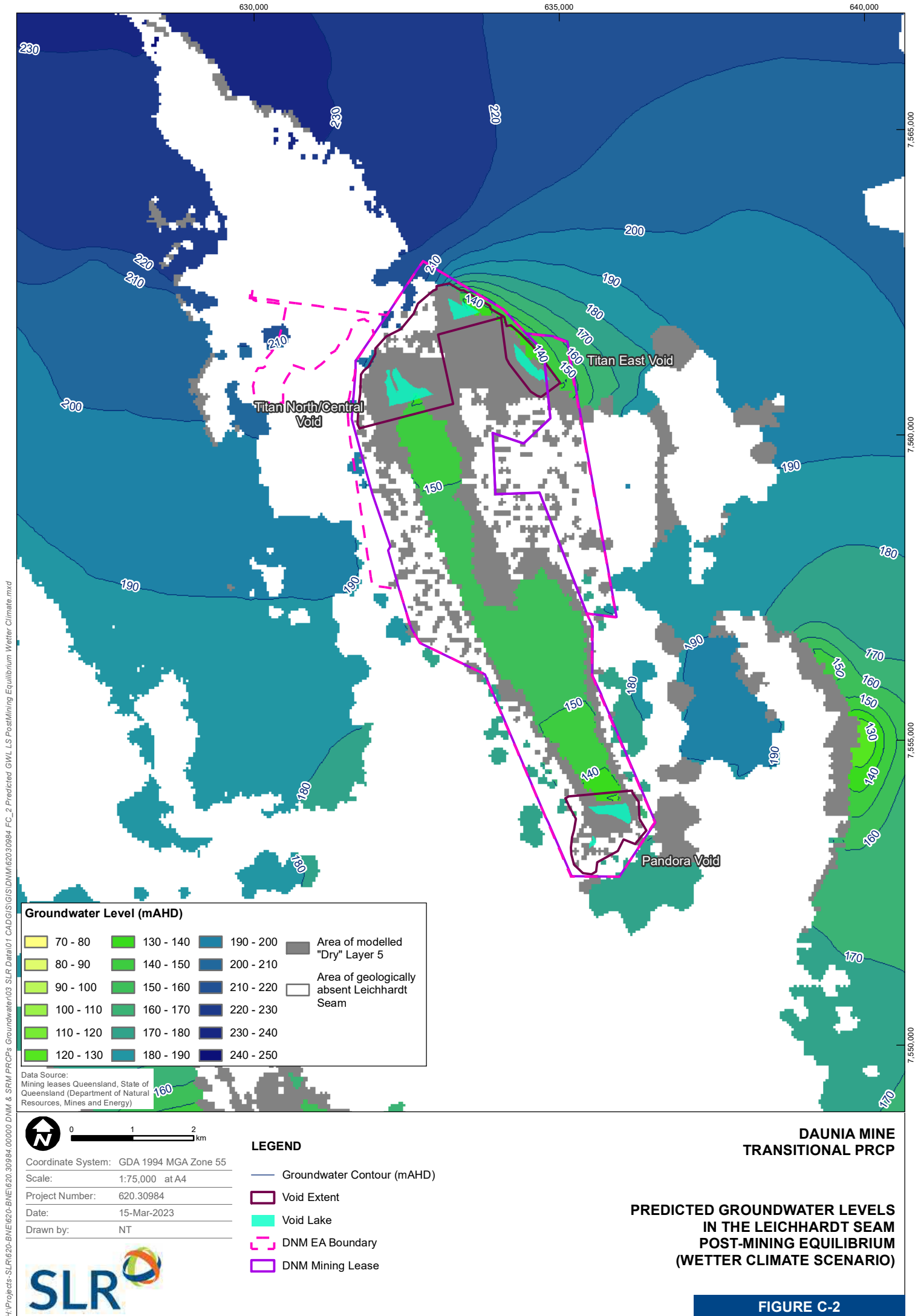
PREDICTED MOVEMENT OF PARTICLES (DRIER CLIMATE SCENARIO)

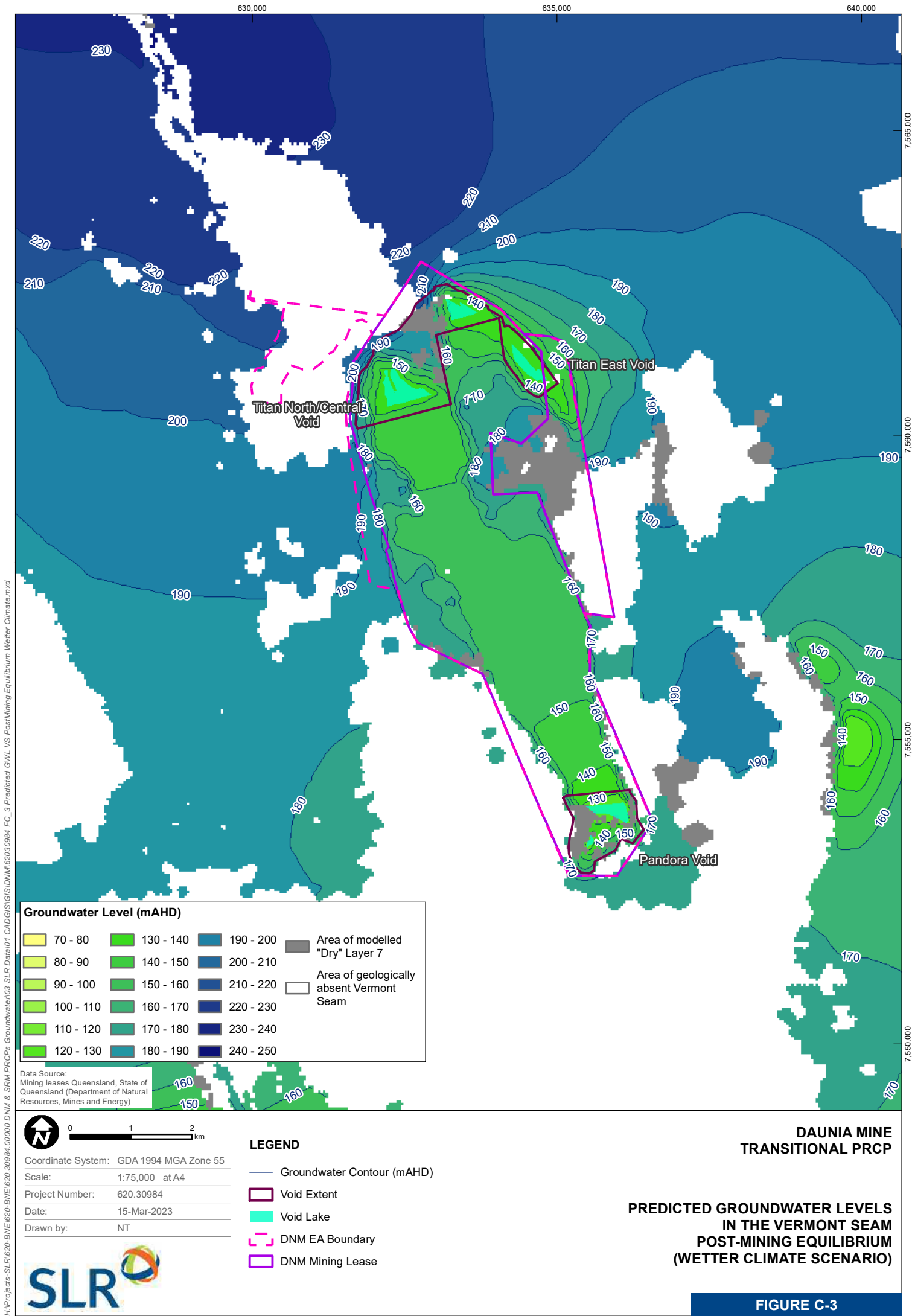
FIGURE B-4

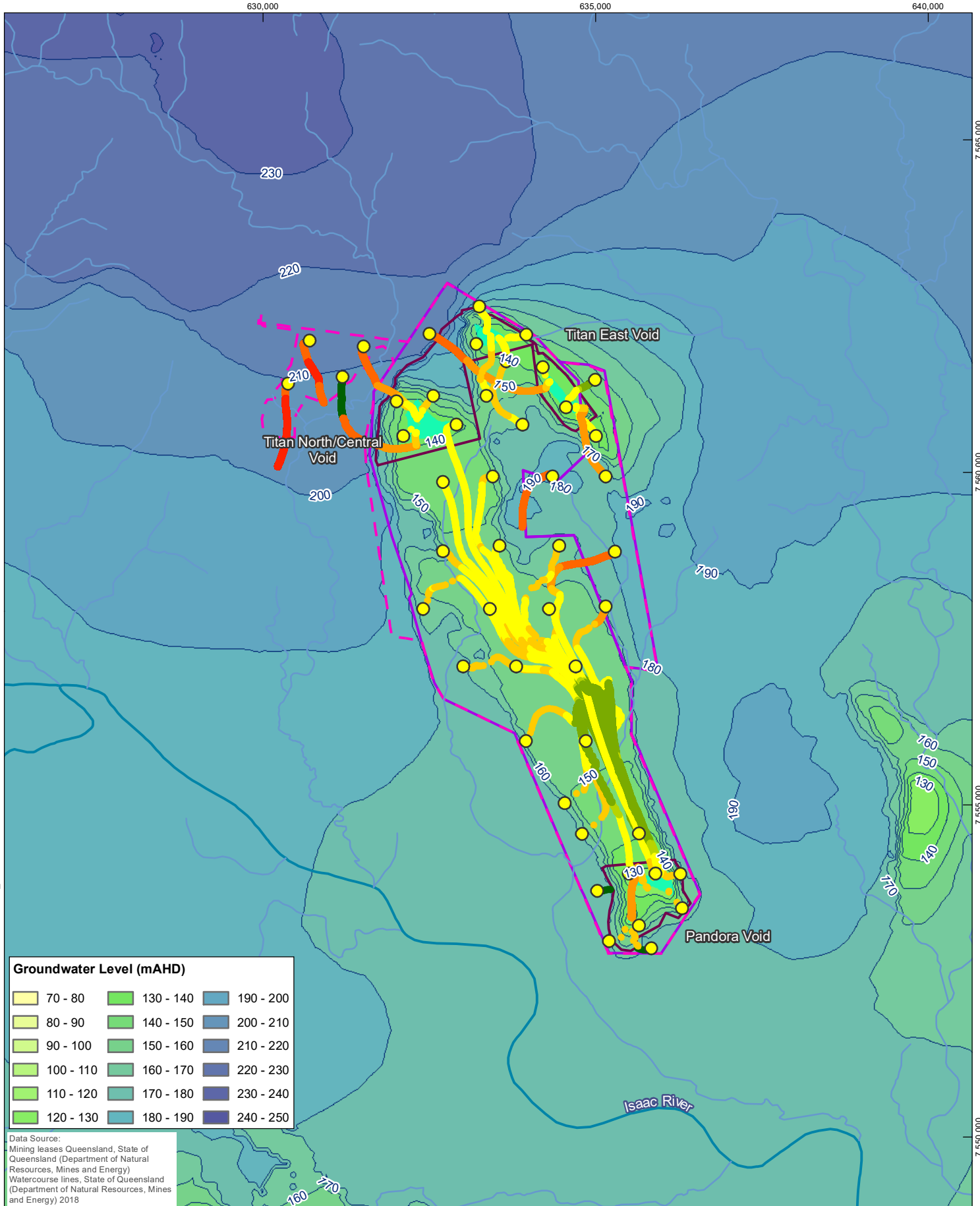
Appendix C – Wetter Climate Scenario Model Predictions



H:\Projects-SLR\620-BNE\620-BNE\620-30984-00000 DNM & SRM PRCPs Groundwater\03 SLR Data\01 CAD\GIS\GIS\DNM\62030984_FC_1 Predicted Water Table Elevation PostMining Equilibrium Wetter Climate.mxd







0 1 2 km

Coordinate System: GDA 1994 MGA Zone 55

Scale: 1:75,000 at A4

Project Number: 620.30984

Date: 15-Mar-2023

Drawn by: NT



LEGEND

- Starting Location of Particle Simulation
- Groundwater Contour (mAHD)
- Major Watercourse
- Minor Watercourse
- Void Extent
- Void Lake

- DNM EA Boundary
- DNM Mining Lease

Model Layer Traversed

- | | | |
|--|---|---|
| ● 2 | ● 5 | ● 8 |
| ● 3 | ● 6 | ● 9 |
| ● 4 | ● 7 | ● 10 |

DAUNIA MINE TRANSITIONAL PRCP

PREDICTED MOVEMENT OF PARTICLES (WETTER CLIMATE SCENARIO)

FIGURE C-4

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DAUNIA MINE (DNM) – MATERIAL CHARACTERISATION STUDY

November 2022



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Client: BMA

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1 INTRODUCTION

BHP Mitsubishi Alliance (BMA) has engaged Landloch to provide a material characterisation study of stockpiled materials at the Daunia Mine (DNM). Specifically, the study will evaluate the quality of materials for their use as growth media in rehabilitation.

To ensure rehabilitation success, the materials planned to be placed near the surface of the landforms need to be assessed for their suitability to support the vegetation required to meet the target post-mining land use (PMLU).

This report evaluates the quality of materials for use as growth media for rehabilitation of the mine and identifies any gaps in the available information or resources.

1.1 Project Description

DNM is an open cut metallurgical coal mine operated by BMA. The mine is located south-east of Moranbah in Queensland's Bowen Basin. The project area covers mining leases ML70115, ML1781, ML70116 and ML70312 (Shared train load out and rail link). Operations started in 2013.

The general arrangement of the DNM is provided in Figure A2 (Appendix A).

1.2 Scope of Work

The scope of work involved the following tasks:

- i. Review previous soils and land assessments undertaken at DNM.
- ii. Review available published soil and land data within the region.
- iii. Conduct data gap analysis to determine information required to:
 - a. Develop an inventory of materials available for rehabilitation; and
 - b. Assess the suitability of materials as a plant growth media.
- iv. Collate existing and recent soil laboratory data.
- v. Topsoil stockpile sampling and analysis.
- vi. Interpret data, characterise materials and prepare this report.

2 DESKTOP REVIEW

2.1 Climate

DNM is situated in Queensland's sub-tropical climatic zone, which is characterised by high summer temperatures, warm dry winters and distinct wet and dry seasons.

Average monthly maximum temperatures tend to range from 24°C to 27°C in winter, and from 33°C to 36°C in summer. Summer temperatures can exceed 40°C for short periods (BoM, 2022)

Average monthly minimum temperatures range from 8°C to 10°C in winter and from 20°C to 22°C in summer (BoM, 2022).

Rainfall is concentrated through the summer with approximately 75% of yearly rainfall occurring between November and March. The median annual rainfall for the area, recorded at Moranbah airport, is 520 mm.

2.2 Topography

The pre-mining topography of the study area is dominated by gently undulating grazing lands with low relief ranging from 240 m ADH in the north down to 190 m ADH in the south. The surrounding land is characterised by poorly defined ephemeral drainage lines that only flow immediately after rain, draining into New Chum Creek and eventually the Isaac River.

2.3 Geology and Soils

2.3.1 Regional geology

DNM is located in the northern part of the Permo-Triassic Bowen Basin containing primarily fluvial and some marine sediments (BHP Billiton Mitsubishi Alliance, 2008). The coal deposits are contained in the Late Permian Rangal Coal Measure, which is overlain by the Late Permian to Early Triassic Rewan Group. The geology in the project area is presented in Appendix A Figure A8.

2.3.2 Overburden geology

Overburden geology at DNM can be broadly classified (Landloch Pty Ltd, 2017) into:

- Weathered zone materials: Cainozoic clays, sands, claystones and sandstones. The Weathered Zone materials are typically sodic, highly erodible and prone to clay dispersion. These materials have varying levels of salinity, but their main constraint is their high erosion risk.
- Unweathered zone materials: Permian sandstones, siltstones and mudstones. Carbonaceous zones are present close to the coal seams. The physical and chemical properties of these materials are highly variable. They are generally sodic, alkaline and non-saline, although there are some materials with elevated salinity levels, and some carbonaceous strata are acidic. Erosion risk varies based on physical properties and sodicity, but generally the sandstones are more competent and resistant to weathering and erosion than the siltstones and mudstones.

2.3.3 Regional soils

Soil mapping of the region identifies two broad soil groups across the project area at a regional scale (State of Queensland (Department of Resources), 2021). These include:

- MM7 – Friable earths; and
- Ro9 – Sodosols

Relevant details of these soil groups are provided in Table 1.

Table 1: Summary details of regional soils in the Study Area.

Soil Landscape Code	Soil Landscape Name	Description	Associated Australian Soil Classification (ASC)
MM7	Friable earths	Chief soils are neutral dark and yellow friable earths with friable brown soils.	Vertosol, Dermosol
Ro9	Sodosols	Sodosols. Dominant soils are hard alkaline duplex brown soils.	Sodosol

2.3.4 Recoverable soils

Pre-mining soil and land suitability assessment of the region, that includes the study area, was completed by CSIRO (Gunn et al, 1967) and agricultural management units were described by Bourne and Tuck (1993). Both surveys produced land and soils information at a scale of 1:500 000.

More detailed soil surveys of the infrastructure and mining area were conducted in August 2004 and April 2008. The 2004 survey was conducted as part of the Poitrel Environmental Impact study (EIS) (BHP Billiton, 2005) and covered the shared infrastructure areas. A total of 195 sites were assessed during the 2008 survey, which covered the mining area at DNM (BHP Billiton Mitsubishi Alliance, 2008). Sampling locations and soil mapping from the 2008 survey are provided in Figures A3 and A4.

A topsoil stripping plan was developed in 2012 by GT Environmental Services which included a soil survey of an additional 250 ha of undisturbed land (Figure A5). The assessment identified four main in situ soil types which correlate with the previous soil assessments.

Across all surveys a total of 11 soil mapping units (SMU), including variants, were identified. A summary of all SMU's, including associated Australian Soils Classification (ASC), are provided in Table 2. Land suitability scores defined from the land suitability classes for use in Queensland (Department of Natural Resources and Mines, 2013) are included. Land suitability decreases progressively from Class 1 to Class 5.

A soil map displaying broad ASC soil types for the DNM area is provided in Figure A6 (Appendix A). The soils data used to generate this map were not collected by Landloch. Rather, the mapping units are a synthesis of soils data and mapping sourced from existing soil assessments for the mine area completed by Bourne and Tuck (1993), P. Baker and G. Tuck as part of the EIS (BMA, 2009) and GT Environmental (2012), along with existing land systems information sourced from the QLD Globe online spatial data system (State of Queensland 2022). The map is Landloch's interpretation of the available soils information.

Table 2: Summary details of the SMUs developed in the previous soil assessments for Daunia mine (BHP Billiton Mitsubishi Alliance, 2008) and (GT Environmental Services, 2012).

SMU	Soil Name	Details	Associated Australian Soil Classification (ASC)	Grazing Class (DNRM, 2013)
DB1	Red Brown Brigalow Upland Clays	Hard setting uniform clays with Brigalow with coarse structured subsoils on hard sandstone below 90 cm. Minor variants include surface laterite gravels and fractured sandstone throughout the profile.	Vertosol, Dermosol	3
DB2	Linear Gilgai on Dark Grey Brown Clays	Cracking and non-cracking clays. Brigalow, Bauhinia, Poplar Box and Dawson Gum.	Vertosol, Dermosol	2
DB3	Alluvial Clay Plains on Dark Cracking Clays	Alluvial clay plains on grey cracking Brigalow clays.	Vertosol	2
DB4	Moderately Well-Structured Grey Brown Cracking Clays	Little or no gilgai	Vertosol	2
DB5	Shallow, Gravelly Red Brown Sandy Clays	Similar to DB1 but much shallower and rockier. Prominent surface gravels and occasional sandstone outcrops.	Gravelly Dermosol	4
DB6	Cracking Clays with Poplar Box and Brigalow	Tall Poplar Box with scattered Brigalow on cracking clays with silty clay loam veneer surface.	Vertosol	3
DE1	Mt Coolibah Uplands with Brown Clay over sandstone	Mountain Coolibah uplands with brown clay on sandstone and other sediments	Vertosol, Dermosol	2
DD1	Oper Downs with Grassland on Dark Cracking Clays	Broad lower elevation alluvial areas	Vertosol	2
A2	Alluvial Sandy Hard Duplex	Hard setting sandy loam duplex soils alongside New Chum Creek often with bleached A2 over hard, coarse structured medium yellow clay often heavily mottled. Poplar Box mixed woodlands with associated Brigalow and Blackbutt.	Chromosol, Sodosol	4
B4	Friable Brigalow scrub soil	Deep well-structured black cracking clay with granular surface mulch.	Vertosol	2

SMU	Soil Name	Details	Associated Australian Soil Classification (ASC)	Grazing Class (DNRM, 2013)
B4v	Variant to B4	Fine granular non-cracking red/brown Brigalow scrub soil.	Vertosol, Dermosol	2

2.4 Waste Materials

The waste materials at DNM consist of overburden/interburden materials (spoil) and coal rejects. The overburden generally consists of moderately weak to strong sandstone, siltstone and claystone, with carbonaceous siltstones (Section 2.3.2).

2.4.1 Spoil materials

Characterisation of the overburden was undertaken by P.W. Baker and Associates Pty. Ltd. (2012) and as part of the EIS (BMA, 2009). Generally, spoil materials at DNM were found to be:

- Non-acid forming, with acid neutralising capacity;
- Strongly alkaline;
- Sodic and dispersive;
- Low to moderately saline, but some strata may exhibit high salinity; and
- Potentially elevated in selected metals.

P.W. Baker and Associates Pty. Ltd. (2012) concluded that most spoil material is suitable as growth medium. The fresh Permian wastes between carbonaceous layers were reported to be better suited to rehabilitated batter slopes and to provide a higher quality growth medium.

2.4.2 Coal rejects

The coal rejects are disposed in the mining pits and spoil and covered by spoil as part of operational process. They are currently not used a rehabilitation resource but future studies and testing may identify some reject material that is beneficial for rehabilitation use due to its high organic carbon and coarse physical structure, or strategies may be developed for mixing reject material with spoil to deliver a more suitable growth medium.

2.5 Topsoil Stockpiles

Information on current topsoil stockpile materials and locations was provided by BHP. Approximate volume of available stockpiled material is 3,839,329 m³ (August 2021). Locations of current topsoil stockpiles on DNM are presented in Figure 1.

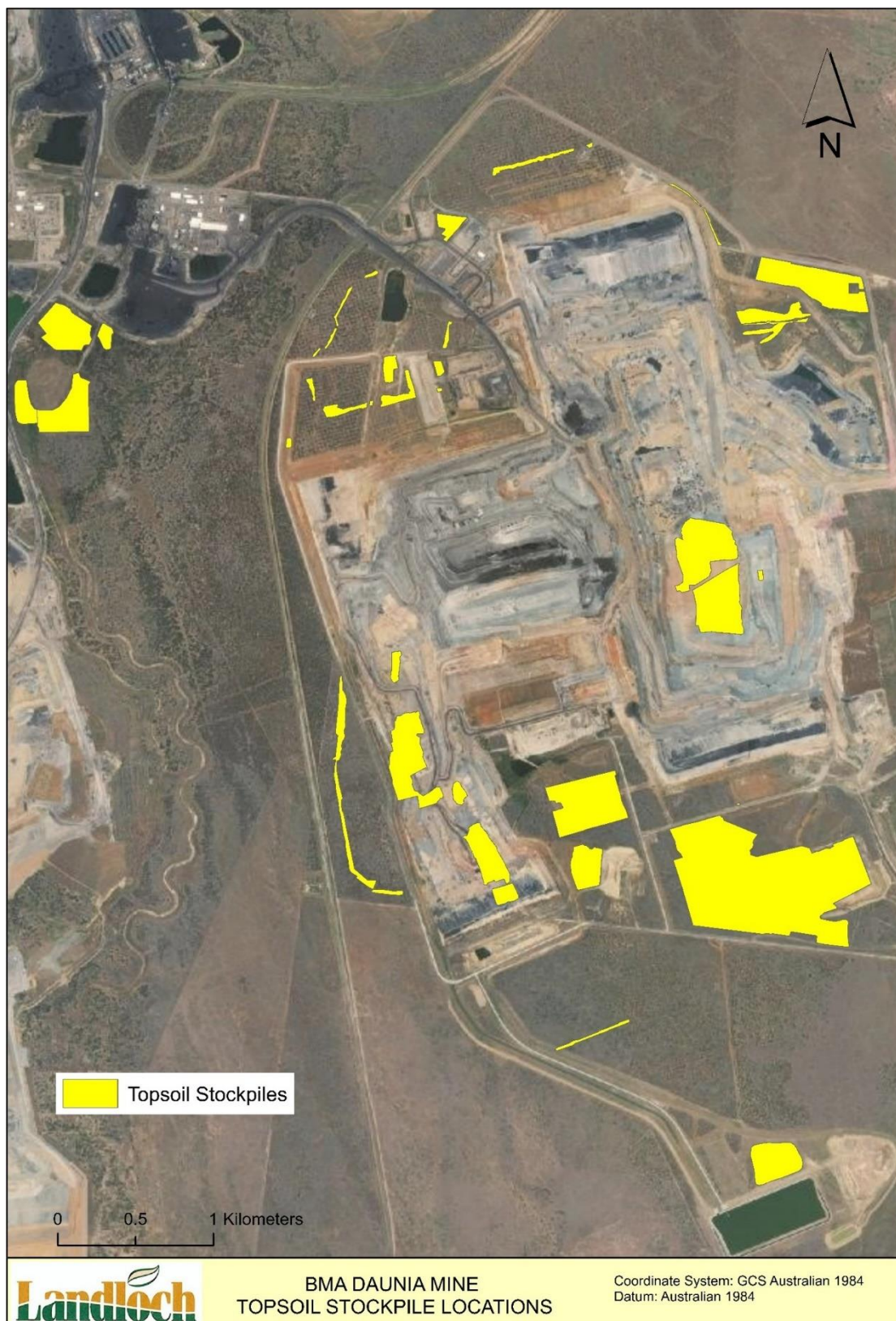


Figure 1: Stockpiled topsoil materials across the Daunia Mine.

2.6 Post Mining Land Uses

The PMLUs are in accordance with the EA and include:

1. Cattle grazing.
2. Woodland habitat.
3. Water storage.
4. Watercourse.

2.7 Revegetation Methodology

The revegetation methods for disturbed land at DNM will normally consist of the following:

- Respreading stockpiled or freshly stripped topsoil, or creating a growth media from spoil;
- Contour ripping;
- Seeding with an appropriate seed mix for the PMLU; and
- Applying appropriate fertiliser and ameliorants for plant establishment if required.

Where available, competent materials will be placed on steeper slopes to aid stability. A suitable seed mix will be used to establish a sustainable vegetation cover.

The material characterisation and landform design studies aim to identify and improve where possible:

- Growth media placement depth and soil profile depths relevant to the PMLU;
- Growth media preparation details;
- Expected growth media amelioration activities.

More details on revegetation can be found in the relevant section of the PRC Plan.

3 METHODOLOGY

3.1 Materials

The following materials were targeted for consideration as potential growth media in the landform design process:

1. Topsoil materials; and
2. Spoil.

When considering the growth media at DNM, the quality of the stockpiled topsoil is more representative of the material available for rehabilitation, compared to the in situ topsoil mapping. Therefore, stockpiled topsoil materials were sampled by Landloch in a field program completed as part of this work.

Spoil data from previous projects was considered in the assessment of spoil as potential growth media in this assessment.

All materials were characterised in terms of basic chemical and physical fertility properties.

Any materials with the potential to be placed at the surface for use as a primary growth media were subjected to additional fertility assessments.

3.2 Topsoil

3.2.1 Field program – topsoil stockpile sampling

The field program was undertaken in two stages on 11–12 February and 15–16 March 2022. Site conditions were wet at the time of inspection, with ponded water observed across the Study Area. For the preceding months, the Bureau of Meteorology recorded Moranbah’s rainfall as 150 mm in November 2021, 84 mm in December 2021, and 97 mm in January 2022.

3.2.2 Sampling plan and intensity

The sampling plan is provided in Table 3 and the stockpiles sampled are presented in Appendix A.

Table 3: Topsoil stockpile sampling program.

Stockpile ID	Sample Sites	Stockpile ID	Sample Sites
1	1	19	1
3	4	20	1
5	1	23	1
6	1	27	1
Dam 7	1	28	1
8	1	38	1
12	2	39	1
13	2	41	1
16	1		
Total			22

The sample density for soil cover material is considered to be at a ‘*moderate (detailed)*’ intensity of 1:25,000, based on the *Guidelines for Surveying Soil and Land Resources (2ed)* (McKenzie, Grundy, Webster, & Ringrose-Voase, 2008). This assumes soil will be placed at an average depth of 0.15m at rehabilitation.

Using these criteria, Table 4 shows the sampling intensity on a *stockpile volume* basis; and based on *soil reinstatement* at rehabilitation to an average depth of 0.15m.

Table 4: Sampling intensity for topsoil stockpiles.

Material	Volume (m ³)	Reinstatement Coverage (ha)	Total Samples	Sampling density (volume)	Sampling density (area)	Survey Scale
Topsoil	3,839,329	1,919	88	1/43,000 m ³	1/21 ha	1:25,000

3.2.3 Sample collection

Samples and descriptions of materials were taken from test pits. Depth of excavation was to the base of the topsoil stockpile, or to the limit of excavation (~3–5 m).

Samples were collected from the stockpiles at depth intervals of 0.5–1 m (e.g. 0.5–1.0 m, 1.5–2.0 m, and 2.5–3.0 m etc.).

Sampling included composite and discrete samples. Each composite sample was composed of materials from three discrete samples. Laboratory analyses were as follows:

- Laboratory analysis of composite samples was a 'detailed' suite, to characterise the soil nutrients and physio-chemical parameters of the stockpile.
- Laboratory analysis of discrete samples was a 'basic' suite of pH and salinity. This analysis indicates the variability within the stockpile and exposes the potential for 'extreme' values to be 'masked' in composite samples.

Brief details about the collected materials were recorded in the field.

3.2.4 Laboratory analysis

Laboratory analysis was undertaken by East West EnviroAg, a laboratory with National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) accreditation. Laboratory analysis involved two different laboratory suites as described below and in Table 5.

Table 5: Laboratory analytical suites.

Analyses	Suite	
	Topsoil	Basic
pH and electrical conductivity	✓	✓
Exchangeable cations (with calculations of effective cation exchange capacity and exchangeable sodium percentage) and chloride	✓	
Total nitrogen and phosphorous; available phosphorous, potassium, and sulphur; trace nutrients (Cu, Zn, Mn, Fe, B), chloride, organic carbon and phosphorus buffer index (PBI), field texture	✓	
Dispersion potential	✓	
Totals	22	66

The 'basic suite' screened for salinity and extremes of pH. This was conducted on all discrete samples from the topsoil stockpiles. Data were used to provide an indication of the heterogeneity of materials within the stockpile. All samples were analysed with the *basic suite*. The 'topsoil suite' extends the *basic suites* to include dispersion, sodicity, exchangeable cations, macro and micronutrients. It was conducted on topsoil materials, as well as samples of any other materials intended to be used as primary growth media.

3.3 Spoil

Geochemical and physical characterisation data for the spoil materials were collated from multiple assessments conducted throughout the project. These included:

- BMA Daunia Coal Mine Project Overburden Assessment (PW Baker & Associates Pty. Ltd., 2012);
- Daunia Mine, One BMA Rehabilitation Monitoring, December 2015 (B. R. Emmerton Pty Ltd, 2015);
- Soil and waste erodibility and landform design: Daunia Mine (Landloch Pty Ltd, 2017). Sampling locations are provided in Figure A7;
- Daunia Coal Mine Project – Environmental Impact Statement (BHP Billiton Mitsubishi Alliance, 2008); and
- BMA ALL SITES_Coal Tailing and Rejects All Sites Earth Systems laboratory data spreadsheet (BHP, 2022).

4 FINDINGS

The two categories of materials available for rehabilitation, characterised as part of this assessment include -

- Topsoil stockpiles; and
- Spoil materials.

Details of these materials are provided below. Site location details are provided in Figure A1 and in Table B1. Stockpile description records and laboratory results are provided in Appendix B.

4.1 Topsoil Stockpiles

The topsoil stockpiles are representative of the material available for rehabilitation once topsoil is stripped and mixed in stockpiles. A total of 88 samples were collected from 22 locations within topsoil stockpiles. A total of 22 samples were analysed for *topsoil suite* and another 66 samples were analysed for *basic suite*.

Their locations are provided in Figure A1 (Appendix A) and laboratory data are presented in Tables B4 and B5 (Appendix B).

Stockpiled topsoil materials for use in rehabilitation were all categorised as Red/Brown Clays and show similar physical properties between stockpiles. The generalised topsoil materials are dark brown, brown or reddish brown with texture of clay loam to medium clay. Gravel content is generally less than 10%, although sometimes gravel content of up to 20% is present. The soils are susceptible to slaking, thereby increasing the risk of erosion. Approximately 20% of stockpiles sampled are sodic. This is likely a result of collecting a portion of sodic subsoil material together with topsoil during the initial stripping.

Erodibility studies (Landloch Pty Ltd, 2017) indicate these soils are comparable to the most stable clay topsoils available for rehabilitation in the region. They are suitable as a topsoil for all rehabilitation areas, provided basic erosion control practices are established and chemical fertility is managed to ensure both initially vigorous vegetation growth and maintenance of suitable levels of surface cover in the longer term. Any sodicity issues will also need to be addressed by incorporating gypsum prior to rehabilitation.

A summary of key chemical and physical properties is presented in Table 6. Figures 2 to 5 are representative of red/brown clay topsoils at DNM.



Figure 2: Soil material at stockpile 1.



Figure 3: Excavated soil at stockpile 6.



Figure 4: Variable soil at stockpile 3.



Figure 5: Soil material at stockpile 19.

Table 6: Summary of key chemical and physical properties for topsoils at Daunia mine.

Analysis	Red/Brown Clay Topsoil
Chemical Properties	
pH _{1:5} (H ₂ O)	Neutral to strongly alkaline (7.8 – 8.7)
EC _{1:5} (dS/m)	Low to moderate (0.15 – 0.43)
ESP (%)	Non-sodic to sodic (1.7 – 7.8)
Total N (mg/kg)	Low to moderate (688 – 1684)
Available P (mg/kg)	Low to moderate (7 – 38)
Available K (mg/kg)	Low (93 – 172)
Organic Carbon (%)	Low to high (0.94 – 1.91)
CEC (meg/100g)	Moderate (13 – 28)
Ca/Mg (ratio)	Low Ca to balanced (2 – 6.5)
Physical Properties	
Clay content (%)	>30
Rock content (%)	<20
Dispersion (EAT)	Slightly dispersive to stable (3b – 7)
Permeability *	Low
Erodibility *	Moderate
Associated regional soil	MM7
Associated mapped soil types	DB2, DB3, DB4, DB6, DE1, DD1, B4, B4V (DB1 and DB5 where gravel content is > 10%)

Note: Chemical properties are based on average 10th and 90th percentile values for all stockpile samples analysed. * Based on measured erodibility parameters (Landloch Pty Ltd, 2017).

4.2 Spoil Materials

From the previous assessments detailed in Section 3.3, broad spoil characteristics were found to be similar across all studies and identify two spoil management groups:

- Unweathered zone materials - Permian spoil; and
- Weathered zone materials - Weathered sediments and spoil.

4.2.1 Fresh Permian spoil

Generally, fresh Permian spoil is a rocky material consisting primarily of sandstone, siltstone and claystone with clay content below 25%, resulting in low water holding capacity. It is generally grey or pale brown in colour. Fresh Permian spoil at the mine, however, can vary depending on the strata location and degree of carbonaceous inclusions present. The materials are sodic and dispersive. A summary of key chemical and physical properties is presented in Table 7.

Of the two spoil materials, fresh Permian is considered the most suitable option for placement close to the final rehabilitated surface. Discrete testing should be conducted

prior to rehabilitation to locate any saline carbonaceous material mixed during stripping. Saline material should only be used as a growth medium if a leachable profile can be constructed.

Fresh or recently stripped Permian sandstone that has not been exposed to extended periods of weathering should be used in the upper soil profile to greatly increase batter slope resistance to erosion while vegetation establishes (Figure 6). Slake durability data indicated that only 25% of Permian samples have a slake durability higher than 70% (Landloch Pty Ltd, 2017). If this material could be isolated, it may be useful to rock armour and stabilise steeper areas. Additional studies and testing for rock properties such as hardness (consolidation and cementation), mineralogy (susceptibility to weathering of the component minerals) and permeability would be useful to locate additional competent material. Figure 7 is representative of Permian sandstone spoil at DNM.



Figure 6: Fresh (<1 month) unweathered Permian sandstone spoil.



Figure 7: Permian spoil material present at Daunia Mine.

4.2.2 Weathered sediments and clay spoil

The weathered sediments and clay spoil is a highly weathered material containing portions of fragile rock and has a clay content of greater than 35%, resulting in moderate to high water holding capacity. It is typically pale orange to orange in colour. The materials are often strongly sodic and dispersive, meaning that – once some leaching of soluble salts occurs – it is likely to be prone to hardsetting and to tunnel and gully erosion. Key chemical and physical properties are summarised in Table 7.

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

Figures 8 and 9 are representative of weathered sediments and clay spoil at DNM.



Figure 8: Weathered clay spoil material at Daunia mine.



Figure 9: Weathered sedimentary spoil with increased rock content.

Table 7: Summary of key chemical and physical properties for spoils at Daunia mine.

Analysis	Spoil Material	
	Permian	Weathered Sediments and Clay
Chemical Properties		
pH _{1:5} (H ₂ O)	Moderate to strongly alkaline (8.4 – 9.4)	Slightly acidic to strongly alkaline (6.4 – 8.8)
EC _{1:5} (uS/cm)	Low to moderate (180 – 820)	Moderate to high (510 – 1200)
ANC (H ₂ SO ₄ /t) *	Moderate to high (13 – 56)	Moderate to high (13 – 56)
PAF	No	No
CEC (meq/100g) *	Moderate to high (23 – 32)	Moderate to high (23 – 32)
ESP (%)	Sodic to strongly sodic (10 – 25)	Non-sodic to strongly sodic (4 – 19)
Ca/Mg (ratio)	Imbalanced to low Ca (0.8 – 2.3)	Imbalanced to balanced (0.7 – 7.2)
Metals	Comparable to background levels	Comparable to background levels
Physical Properties		
Clay content (%)	<25	>35
Rock content (%)	>30	<20
Slake durability (%)	Moderate (50 – 75)	Low (<50)
Permeability	Very high	Low to moderate
EAT *	Dispersive (Class 2)	Dispersive (Class 2)
Dispersion risk	Moderate	Moderate

* Chemical properties are based on average 25th and 75th percentile values for all spoil samples analysed.

4.2.3 Excluded material

Chemical analysis identified two stockpile areas with limiting soil properties that would restrict rehabilitation success. Stockpile 5 and an area of stockpiled material near stockpile 13 (nominally named stockpile 13 subsoil) are highly saline and strongly sodic. Groundcover observations indicated limited vegetation has established across the stockpile surfaces at the time of sampling (Figures 10 and 11). The chemical and physical properties indicate the bulk of these stockpiles are likely to be subsoil material.

It is recommended that this material is excluded from use as primary growth media and where possible, buried below a minimum of two metres of non-saline soil.



Figure 10: Saline and sodic soil around stockpile 13.



Figure 11: Saline and sodic soil present a stockpile 5.

5 GROWTH MEDIA SUITABILITY AND AMELIORATION

The materials encountered have been classified according to their ability to support plant growth, as either *primary* or *secondary* growth media.

5.1 Primary Growth Media

Primary growth media infers the ability of materials to be used as a topsoil or topsoil surrogate.

It is the upper-most layer of soil/material placed over the rehabilitated area. It can be various thicknesses depending on the PMLU and consists of surface soil (topsoil) materials recovered prior to mining and applied over the area, or a growth medium developed from spoil, ameliorated to a standard suitable to support sustainable plant growth.

Compared to subsoil and overburden materials, it is typically higher in organic matter and macro- and micronutrients and has low to negligible limitations to plant growth. Its primary purposes are to provide nutrients and a stable surface for vegetation establishment.

If adequate suitable topsoil is not available, an alternative may be derived from high quality spoil with amelioration. If this is required, analysis of macronutrients is to be conducted to determine the fertility stores needed to sustain healthy vegetation growth and identify any additional amelioration requirements for the spoil materials if used as primary growth media. Amelioration products and application rates for the primary growth media should be assessed by a suitably qualified professional prior to rehabilitation and consider the desired PMLU and vegetation.

5.2 Secondary Growth Media

Secondary growth media infers the ability of materials to be used as a substrate or substrate surrogate. It may consist of the spoil material that is capped with the primary growth medium or may be an intermediate layer placed on the spoil material, and then capped with primary growth medium. The main purpose of the secondary growth medium is to increase the soil water storage capacity of the soil profile and/or to meet the soil depth criterion for certain vegetative PMLUs and target vegetation communities. In some circumstances, secondary growth media may be able to be sufficiently improved by the addition of ameliorants (e.g. gypsum, lime, organic matter) to convert them to a primary growth medium.

5.3 Suitability Classification

A four-class suitability system is applied in the evaluation of materials as growth media. These classes are defined as follows:

Class A – Good Quality

- Negligible limitations to plant growth.
- Good quality material for intended purpose.
- *Nil* to *low* levels of ameliorants will be required.

Class B – Fair Quality

- Minor limitations to plant growth.
- Reasonable quality material for intended purpose.
- *Low* to *moderate* levels of ameliorants may will be required.

Class C – Marginal Quality

- Moderate limitations to plant growth.
- *Moderate* to *high* levels of ameliorants may be required to improve material quality to support plant growth.

Class D – Not Suitable

- Severe limitations to plant growth.
- It will generally be uneconomic or unviable to amend these materials to the degree needed to support plant growth.

Suitability of materials as primary or secondary growth media is presented with recommendations in Table 8.

Table 8: Fertiliser and ameliorant treatment rates for materials and growth media suitability classification.

Material	Limitations	Amendments	Growth Media Suitability (Classes)	
			Primary (1)	Secondary (2)
Red/brown clay topsoil	- Sometimes strongly alkaline. - Sometimes sodic. - Often low N, P, K, Ca, and TOC.	- Gypsum: approximately 25% of stockpiles, requirements and rates should be calculated for individual stockpile prior to use in rehabilitation. - Fertiliser and/or compost rates are to be determined by a suitably qualified person prior to individual stockpiles being used in rehabilitation.	1A	2A
Material at stockpile 5 and near stockpile 13 (subsoil)	- Strongly alkaline. - High salinity. - Strongly sodic. - Low N, P, K and OC.	- Nil - Soil quality low - Bury all saline material to a depth greater than 2 metres below the surface.	1D	2C/D
Permian spoil	- Strongly alkaline. - Occasionally moderate salinity. - Sodic to strongly sodic and dispersive. - Rock content up to 50 %.	Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. If to be used as a primary growth media then further assessment by a suitably qualified person is required to determine amelioration required.	1B/C	2A
Weathered sediments and clay spoil	- Often strongly alkaline. - Moderate to high salinity. - Often sodic to strongly sodic and dispersive. - Slake durability <50%. - Low permeability.	- Gypsum: due to heterogeneity between spoil samples, rates should be calculated for broad spoil areas after placement for rehabilitation. - Bury all saline material to a depth greater than 2 metres below the surface.	1D	2C

Notes:

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

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

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

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

5.4 Fertiliser and Ameliorants

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

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

Amelioration recommendation for woodland areas should be assessed on a case-by-case basis and represent the specific requirements of the target vegetation community.

5.4.1 Gypsum

Gypsum has been recommended for sodic/dispersive materials or where calcium is low. It should be applied during soil preparation stages, in a manner that allows for as thorough mixing as is practicable of the surface materials. Gypsum should be applied prior to seeding and fertilising. The depth to which sodicity is ameliorated should be dependent upon erosion risk / gradient. For slopes with gradients

- less than approximately 35 %, incorporate gypsum into the upper 0.3 m of sodic materials.
- greater than approximately 35 %, incorporate gypsum into the upper 0.5 m of sodic materials.

Considering the annual rainfall depth at DNM is approximately 520 mm, it is expected that as a 'rule of thumb' gypsum will dissolve at a rate of 0.5–1 t/ha/y. Hence, there is benefit in applying gypsum at recovery of materials, or as soon as is practicable in the rehabilitation program.

5.4.2 Fertiliser

A balanced NPK fertiliser such as Crop King (CK) 55 (N: ~13.5%, P: ~15%, K: 12.5%) and slow-release nitrogen source such as Coated Urea (N: ~46%) or organic compost is recommended to provide a balanced source of nutrients to plants during rehabilitation. Any composted material should comply with the Australian Standard for Composting (AS4454-2012).

Fertiliser and mulch/compost should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. Spreaders are typically suitable for slopes with gradients less than 35%, and pneumatic or hydraulic applications will be required for steeper slopes. Accurate application rates should be determined by a suitably qualified person prior to use in rehabilitation.

6 SUMMARY AND RECOMMENDATIONS

This material characterisation summary describes and characterises the materials identified on-site for use in rehabilitation, as per the topsoil stockpile assessment, previous soil and spoil assessments and other DNM project related documents.

6.1 Topsoil Quality and Stockpiles

Generally, the topsoil material is considered to be of adequate quality for use as a primary growth medium. Due to the high degree of heterogeneity in topsoil material, the summarised laboratory data should be considered representative of the topsoil materials as a whole, and not representative of individual stockpiles. As such, the sampling program is considered adequate to describe these materials into broad management groups. Therefore, any stockpile not included in this assessment should be sampled and characterised prior to use in rehabilitation.

6.1.1 Topsoil management

The main limitations of topsoil materials for use in rehabilitation are sodicity and low fertility.

Amelioration of sodicity requires the thorough incorporation of gypsum. However, gypsum is only required on approximately 25% of stockpiles sampled. Therefore, it is recommended that individual stockpiles are assessed for gypsum requirements prior to use in rehabilitation.

Generally, chemical fertility of the available topsoils is quite low. A balanced NPK fertiliser or compost should be applied during rehabilitation to provide a starter source of nutrients for initial vegetation growth. Additional applications may be required to maintain adequate fertility levels.

Amelioration products and application rates should be assessed by a suitably qualified professional prior to use for rehabilitation and to complement the desired PMLU.

6.2 Spoil Materials

Generally, Permian spoil materials at the mine are suitable to be used as secondary growth media through varying degrees of amelioration. Fresh Permian spoil is considered the most beneficial for use in the upper soil profile as it offers the highest stability to erosion. Where possible, placing the weathered zone sediments and clay spoil in the upper soil profile should be avoided.

The laboratory analysis and erodibility testing of spoil materials identified there may be limitations for their use as a *primary growth media*. The main limitation of some spoil materials is the tendency to rapidly weather when exposed, making them susceptible to erosion where adequate vegetation cover is not established. However, fresh Permian material may provide suitable growth media for establishment of woodland vegetation with sufficient amelioration. This material has only minor

chemical limitations and is unlikely to significantly reduce growth of most plant species used in rehabilitation. Spoil testing did not consider macro and micro nutrient fertility of the Permian. It is recommended that analysis of macronutrients be conducted to determine the fertility stores needed to sustain healthy vegetation growth and identify any additional amelioration requirements for the spoil materials if used as a primary growth media.

Data suggests that relatively competent rock with a slake durability higher than 70% is present on site. If this material can be isolated, it could be used as a rock armour to greatly increase batter slope resistance to erosion and to stabilise steeper areas in the short-term until vegetation establishes.

6.3 Growth Media for PMLU

Physical and chemical properties of the soil and spoil materials available on site meet the requirements to establish the PMLU for rehabilitated areas of cattle grazing or woodland habitat. It is recommended that the growth media is assessed by an appropriately qualified person prior to rehabilitation, to identify the required ameliorants and fertilisers.

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APPENDIX A: MAPS AND FIGURES

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Figure A1: Distribution of stockpiled topsoil materials and sampling locations at Daunia Mine. All stockpiles sampled are representative of a singular management group.



Figure A2: DNM site layout (October 2021).

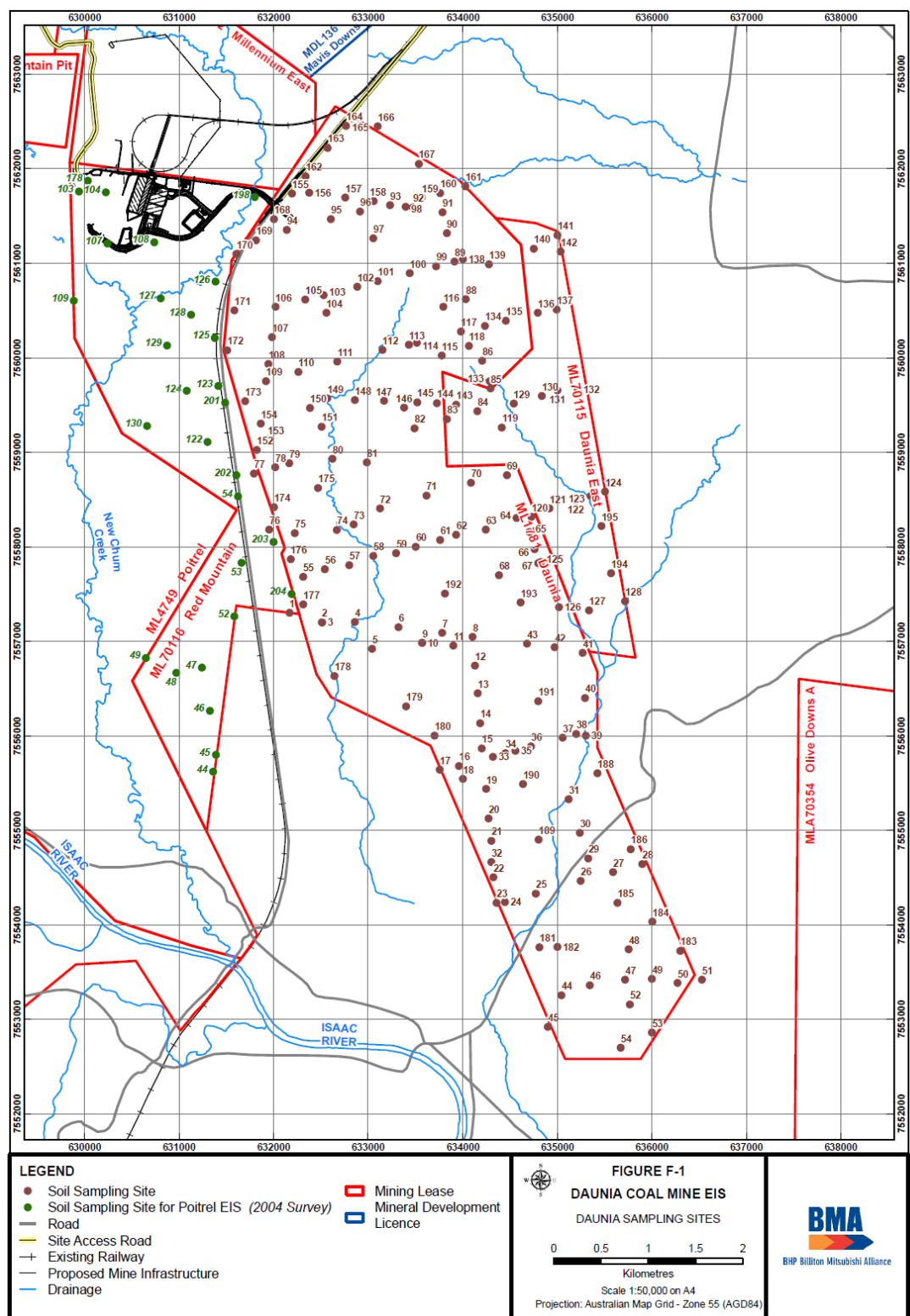


Figure A3: Pre-mined soil survey sampling sites conducted by Peter Baker and Graham Tuck (BHP Billiton Mitsubishi Alliance, 2008).

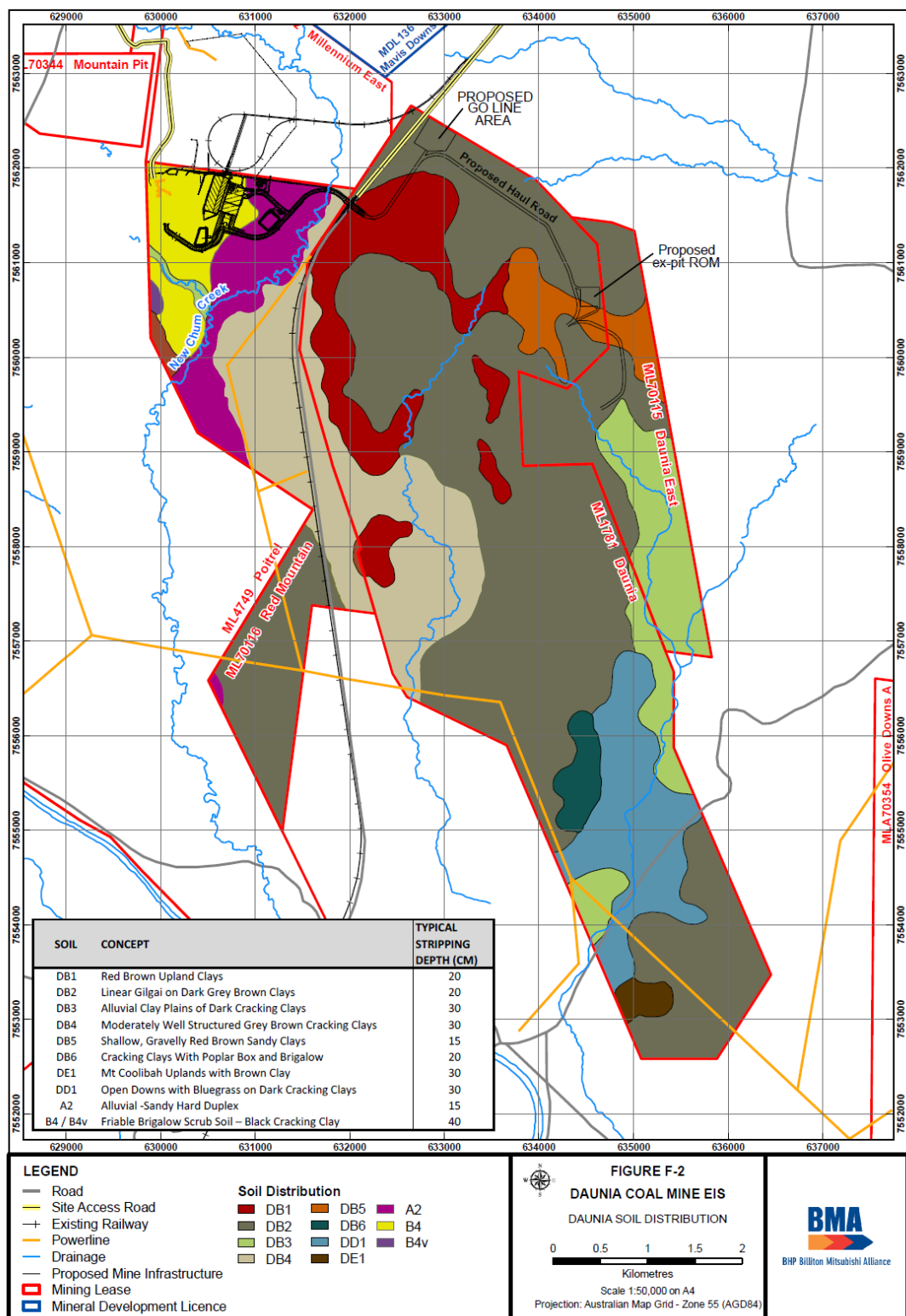


Figure A4: Soil mapping units for the pre-mined soil survey conducted by Peter Baker and Graham Tuck (BHP Billiton Mitsubishi Alliance, 2008).

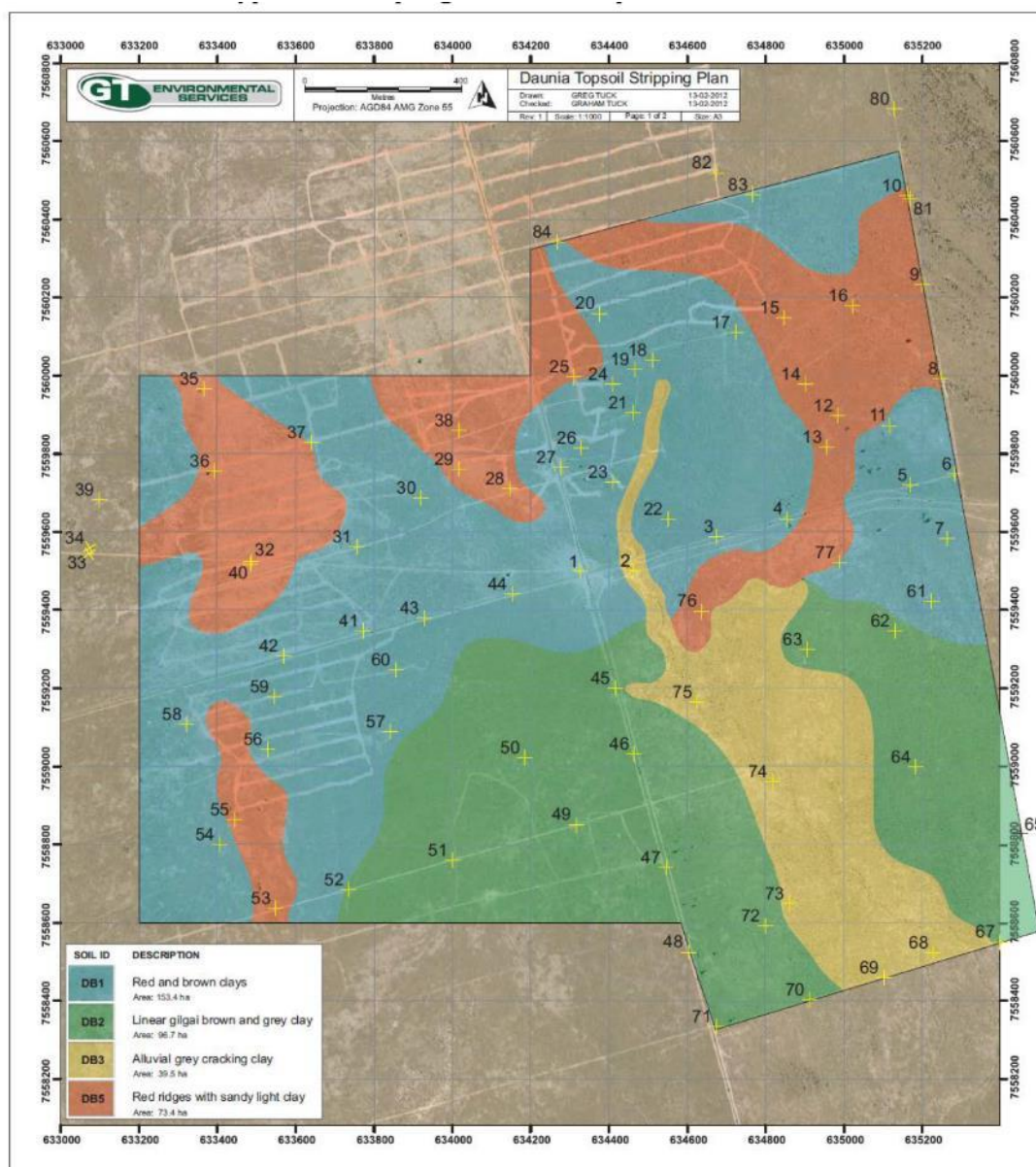


Figure A5: Pre-mined soil mapping units (GT Environmental Services, 2012).

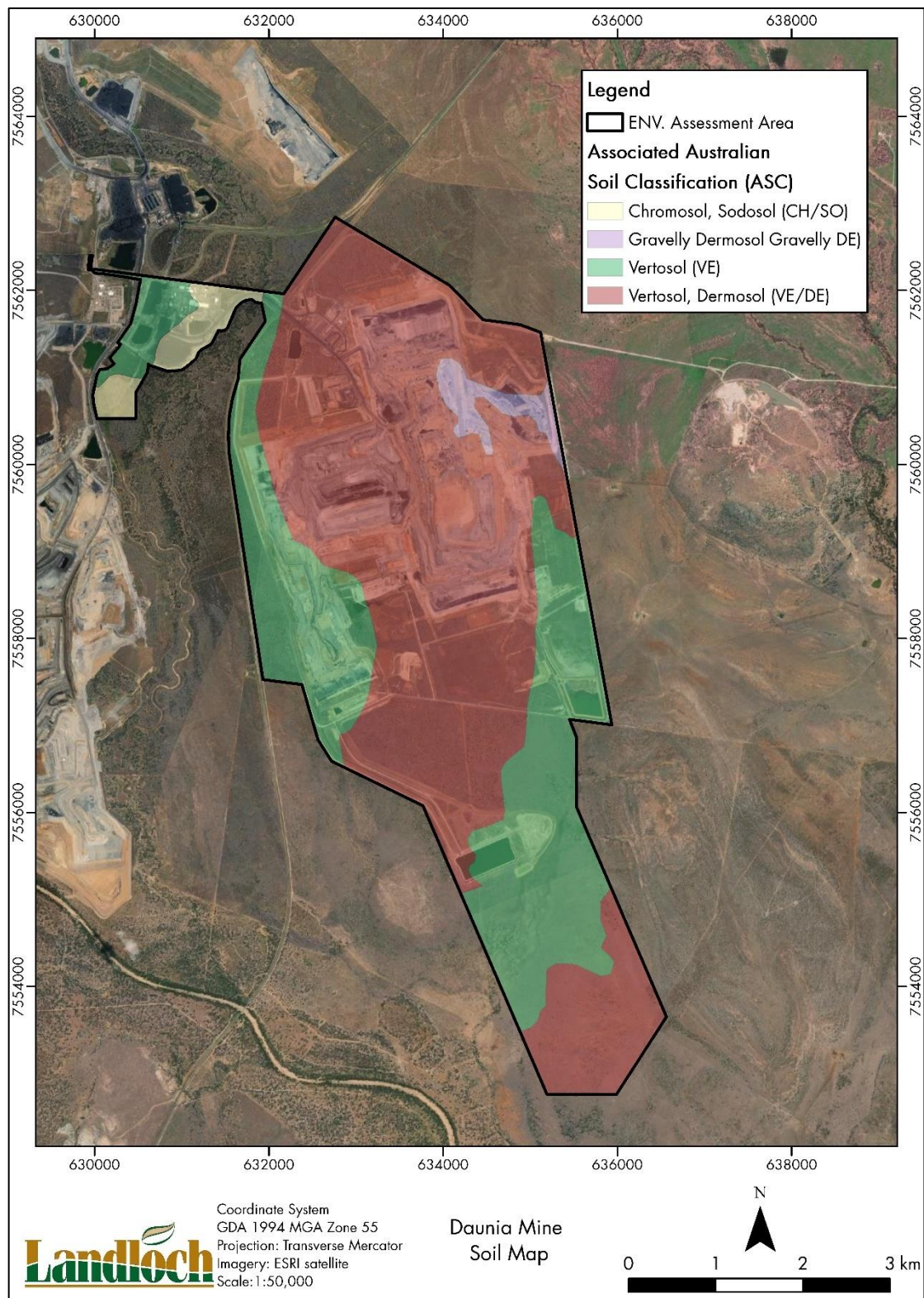


Figure A6: ASC soil mapping synthesised from existing soil assessments (Bourne, G.F. and Tuck, G.A., 1993), (BHP Billiton Mitsubishi Alliance, 2008), (State of Queensland (Department of Resources), 2021) and (GT Environmental Services, 2012).



Figure A7: Topsoil and spoil sampling locations for erodibility studies (Landloch Pty Ltd, 2017) (PW Baker & Associates Pty. Ltd., 2012).

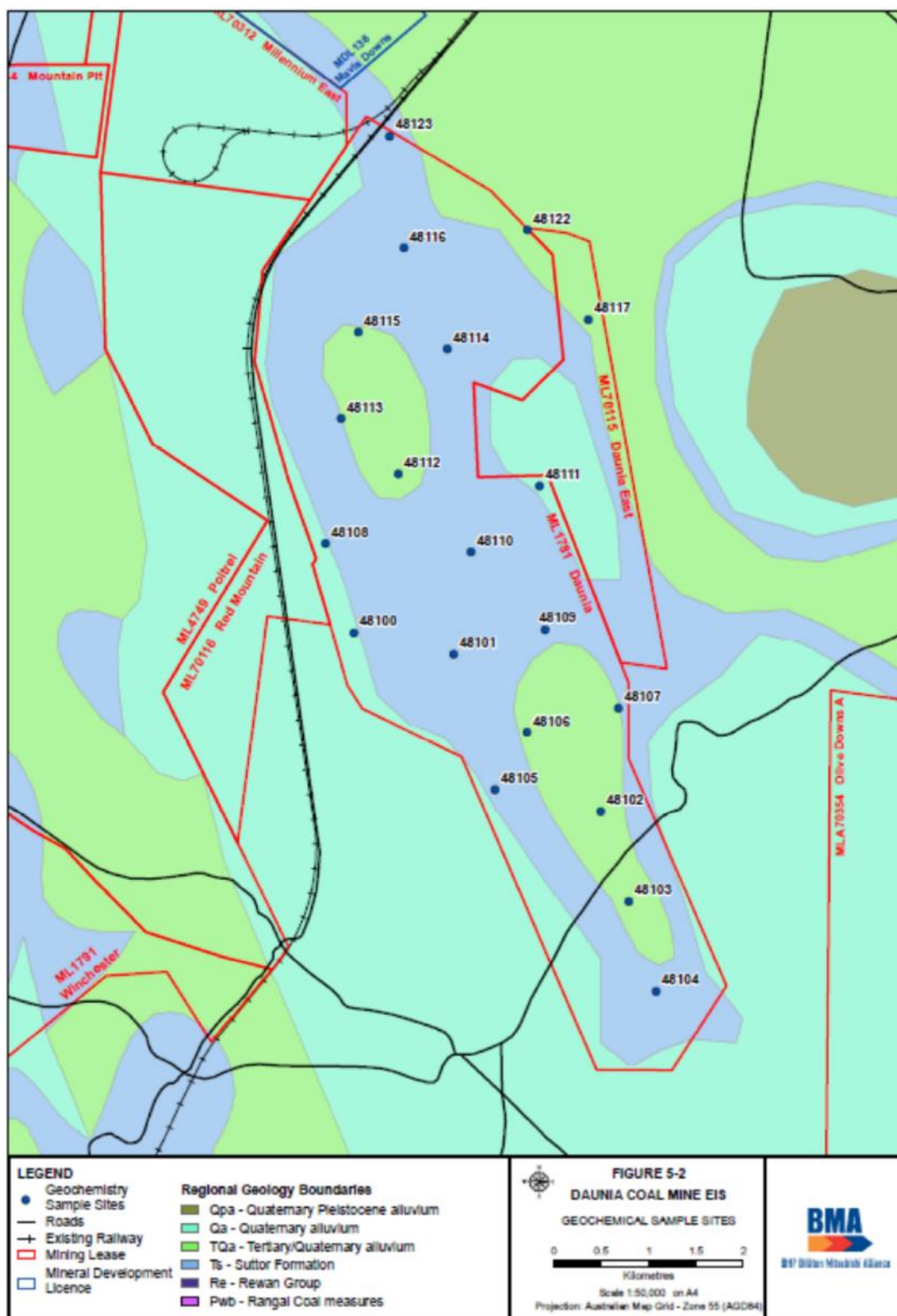


Figure A8: Spoil sampling locations for EIS (BMA, 2009).

APPENDIX B: DATA TABLES

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Table B1: Sampling site locations (February).

Site ID	Type	UTM
1	Topsoil stockpile	55 K 633530.28 7558070.615
8	Topsoil stockpile	55 K 635095.08 7561379.124
19	Topsoil stockpile	55 K 634350.06 7559392.320
5	Topsoil stockpile	55 K 634825.96 7561178.267
38	Topsoil stockpile	55 K 632932.40 7557533.752
39	Topsoil stockpile	55 K 632864.52 7557774.988
3d	Topsoil stockpile	55 K 635063.87 7557744.922
6	Topsoil stockpile	55 K 634441.10 7555788.815
20	Topsoil stockpile	55 K 634105.15 7559594.284
23a	Topsoil stockpile	55 K 634714.18 7561296.627
3a	Topsoil stockpile	55 K 634061.33 7557728.968
3b	Topsoil stockpile	55 K 634032.27 7557471.037
3c	Topsoil stockpile	55 K 634281.98 7557637.969
3e	Topsoil stockpile	55 K 634624.10 7557439.918
41	Topsoil stockpile	55 K 633406.10 7557623.859

Table B2: Sampling site locations (March).

Site ID	Type	UTM
28	Topsoil stockpile	55 K 633101.94 7562220.869
27a	Topsoil stockpile	55 K 632834.16 7562046.001
12	Topsoil stockpile	55 K 632295.27 7560887.451
16	Topsoil stockpile	55 K 632263.90 7558489.322
13	Topsoil stockpile	55 K 631965.91 7557987.506
13 subsoil	Topsoil stockpile	55 K 631955.56 7557974.556
Dam 7	Topsoil stockpile	55 K 632603.74 7561057.809

Table B3: Morphological description of stockpiled soil materials. Part 1 of 2.

Field Order	Date	Site ID	Layer (m)	Lower Depth (m)	Texture Group 1 ^o	Texture Field	Colour (rapid)		Total Coarse Fragment %	Origin (i.e topsoil, subsoil, overburden); Parent Materials; and Proportions	Comments
							Primary	Secondary			
13	12.2.22	st.1	0.5		CLAY	Light Medium Clay	Brown	Red	<2	topsoil	topsoil bulked. cracking crust surface. weed and some grass cover.
			1.5		CLAY	Light Medium Clay	Brown	Red	<2	topsoil	
			2.5		CLAY	Light Medium Clay	Brown	Red	<2	topsoil	
8	11.2.22	st.3a	0.5		CLAY	Medium Clay	Dark Grey	Brown	<2	topsoil	carbonates in soil, smooth and silty to touch, formed ribbon like pottery clay.
			1.5		CLAY	Medium Clay	Dark Grey	Dark Brown	<2	topsoil	
			2+		CLAY	Medium Clay	Dark Grey	Red	<2	topsoil	
7	11.2.22	st.3b	0.5		CLAY	Medium Clay	Grey	Brown	0	topsoil	bulkied topsoil .
			1.5		CLAY	Medium Clay	Grey	Brown	0	topsoil	
			2m		CLAY	Medium Clay	Grey	Brown	0	topsoil	
9	11.2.22	st.3c	0.5		CLAY	Medium Clay	Grey	Brown	<2	topsoil	caco3, smooth silt, high clay content
			1.5		CLAY	Heavy Clay	Grey	Brown	<2	topsoil	
6	11.2.22	st.3d	0.5		CLAY	Light Medium Clay	Red	Brown	0	topsoil	very smooth. clay dominant. area well covered in grass.
			1.5		CLAY	Light Medium Clay	Red	Brown	0	topsoil	
			2.5		CLAY	Light Medium Clay	Red	Brown	0	topsoil	
10	11.2.22	st.3e	0.5		CLAY	Medium Heavy Clay	Red	Brown	0	topsoil bulked.	well covered in grass, bulkied soils, caco3 present, heavy clay, lot of pressure to manipulate
			1.5		CLAY	Medium Heavy Clay	Dark Grey	Red	0	topsoil bulked.	
			2.5		CLAY	Medium Heavy Clay	Dark Grey	Dark Brown	0	topsoil bulked.	
3	11.2.22	st.5	0.5		CLAY	Medium Clay	Brown		20-30	topsoil	rocky surface. weed growth on piles, silky to touch. rock throughout profile
			1.5		CLAY	Medium Clay	Brown		20-30	topsoil	
			2.5		CLAY	Medium Clay	Brown		20-30	topsoil	
12	11.2.22	st.6	0.5		CLAY	Medium Clay	Dark Grey	Grey	0	topsoil.	grassed covered. carbonates present.
			1.5		CLAY	Medium Clay	Dark Brown	Grey	0	topsoil.	
			2.5		CLAY	Medium Clay	Dark Brown		0	topsoil.	
1	11.2.22	st.8	0.5		CLAY	Clay Loam	Red	Brown	0	topsoil	area well grassed
			1.5		CLAY	Clay Loam	Red	Brown	0	topsoil	
5	11.2.22	st.19	2		CLAY	Clay Loam	Red	Brown	10-20	topsoil	very high stock piles, sampled from edge. grass cover and rocks on surface.
			3		CLAY	Clay Loam	Red	Brown	10-20	topsoil	
			4		CLAY	Clay Loam	Red	Brown	10-20	topsoil	
4	11.2.22	st.20	0.5		CLAY	Light Medium Clay	Grey	Brown	<2	topsoil	moisture throughout, well grassed over top
			1.5		CLAY	Light Medium Clay		Red	<2	topsoil	
			2.5		CLAY	Light Medium Clay		Brown	<2	topsoil	
2	11.2.22	st.23A	0.5		CLAY	Loam	Grey	Brown	0	topsoil	rocky surface weed growth across piles
			1.5		CLAY	Loam	Grey	Brown	0	topsoil	

Table B3: Morphological description of stockpiled soil materials. Part 2 of 2.

Field Order	Date	Site ID	Layer (m)	Lower Depth (m)	Texture Group 1°	Texture Field	Colour (rapid)		Total Coarse Fragment %	Origin (i.e topsoil, subsoil, overburden); Parent Materials; and Proportions	Comments
							Primary	Secondary			
15	12.2.22	st.38	0.5		CLAY	Light Clay	Grey	Red	0	topsoil.	topsoil piles. little grass cover. few weeds.
			1.5		CLAY	Light Clay	Grey	Red	0	topsoil.	
			2.5		CLAY	Light Clay	Grey	Red	<2	topsoil.	
14	12.2.22	st.39.	0.5		CLAY	Light Medium Clay	Brown	Red	0	topsoil	discrete topsoil piles. weeds across piles. some grasses. topsoil stockpiles ontop of previously dumped and flattered tps.
			1.5		CLAY	Light Medium Clay	Red	Brown	0	topsoil	
			2.5		CLAY	Light Medium Clay	Red	Brown	0	topsoil	
11	11.2.22	st.41	0.5		CLAY	Medium Heavy Clay	Dark Grey	Dark Brown	0	topsoil	cracking surface, crusting, covered with grass, soil bulked
			1.5		CLAY	Medium Heavy Clay	Dark Grey	Dark Brown	0	topsoil	
			2.5		CLAY	Medium Heavy Clay	Dark Grey	Dark Brown	0	topsoil	
1	15.3.22	st28	0.5	1	CLAY	Light Medium Clay	Red	Brown	0	topsoil	fe stone present, weeds over stockpile.
			1.5	2	CLAY	Light Medium Clay	Red	Brown	0	topsoil	
			2.5	3	CLAY	Light Medium Clay	Red	Brown	0	topsoil	
2	15.3.22	st12a	0.5	1	CLAY	Light Clay	Red	Brown	2-5	topsoil	fe stone and shale like sediments weeds over top
			1.5	2	CLAY	Light Clay	Red	Brown	2-5	topsoil	
3	15.2.22	st.12b	0.5	1	CLAY	Light Clay	Red	Yellow	0	topsoil	fe stone, vry dry like talc
			1.5	2	CLAY	Light Clay	Red	Yellow	0	topsoil	
4	15.3.22	st27	0.5	1	CLAY	Light Clay	Red	Brown	2-5	topsoil	high percentage grass cover
			1.5	2	CLAY	Light Clay	Red	Brown	0	topsoil	
			2.5	3	CLAY	Light Clay	Red	Yellow	0	topsoil	
5	15.2.22	st16	0.5	1	CLAY	Light Medium Clay	Brown	Red	20-30	topsoil	areas are well covered in grasses and weeds. stony throughout. sample from topsoil bunded up.
			1.5	2	CLAY	Light Medium Clay	Brown	Red	20-30	topsoil	
6	15.3.22	st13	2	2.5	CLAY	Medium Clay	Brown	Red	<2	topsoil	indicative only at site
			3	3.5	CLAY	Medium Clay	Brown	Red	0	topsoil	
			4	4.5	CLAY	Medium Clay	Brown	Red	0	topsoil	
7	15.3.22	st13 subsoil	0.5	1	CLAY	Medium Clay	Pale Grey	Brown	0	subsoil	very bare. accessed on foot
			1.5	2	CLAY	Medium Clay	Pale Grey	Brown	0	subsoil	
			2.5	3	CLAY	Medium Clay	Pale Grey	Brown	0	subsoil	
8	15.3.22	dam 7	0.5	1	CLAY	Light Clay	Red	Brown	2-5	topsoil	accessed on foot
			1.5	2	CLAY	Light Clay	Red	Brown	0	topsoil	
			2.5	3	CLAY	Light Clay	Red	Brown	0	topsoil	

Table B4: Laboratory analysis data for topsoil stockpiles. Part 1 of 4.

TABLE B4. Laboratory Results ALL SITES													
	Lab No	220789-4		220789-8		220789-11		220789-15		220789-20		220789-24	
	Sample ID	St.1		St.3a		St.3c		St.3d		St.3e		St.5	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		MC		LMC		LMC		LMC		MC	
Analyses	Unit												
pH - Water	pH units	8.59	H.Alk	8.42	M.Alk	8.47	M.Alk	8.32	M.Alk	8.64	H.Alk	8.87	H.Alk
Electrical Conductivity	dS/m	0.33	M.Sal	0.22	L.Sal	0.15	L.Sal	0.17	L.Sal	0.21	L.Sal	0.85	H.Sal
Chloride	mg/kg	252.0	L.Sal	59.9	VL.Sal	33.0	VL.Sal	59.8	VL.Sal	49.4	VL.Sal	927.0	H.Sal
Total Nitrogen - Kjeldahl	mg/kg	792.0	L	1153.0	L	1155.0	L	1685.0	M	916.0	L	332.0	VL
Total Phosphorus - Nitric/Perchloric	mg/kg	207.0	*	218.0	*	262.0	*	368.0	*	239.0	*	254.0	*
Phosphorus - Colwell extr	mg/kg	6.7	L	8.5	L	33.2	M	83.2	H	10.0	L	5.1	L
Potassium - Colwell ext	mg/kg	96.80	VL	113.00	VL	104.00	VL	173.00	L	89.50	VL	103.00	VL
Sulphur - KCl	mg/kg	18.9	H	11.5	M	8.2	M	10.6	M	8.9	M	4.6	L
Organic Carbon	%	1.14	M	1.16	M	1.21	M	1.83	H	1.02	M	0.31	EL
Copper	mg/kg	0.90	M	0.74	M	1.09	M	1.02	M	0.94	M	0.42	M
Iron	mg/kg	4.18	*	3.38	*	6.89	*	4.18	*	3.88	*	2.86	*
Manganese	mg/kg	3.84	M	2.84	M	5.47	M	5.90	M	4.18	M	2.00	M
Zinc	mg/kg	0.56	L	0.34	L	0.37	L	0.48	L	0.38	L	0.30	L
Boron	mg/kg	1.50	M	0.82	L	0.78	L	1.32	M	1.08	M	1.46	M
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	20.9	M	31.3	H	34.7	H	28.2	H	23.8	M	20.9	M
Ex Calcium Percent	%	60.92	L	76.74	Normal	82.93	H	83.66	H	79.62	Normal	44.22	L
Ex Magnesium Percent	%	31.57	H	18.67	H	13.59	Normal	13.18	Normal	15.67	H	36.83	H
Ex Potassium Percent	%	0.91	L	0.88	L	0.81	L	1.28	Normal	0.65	L	0.76	L
Ex Sodium Percent	%	6.55	Sodic	3.68	N.Sodic	2.52	N.Sodic	1.84	N.Sodic	4.02	N.Sodic	18.13	H.Sodic
Ex Aluminium Percent	%	0.05	VL	0.04	VL	0.15	VL	0.04	VL	0.05	VL	0.05	VL
Exchangeable Calcium	meq/100g	12.74	H	24.02	VH	28.78	VH	23.59	VH	18.93	H	9.24	M
Exchangeable Magnesium	meq/100g	6.60	H	5.84	H	4.72	H	3.72	H	3.73	H	7.69	H
Exchangeable Potassium	meq/100g	0.19	VL	0.27	L	0.28	L	0.36	M	0.15	VL	0.16	VL
Exchangeable Sodium	meq/100g	1.37	H	1.15	H	0.87	H	0.52	M	0.96	H	3.79	VH
Exchangeable Aluminium	meq/100g	0.01	H	0.01	H	0.05	E	0.01	H	0.01	H	0.01	H
Calcium/Magnesium Ratio	-	1.9	Low Ca	4.1	Balanced	6.1	Balanced	6.3	Balanced	5.1	Balanced	1.2	Low Ca
Emerson Aggregate	Class	7.0	Stable	7.0	Stable	4.0	Slaking	4.0	Slaking	3b	Slight Disp	4.0	Slaking
Phosphorus Buffer Index	mg/kg	98.5	*	102.0	*	109.0	*	109.0	*	94.3	*	72.5	*

Highly acidic

Extremely alkaline

High salinity

Sodic

Strongly sodic

Table B4: Laboratory analysis data for topsoil stockpiles. Part 2 of 4.

TABLE B4. Laboratory Results ALL SITES													
	Lab No	220789-28		220789-31		220789-35		220789-40		220789-43		220789-47	
	Sample ID	St.6		St.8		St19		St.20		St23a		St38	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	MC		MC		LMC		MC		MC		MC	
Analyses	Unit												
pH - Water	pH units	8.19	M.Alk	8.12	M.Alk	8.05	M.Alk	8.54	H.Alk	8.6	H.Alk	8.32	M.Alk
Electrical Conductivity	dS/m	0.21	L.Sal	0.23	L.Sal	0.29	M.Sal	0.31	M.Sal	0.44	M.Sal	0.23	L.Sal
Chloride	mg/kg	52.2	VL.Sal	69.8	VL.Sal	59.4	VL.Sal	134.0	L.Sal	394.0	M.Sal	80.6	VL.Sal
Total Nitrogen - Kjeldahl	mg/kg	962.0	L	1919.0	M	1124.0	L	1024.0	L	685.0	L	1379.0	L
Total Phosphorus - Nitric/Perchloric	mg/kg	197.0	*	421.0	*	303.0	*	205.0	*	399.0	*	288.0	*
Phosphorus - Colwell extr	mg/kg	12.9	L	28.5	L	30.8	M	21.1	L	22.6	L	69.2	M
Potassium - Colwell ext	mg/kg	84.20	VL	162.00	L	194.00	M	113.00	VL	104.00	VL	123.00	L
Sulphur - KCl	mg/kg	8.8	M	14.8	H	17.1	H	18.7	H	19.1	H	11.5	M
Organic Carbon	%	1.07	M	1.88	H	1.12	M	1.19	M	1.07	M	1.48	M
Copper	mg/kg	0.46	M	1.06	M	1.26	M	0.7	M	0.82	M	0.9	M
Iron	mg/kg	5.38	*	6.16	*	7.00	*	3.48	*	4.20	*	7.98	*
Manganese	mg/kg	4.86	M	7.20	M	7.14	M	3.46	M	2.12	M	4.84	M
Zinc	mg/kg	0.34	L	0.72	L	0.70	L	0.36	L	0.50	L	0.42	L
Boron	mg/kg	0.76	L	0.86	L	0.86	L	1.36	M	0.92	L	1.24	M
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	14.2	M	16.7	M	15.2	M	24.6	M	14.8	M	15.1	M
Ex Calcium Percent	%	68.40	Normal	79.67	Normal	82.71	H	79.72	Normal	69.37	Normal	78.03	Normal
Ex Magnesium Percent	%	27.00	H	17.02	H	12.78	Normal	15.84	H	22.51	H	18.56	H
Ex Potassium Percent	%	0.65	L	1.55	Normal	2.26	Normal	0.61	L	0.85	L	0.82	L
Ex Sodium Percent	%	3.87	N.Sodic	1.69	N.Sodic	2.15	N.Sodic	3.79	N.Sodic	7.19	Sodic	2.52	N.Sodic
Ex Aluminium Percent	%	0.08	VL	0.07	VL	0.10	VL	0.05	VL	0.08	VL	0.07	VL
Exchangeable Calcium	meq/100g	9.69	M	13.30	H	12.57	H	19.59	H	10.27	H	11.81	H
Exchangeable Magnesium	meq/100g	3.83	H	2.84	M	1.94	M	3.89	H	3.33	H	2.81	M
Exchangeable Potassium	meq/100g	0.09	VL	0.26	L	0.34	M	0.15	VL	0.13	VL	0.12	VL
Exchangeable Sodium	meq/100g	0.55	M	0.28	L	0.33	M	0.93	H	1.07	H	0.38	M
Exchangeable Aluminium	meq/100g	0.01	H	0.01	H	0.02	H	0.01	H	0.01	H	0.01	H
Calcium/Magnesium Ratio	-	2.5	Low Ca	4.7	Balanced	6.5	Balanced	5.0	Balanced	3.1	Low Ca	4.2	Balanced
Emerson Aggregate	Class	7	Stable	7	Stable	7	Stable	7	Stable	4	Slaking	4	Slaking
Phosphorus Buffer Index	mg/kg	58.4	*	88.6	*	83.2	*	98.4	*	67.8	*	107	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic
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Table B4: Laboratory analysis data for topsoil stockpiles. Part 3 of 4.

TABLE B4. Laboratory Results ALL SITES													
	Lab No	220789-51		220789-55		220789-59		220789-62		220789-65		220789-69	
	Sample ID	St39		St.41		St.28		St.12a		St12b		St.27	
	Sample Depth (m)	Composite		Composite		Composite		Composite		Composite		Composite	
	Field Texture	LMC		MC		LMC		LC		LMC		MC	
Analyses	Unit												
pH - Water	pH units	8.31	M.Alk	8.7	H.Alk	8.54	H.Alk	7.81	L.Alk	8.41	M.Alk	7.77	L.Alk
Electrical Conductivity	dS/m	0.18	L.Sal	0.29	M.Sal	0.13	L.Sal	0.19	M.Sal	0.22	L.Sal	0.31	M.Sal
Chloride	mg/kg	29.0	VL.Sal	202.0	L.Sal	46.4	VL.Sal	52.2	VL.Sal	121.0	L.Sal	49.6	VL.Sal
Total Nitrogen - Kjeldahl	mg/kg	1041.0	L	711.0	L	1099.0	L	1671.0	M	999.0	L	1603.0	M
Total Phosphorus - Nitric/Perchloric	mg/kg	304.0	*	169.0	*	290.0	*	697.0	*	435.0	*	264.0	*
Phosphorus - Colwell extr	mg/kg	28.4	L	11.2	L	38	M	24.8	M	30.2	M	11.9	L
Potassium - Colwell ext	mg/kg	122.00	L	92.10	VL	99.80	VL	218.00	M	122.00	L	98.30	VL
Sulphur - KCl	mg/kg	11.6	M	17.2	H	6.9	L	14.1	H	19.8	H	20.0	FALSE
Organic Carbon	%	0.94	L	0.97	L	1.25	M	2.36	H	1.5	M	1.91	H
Copper	mg/kg	0.88	M	0.8	M	0.98	M	1.94	M	1.22	M	0.94	M
Iron	mg/kg	5.01	*	4.08	*	4.86	*	8.42	*	4.84	*	4.58	*
Manganese	mg/kg	4.98	M	7.26	M	5.92	M	11.40	M	6.72	M	13.80	M
Zinc	mg/kg	0.43	L	0.30	L	0.44	L	1.42	M	0.92	M	0.62	L
Boron	mg/kg	0.91	L	2.44	H	1.04	M	0.74	L	0.78	L	0.87	L
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	17.8	M	20.7	M	17.4	M	13.6	M	14.1	M	13.3	M
Ex Calcium Percent	%	82.04	H	63.00	L	80.67	H	83.91	H	82.17	H	83.62	H
Ex Magnesium Percent	%	14.76	Normal	28.45	H	16.04	H	11.86	Normal	12.54	Normal	14.01	Normal
Ex Potassium Percent	%	1.11	Normal	0.59	L	0.87	L	2.46	Normal	1.73	Normal	1.12	Normal
Ex Sodium Percent	%	2.02	N.Sodic	7.90	Sodic	2.35	N.Sodic	1.69	N.Sodic	3.15	N.Sodic	1.17	N.Sodic
Ex Aluminium Percent	%	0.07	VL	0.06	VL	0.06	VL	0.08	VL	0.41	VL	0.08	VL
Exchangeable Calcium	meq/100g	14.64	H	13.07	H	14.04	H	11.44	H	11.58	H	11.14	H
Exchangeable Magnesium	meq/100g	2.63	M	5.90	H	2.79	M	1.62	M	1.77	M	1.87	M
Exchangeable Potassium	meq/100g	0.20	VL	0.12	VL	0.15	VL	0.34	M	0.24	L	0.15	VL
Exchangeable Sodium	meq/100g	0.36	M	1.64	H	0.41	M	0.23	L	0.44	M	0.16	L
Exchangeable Aluminium	meq/100g	0.01	H	0.01	H	0.01	H	0.01	H	0.06	E	0.01	H
Calcium/Magnesium Ratio	-	5.6	Balanced	2.2	Low Ca	5.0	Balanced	7.1	Balanced	6.6	Balanced	6.0	Balanced
Emerson Aggregate	Class	4	Slaking	4	Slaking	4	Slaking	5	Slaking	4	Slaking	5	Slaking
Phosphorus Buffer Index	ma/ka	93.5	*	96.2	*	118	*	72.8	*	80.4	*	84	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic
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Table B4: Laboratory analysis data for topsoil stockpiles. Part 4 of 4.

TABLE B4. Laboratory Results ALL SITES													
	Lab No	220789-72		220789-76		220789-80		220789-84		Mean		Min	Max
	Sample ID	St16		St13		St13 subsoil		Dam 7					
	Sample Depth (m)	Composite		Composite		Composite		Composite					
	Field Texture	MC		LMC		MC		LMC					
Analyses	Unit												
pH - Water	pH units	8.76	H.Alk	8.67	H.Alk	8.46	M.Alk	7.73	L.Alk	8.4	M.Alk	7.7	8.9
Electrical Conductivity	dS/m	0.25	M.Sal	0.11	VL.Sal	1.41	VH.Sal	0.3	M.Sal	0.32	M.Sal	0.11	1.41
Chloride	mg/kg	143.0	L.Sal	12.2	VL.Sal	1275.0	H.Sal	131.0	L.Sal	192	L.Sal	12	1275
Total Nitrogen - Kjeldahl	mg/kg	803.0	L	1086.0	L	371.0	VL	1704.0	M	1101	L	332	1919
Total Phosphorus - Nitric/Perchloric	mg/kg	286.0	*	240.0	*	215.0	*	333.0	*	300	*	169	697
Phosphorus - Colwell extr	mg/kg	14.6	L	15.2	L	3.86	L	25.8	L	24		4	83
Potassium - Colwell ext	mg/kg	110.00	VL	119.00	VL	118.00	VL	149.00	L	123		84	218
Sulphur - KCl	mg/kg	19.6	H	5.7	L	164.0	VH	29.5	VH	20.97	VH	4.64	164.00
Organic Carbon	%	1.2	M	1.3	M	0.41	VL	2.8	H	1.32	M	0.31	2.80
Copper	mg/kg	0.86	M	1.08	M	1.14	M	1.18	M	0.97	M	0.42	1.94
Iron	mg/kg	3.82	*	3.10	*	3.56	*	5.16	*	5	*	3	8
Manganese	mg/kg	4.00	M	3.58	M	4.84	M	13.20	M	5.89	M	2.00	13.80
Zinc	mg/kg	0.54	L	0.38	L	0.28	VL	0.96	M	0.53	L	0.28	1.42
Boron	mg/kg	0.79	L	0.89	L	3.13	H	0.57	L	1.14	M	0.57	3.13
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	*	*	*	*
Cation Exchange Capacity	meq/100g	17.6	M	18.4	M	24.4	M	10.0	L	19.4	M	10.0	34.7
Ex Calcium Percent	%	76.28	Normal	79.35	Normal	54.72	L	85.19	H	75.3	Normal	44.2	85.2
Ex Magnesium Percent	%	18.63	H	17.46	H	28.69	H	10.08	Normal	18.9	H	10.1	36.8
Ex Potassium Percent	%	0.95	L	1.06	Normal	1.02	Normal	2.01	Normal	1.1	Normal	0.6	2.5
Ex Sodium Percent	%	4.00	N.Sodic	2.07	N.Sodic	15.40	H.Sodic	2.53	N.Sodic	4.6	N.Sodic	1.2	18.1
Ex Aluminium Percent	%	0.14	VL	0.06	VL	0.16	VL	0.18	VL	0.1	VL	0.0	0.4
Exchangeable Calcium	meq/100g	13.44	H	14.58	H	13.37	H	8.52	M	14.6	H	8.5	28.8
Exchangeable Magnesium	meq/100g	3.28	H	3.21	H	7.01	H	1.01	M	3.7	H	1.0	7.7
Exchangeable Potassium	meq/100g	0.17	VL	0.19	VL	0.25	L	0.20	L	0.2	L	0.1	0.4
Exchangeable Sodium	meq/100g	0.70	H	0.38	M	3.76	VH	0.25	L	0.9	H	0.2	3.8
Exchangeable Aluminium	meq/100g	0.03	VH	0.01	H	0.04	E	0.02	VH	0.0	H	0.0	0.1
Calcium/Magnesium Ratio	-	4.1	Balanced	4.5	Balanced	1.9	Low Ca	8.4	Low Mg	4.6	Balanced	1.2	8.4
Emerson Aggregate	Class	7	Stable	4	Slaking	4	Slaking	4	Slaking	*	*	*	*
Phosphorus Buffer Index	mg/kg	92.1	*	114	*	110	*	68.9	*	*	*	*	*

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic
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Table B5: Laboratory analysis data for discrete topsoil stockpile samples. Part 1 of 2.

TABLE B5. Laboratory Results																					
ALL SITES																					
	Lab No	220789-1		220789-2		220789-3		220789-5		220789-6		220789-7		220789-9		220789-		220789-		220789-	
	Sample ID	St.1		St.1		St.1		St.3a		St.3a		St.3a		St.3c		St.3c		St.3d		St.3d	
	Sample Depth (m)	0.5 -1.0		1.5- 2.0		2.5 -3		0.5-1.0		1.5-2.0		2.0 +		0.5-1.0		1.5-2.0		0.5 -1.0		1.5-2.0	
	Field Texture	LMC		LMC		LMC		MC		MC		MC		MC		MC		LMC		LMC	
Analyses	Unit																				
pH - Water	pH units	8.40	M.Alk	8.67	H.Alk	8.72	H.Alk	8.77	H.Alk	8.47	M.Alk	8.44	M.Alk	8.56	H.Alk	8.34	M.Alk	8.35	M.Alk	8.56	H.Alk
Electrical Conductivity	dS/m	0.35	M.Sal	0.36	M.Sal	0.19	L.Sal	0.11	VL.Sal	0.20	L.Sal	0.24	M.Sal	0.14	L.Sal	0.16	L.Sal	0.09	VL.Sal	0.13	L.Sal
	Lab No	220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-	
	Sample ID	St.3d		St.3e		St.3e		St.3e		St.3e		St.5		St.5		St.5		St.6		St.6	
	Sample Depth (m)	2.0-2.5		0.5-1.0		1.0 -1.5		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0	
	Field Texture	LMC		MHC		MHC		MHC		MHC		MC		MC		MC		MC		MC	
Analyses	Unit																				
pH - Water	pH units	8.27	M.Alk	8.78	H.Alk	-	FALSE	8.76	H.Alk	8.65	H.Alk	8.99	H.Alk	8.75	H.Alk	8.98	H.Alk	8.74	H.Alk	8.12	M.Alk
Electrical Conductivity	dS/m	0.32	M.Sal	0.14	L.Sal	-	FALSE	0.20	L.Sal	0.23	L.Sal	0.90	H.Sal	0.87	H.Sal	0.82	H.Sal	0.15	L.Sal	0.25	M.Sal
	Lab No	220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-	
	Sample ID	St.6		St.8		St.8		St.19		St.19		St.19		St.20		St.20		St.20		St.20	
	Sample Depth (m)	2.5-3.0		0.5-1.0		1.5-2.0		2 - 2.5		3 - 3.5		3.5 – 4.0		0.5-1.0		1.5- 2.0		2.5 - 3		3.5-4.0	
	Field Texture	MC		CL		CL		CL		CL		CL		LMC		LMC		LMC		SL	
Analyses	Unit																				
pH - Water	pH units	8.11	M.Alk	8.06	M.Alk	8.15	M.Alk	8	M.Alk	7.88	L.Alk	7.84	L.Alk	8.48	M.Alk	8.49	M.Alk	8.52	H.Alk	8.45	M.Alk
Electrical Conductivity	dS/m	0.2	L.Sal	0.3	M.Sal	0.19	M.Sal	0.32	M.Sal	0.23	M.Sal	0.23	M.Sal	0.39	M.Sal	0.39	M.Sal	0.3	M.Sal	0.33	M.Sal
	Lab No	220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-	
	Sample ID	St23a		St23a		St38		St38		St38		St39		St39		St39		St.41		St.41	
	Sample Depth (m)	0.5-1.0		1.5-2.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0	
	Field Texture	L		L		LC		LC		LC		LMC		LMC		LMC		MHC		MHC	
Analyses	Unit																				
pH - Water	pH units	8.46	M.Alk	8.45	M.Alk	8.33	M.Alk	8.32	M.Alk	8.27	M.Alk	8.17	M.Alk	8.13	M.Alk	8.01	M.Alk	8.72	H.Alk	8.48	M.Alk
Electrical Conductivity	dS/m	0.45	H.Sal	0.41	M.Sal	0.25	M.Sal	0.26	M.Sal	0.35	M.Sal	0.21	L.Sal	0.24	M.Sal	0.21	L.Sal	0.31	M.Sal	0.22	L.Sal

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic
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Table B5: Laboratory analysis data for discrete topsoil stockpile samples. Part 2 of 2.

TABLE B5. Laboratory Results ALL SITES																					
	Lab No	220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-	
	Sample ID	St.41		St.28		St.28		St.28		St.12a		St.12a		St12b		St12b		St.27		St.27	
	Sample Depth (m)	2.5-3.0		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0		1.5-2.0		0.5-1.0		1.5-2.0		0.5-1.0		1.5-2.0	
	Field Texture	MHC		LMC		LMC		LMC		LC		LC		LC		LC		LC		LC	
Analyses	Unit																				
pH - Water	pH units	8.71	H.Alk	8.44	M.Alk	8.4	M.Alk	8.43	M.Alk	7.81	L.Alk	7.48	L.Alk	8.3	M.Alk	8.49	M.Alk	8.08	M.Alk	7.69	L.Alk
Electrical Conductivity	dS/m	0.35	M.Sal	0.14	L.Sal	0.11	VL.Sal	0.13	L.Sal	0.19	M.Sal	0.14	L.Sal	0.2	M.Sal	0.21	M.Sal	0.26	M.Sal	0.33	M.Sal
	Lab No	220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-		220789-	
	Sample ID	St.27		St16		St16		St13		St13		St13		St13 subsoil		St13 subsoil		St13 subsoil		Dam 7	
	Sample Depth (m)	2.5-3.0		0.5-1.0		1.5-2.0		2-2.5		3-3.5		4-4.5		0.5-1.0		1.5-2.0		2.5-3.0		0.5-1.0	
	Field Texture	LC		LMC		LMC		MC		MC		MC		MC		MC		MC		LC	
Analyses	Unit																				
pH - Water	pH units	8.04	M.Alk	8.73	H.Alk	8.66	H.Alk	8.63	H.Alk	8.45	M.Alk	8.8	H.Alk	8.36	M.Alk	8.69	H.Alk	8.65	H.Alk	7.77	L.Alk
Electrical Conductivity	dS/m	0.28	M.Sal	0.27	M.Sal	0.24	M.Sal	0.12	L.Sal	0.11	VL.Sal	0.11	VL.Sal	1.61	E.Sal	0.96	VH.Sal	1.11	VH.Sal	0.38	M.Sal
	Lab No	220789-		220789-																	
	Sample ID	Dam 7		Dam 7																	
	Sample Depth (m)	1.5-2.0		2.5-3.0																	
	Field Texture	LC		LC																	
Analyses	Unit																				
pH - Water	pH units	7.91	M.Alk	7.94	M.Alk																
Electrical Conductivity	dS/m	0.26	M.Sal	0.31	M.Sal																

	Highly acidic		Extremely alkaline		High salinity		Sodic		Strongly sodic
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Table B6: Laboratory analysis data for discrete heavy loam and clay topsoils. Part 1 of 2.

TABLE B8. Laboratory Results ALL SITES																					
	Lab No	220725-13		220725-15		220725-16		220725-34		220725-35		220725-36		220725-46		220725-47		220725-48		220725-50	
	Sample ID	SRM_36		SRM_36		SRM_36		SRM_34		SRM_34		SRM_34		SRM_94		SRM_94		SRM_94		SRM_85	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	8.22	M.Alk	8.01	M.Alk	8.55	H.Alk	8.11	M.Alk	8.76	H.Alk	8.70	H.Alk	8.39	M.Alk	8.63	H.Alk	7.83	L.Alk	8.38	M.Alk
Electrical Conductivity	dS/m	0.13	L.Sal	0.03	VL.Sal	0.04	VL.Sal	0.04	VL.Sal	0.08	L.Sal	0.08	L.Sal	0.04	VL.Sal	0.06	VL.Sal	0.08	L.Sal	0.03	VL.Sal
	Lab No	220725-51		220725-52		220725-54		220725-55		220725-56		220725-58		220725-59		220725-60		220725-62		220725-63	
	Sample ID	SRM_85		SRM_85		SRM_108		SRM_108		SRM_108		SRM_90		SRM_90		SRM_90		SRM_109		SRM_109	
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5	
Analyses	Unit																				
pH - Water	pH units	7.46	L.Alk	6.88	Neutral	6.85	Neutral	7.59	L.Alk	7.66	L.Alk	8.5	H.Alk	8.17	M.Alk	7.86	L.Alk	6.79	Neutral	6.60	Neutral
Electrical Conductivity	dS/m	0.11	L.Sal	0.05	VL.Sal	0.02	VL.Sal	0.02	VL.Sal	0.05	VL.Sal	0.06	VL.Sal	0.06	VL.Sal	0.08	L.Sal	0.02	VL.Sal	0.03	VL.Sal
	Lab No	220725-64		220725-70		220725-71		220725-72		220725-74		220725-75		220725-76		220725-78		220725-79		220725-80	
	Sample ID	SRM_109		SRM_88		SRM_88		SRM_88		SRM_63		SRM_63		SRM_63		SRM_89		SRM_89		SRM_89	
	Sample Depth (m)	2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5	
Analyses	Unit																				
pH - Water	pH units	9.74	E.Alk	6.50	L.Acid	6.88	Neutral	6.71	Neutral	5.88	M.acid	5.72	M.acid	5.64	M.acid	8.58	H.Alk	8.67	H.Alk	7.89	L.Alk
Electrical Conductivity	dS/m	0.05	VL.Sal	0.02	VL.Sal	0.01	VL.Sal	0.03	VL.Sal	0.02	VL.Sal	0.03	VL.Sal	0.02	VL.Sal	0.08	L.Sal	0.09	L.Sal	0.06	VL.Sal
	Lab No	220725-82		220725-83		220725-84		220725-94		220725-95		220725-96		220725-102		220725-103		220725-104		220725-106	
	Sample ID	SRM_36		SRM_36		SRM_36		SRM_106		SRM_106		SRM_106		SRM_74		SRM_74		SRM_74		SRM_70	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	6.68	Neutral	6.28	L.Acid	6.35	L.Acid	6.94	Neutral	6.72	Neutral	6.57	L.Acid	7.76	L.Alk	6.50	L.Acid	6.66	Neutral	8.78	H.Alk
Electrical Conductivity	dS/m	0.03	VL.Sal	0.05	VL.Sal	0.06	VL.Sal	0.02	VL.Sal	0.06	VL.Sal	0.05	VL.Sal	0.05	VL.Sal	0.11	L.Sal	0.04	VL.Sal	0.08	L.Sal
	Lab No	220725-107		220725-108		220725-110		220725-111		220725-112		220725-114		220725-115		220725-116		220725-118		220725-119	
	Sample ID	SRM_70		SRM_70		SRM_83		SRM_83		SRM_83		SRM_24		SRM_24		SRM_24		SRM_28		SRM_28	
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5	
Analyses	Unit																				
pH - Water	pH units	8.83	H.Alk	8.49	M.Alk	6.84	Neutral	7.37	Neutral	7.95	M.Alk	7.01	Neutral	6.72	Neutral	6.51	L.Acid	8.39	M.Alk	7.59	L.Alk
Electrical Conductivity	dS/m	0.09	L.Sal	0.08	L.Sal	0.02	VL.Sal	0.02	VL.Sal	0.03	VL.Sal	0.01	VL.Sal	0.02	VL.Sal	0.07	L.Sal	0.09	L.Sal	0.15	M.Sal
	Lab No	220725-120		220725-122		220725-123		220725-124		220725-126		220725-127		220725-128		220725-130		220725-131		220725-132	
	Sample ID	SRM_28		SRM_46		SRM_46		SRM_46		SRM_49		SRM_49		SRM_49		SRM_31		SRM_31		SRM_31	
	Sample Depth (m)	2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5	
Analyses	Unit																				
pH - Water	pH units	7.58	L.Alk	8.42	M.Alk	7.18	Neutral	7.82	L.Alk	6.53	L.Acid	8.32	M.Alk	6.54	L.Acid	6.11	L.Acid	6.48	L.Acid	5.59	H.Acid
Electrical Conductivity	dS/m	0.10	L.Sal	0.18	M.Sal	0.25	M.Sal	0.34	H.Sal	0.03	VL.Sal	0.07	L.Sal	0.02	VL.Sal	0.07	L.Sal	0.07	L.Sal	0.09	L.Sal
	Lab No	220725-134		220725-135		220725-136		220725-138		220725-139		220725-140		220725-142		220725-143		220725-144		220725-146	
	Sample ID	SRM_51		SRM_51		SRM_51		SRM_73		SRM_73		SRM_73		SRM_135		SRM_135		SRM_135		SRM_41	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	8.79	H.Alk	8.77	H.Alk	7.21	Neutral	7.11	Neutral	6.97	Neutral	7.22	Neutral	7.45	L.Alk	8.13	M.Alk	7.13	Neutral	6.96	Neutral
Electrical Conductivity	dS/m	0.06	VL.Sal	0.04	VL.Sal	0.19	M.Sal	0.02	VL.Sal	0.02	VL.Sal	0.06	VL.Sal	0.06	VL.Sal	0.03	VL.Sal	0.09	L.Sal	0.02	VL.Sal
	Lab No	220725-147		220725-148		220725-158		220725-159		220725-160		220725-170		220725-171		220725-172		220725-174		220725-175	
	Sample ID	SRM_41		SRM_41		SRM_13		SRM_13		SRM_13		SRM_160		SRM_160		SRM_160		SRM_70		SRM_70	
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5	
Analyses	Unit																				
pH - Water	pH units	6.12	L.Acid	6.00	M.Acid	7.06	Neutral	7.11	Neutral	7.05	Neutral	6.10	L.Acid	6.23	L.Acid	6.28	L.Acid	5.67	M.Acid	5.87	M.Acid
Electrical Conductivity	dS/m	0.08	L.Sal	0.10	L.Sal	0.21	M.Sal	0.14	L.Sal	0.15	M.Sal	0.07	L.Sal	0.11	L.Sal	0.13	L.Sal	0.06	VL.Sal	0.07	L.Sal
		Highly acidic				Extremely alkaline						High salinity									

	Highly acidic		Extremely alkaline		High salinity
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Table B6: Laboratory analysis data for discrete heavy loam and clay topsoils. Part 2 of 2.

TABLE B8. Laboratory Results ALL SITES																					
	Lab No	220725-176	220725-178	220725-179	220725-180	220725-190	220725-191	220725-192	220725-194	220725-195	220725-196										
	Sample ID	SRM_70	SRM_176	SRM_176	SRM_176	SRM_129a	SRM_129a	SRM_129a	SRM_129b	SRM_129b	SRM_129b										
	Sample Depth (m)	2.5	0.5	1.5	2.5	0.5	1.5	2.5	0.5	1.5	2.5										
Analyses	Unit																				
pH - Water	pH units	5.38	H.Acid	5.21	H.Acid	5.64	M.Acid	5.47	H.Acid	8.02	M.Alk	7.69	L.Alk	6.85	Neutral	7.90	M.Alk	6.87	Neutral	8.63	H.Alk
Electrical Conductivity	dS/m	0.06	VL.Sal	0.05	VL.Sal	0.04	VL.Sal	0.07	L.Sal	0.07	L.Sal	0.08	L.Sal	0.06	VL.Sal	0.07	L.Sal	0.09	L.Sal	0.12	L.Sal
	Lab No	220725-198	220725-199	220725-200	220725-202	220725-203	220725-204	220725-210	220725-211	220725-212	220725-214										
	Sample ID	SRM_113	SRM_113	SRM_113	SRM_119	SRM_119	SRM_119	SRM_128	SRM_128	SRM_128	SRM_149										
	Sample Depth (m)	0.5	1.5	2.5	0.5	1.5	2.5	0.5	1.5	2.5	0.5										
Analyses	Unit																				
pH - Water	pH units	8.43	M.Alk	6.40	L.Acid	6.64	Neutral	7.86	L.Alk	7.43	L.Alk	7.22	Neutral	7.25	Neutral	7.21	Neutral	7.34	Neutral	7.26	Neutral
Electrical Conductivity	dS/m	0.04	VL.Sal	0.07	L.Sal	0.13	L.Sal	0.03	VL.Sal	0.12	L.Sal	0.11	L.Sal	0.02	VL.Sal	0.05	VL.Sal	0.05	VL.Sal	0.03	VL.Sal
	Lab No	220725-215	220725-216	220725-306	220725-307	220725-308	220725-310	220725-311	220725-312	220725-314	220725-315										
	Sample ID	SRM_149	SRM_149	SRM_10b	SRM_10b	SRM_10b	SRM_10a	SRM_10a	SRM_10a	SRM_10c	SRM_10c										
	Sample Depth (m)	1.5	2.5	0.5	1.5	2.5	0.5	1.5	2.5	0.5	1.5										
Analyses	Unit																				
pH - Water	pH units	7.34	Neutral	7.90	M.Alk	8.37	M.Alk	8.38	M.Alk	8.81	H.Alk	7.96	M.Alk	7.24	Neutral	7.77	L.Alk	8.88	H.Alk	8.29	M.Alk
Electrical Conductivity	dS/m	0.23	M.Sal	0.33	M.Sal	0.16	M.Sal	0.20	M.Sal	0.09	L.Sal	0.04	VL.Sal	0.04	VL.Sal	0.17	M.Sal	0.08	L.Sal	0.24	M.Sal
	Lab No	220725-316	220725-318	220725-319	220725-320	220725-322	220725-323	220725-324	220725-374	220725-375	220725-376										
	Sample ID	SRM_10c	SRM_169	SRM_169	SRM_169	SRM_17	SRM_17	SRM_17	SRM_7	SRM_7	SRM_7										
	Sample Depth (m)	2.5	0.5	1.5	2.5	0.5	1.5	2.5	0.5	1.5	2.5										
Analyses	Unit																				
pH - Water	pH units	8.56	H.Alk	6.51	L.Acid	6.48	L.Acid	6.58	L.Acid	6.18	L.Acid	6.06	M.Acid	6.17	L.Acid	6.48	L.Acid	6.8	Neutral	6.59	L.Acid
Electrical Conductivity	dS/m	0.19	M.Sal	0.02	VL.Sal	0.03	VL.Sal	0.02	VL.Sal	0.10	L.Sal	0.10	L.Sal	0.12	L.Sal	0.05	VL.Sal	0.03	VL.Sal	0.31	M.Sal
		Highly acidic				Extremely alkaline															

Table B7: Laboratory analysis data for discrete cracking clay topsoils.

TABLE B9. Laboratory Results ALL SITES																					
	Lab No	220725-154		220725-155		220725-156		220725-162		220725-163		220725-164		220725-166		220725-167		220725-168		220725-218	
	Sample ID	SRM_58		SRM_58		SRM_58		SRM_131		SRM_131		SRM_131		SRM_178		SRM_178		SRM_178		SRM_133	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	7.41	L.Alk	8.32	M.Alk	7.83	L.Alk	8.58	H.Alk	7.60	L.Alk	6.88	Neutral	6.97	Neutral	6.63	Neutral	7.18	Neutral	8.11	M.Alk
Electrical Conductivity	dS/m	0.30	M.Sal	0.39	H.Sal	0.17	M.Sal	0.25	M.Sal	0.26	M.Sal	0.27	M.Sal	0.45	H.Sal	0.57	H.Sal	0.58	H.Sal	0.14	L.Sal
	Lab No	220725-219		220725-220		220725-242		220725-243		220725-244		220725-246		220725-247		220725-248		220725-250		220725-251	
	Sample ID	SRM_133		SRM_133		SRM_21b		SRM_21b		SRM_21b		SRM_21a		SRM_21a		SRM_21a		SRM_144b		SRM_144b	
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5	
Analyses	Unit																				
pH - Water	pH units	8.13	L.Acid	8.41	M.Alk	7.35	Neutral	7.53	L.Alk	7.50	L.Alk	8.86	H.Alk	8.85	H.Alk	8.89	H.Alk	8.58	H.Alk	8.83	H.Alk
Electrical Conductivity	dS/m	0.19	L.Sal	0.26	M.Sal	0.15	M.Sal	0.15	M.Sal	0.14	L.Sal	0.13	L.Sal	0.18	M.Sal	0.17	M.Sal	0.13	L.Sal	0.16	M.Sal
	Lab No	220725-252		220725-254		220725-255		220725-256		220725-258		220725-259		220725-260		220725-262		220725-263		220725-264	
	Sample ID	SRM_144b		SRM_144a		SRM_144a		SRM_144a		SRM_163d		SRM_163d		SRM_163d		SRM_163b		SRM_163b		SRM_163b	
	Sample Depth (m)	2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5	
Analyses	Unit																				
pH - Water	pH units	8.69	H.Alk	8.76	H.Alk	8.97	H.Alk	8.97	H.Alk	7.89	L.Alk	8.87	H.Alk	8.32	M.Alk	8.58	H.Alk	8.96	H.Alk	8.43	M.Alk
Electrical Conductivity	dS/m	0.19	M.Sal	0.14	L.Sal	0.21	M.Sal	0.19	M.Sal	0.16	M.Sal	0.22	M.Sal	0.34	H.Sal	0.26	M.Sal	0.19	M.Sal	0.31	M.Sal
	Lab No	220725-266		220725-267		220725-268		220725-270		220725-271		220725-272		220725-274		220725-275		220725-276		220725-278	
	Sample ID	SRM_163a		SRM_163a		SRM_163a		SRM_45		SRM_45		SRM_45		SRM_142		SRM_142		SRM_142		SRM_123	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	7.90	M.Alk	8.89	H.Alk	8.49	M.Alk	8.7	H.Alk	8.44	M.Alk	8.47	M.Alk	8.91	H.Alk	9.13	E.Alk	9.05	E.Alk	8.70	H.Alk
Electrical Conductivity	dS/m	0.14	L.Sal	0.21	M.Sal	0.30	M.Sal	0.14	L.Sal	0.16	M.Sal	0.16	M.Sal	0.48	H.Sal	0.33	M.Sal	0.38	H.Sal	0.12	L.Sal
	Lab No	220725-279		220725-280		220725-282		220725-283		220725-284		220725-286		220725-287		220725-288		220725-290		220725-291	
	Sample ID	SRM_123		SRM_123		SRM_64		SRM_64		SRM_64		SRM_134		SRM_134		SRM_134		SRM_145		SRM_145	
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5	
Analyses	Unit																				
pH - Water	pH units	8.40	M.Alk	8.53	H.Alk	8.39	M.Alk	8.16	M.Alk	8.26	M.Alk	7.99	M.Alk	8.17	M.Alk	8.09	M.Alk	8.86	H.Alk	8.49	M.Alk
Electrical Conductivity	dS/m	0.20	M.Sal	0.18	M.Sal	0.12	L.Sal	0.13	L.Sal	0.12	L.Sal	0.23	M.Sal	0.20	M.Sal	0.18	M.Sal	0.22	M.Sal	0.28	M.Sal
	Lab No	220725-292		220725-294		220725-295		220725-296		220725-302		220725-303		220725-304		220725-326		220725-327		220725-328	
	Sample ID	SRM_145		SRM_154		SRM_154		SRM_154		SRM_148		SRM_148		SRM_148		SRM_52		SRM_52		SRM_52	
	Sample Depth (m)	2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5	
Analyses	Unit																				
pH - Water	pH units	8.57	H.Alk	8.11	M.Alk	8.14	M.Alk	7.97	M.Alk	8.51	H.Alk	8.22	M.Alk	8.52	H.Alk	8.98	H.Alk	7.53	L.Alk	8.25	M.Alk
Electrical Conductivity	dS/m	0.26	M.Sal	0.28	M.Sal	0.25	M.Sal	0.24	M.Sal	0.35	H.Sal	0.13	L.Sal	0.30	M.Sal	0.20	M.Sal	0.31	M.Sal	0.29	M.Sal
	Lab No	220725-330		220725-331		220725-332		220725-334		220725-335		220725-336		220725-338		220725-339		220725-340		220725-342	
	Sample ID	SRM_139		SRM_139		SRM_139		SRM_152a		SRM_152a		SRM_152a		SRM_152b		SRM_152b		SRM_152b		SRM_152c	
	Sample Depth (m)	0.5		1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5		0.5	
Analyses	Unit																				
pH - Water	pH units	8.81	H.Alk	8.49	M.Alk	8.50	H.Alk	8.65	H.Alk	8.46	M.Alk	8.62	H.Alk	9.02	E.Alk	8.68	H.Alk	8.54	H.Alk	8.86	H.Alk
Electrical Conductivity	dS/m	0.33	M.Sal	0.3	M.Sal	0.23	M.Sal	0.25	M.Sal	0.21	M.Sal	0.21	M.Sal	0.29	M.Sal	0.33	M.Sal	0.36	H.Sal	0.24	M.Sal
	Lab No	220725-343		220725-344		220725-346		220725-347		220725-348		220725-350		220725-351		220725-352					
	Sample ID	SRM_152c		SRM_152c		SRM_152g		SRM_152g		SRM_152g		SRM_153		SRM_153		SRM_153					
	Sample Depth (m)	1.5		2.5		0.5		1.5		2.5		0.5		1.5		2.5					
Analyses	Unit																				
pH - Water	pH units	8.43	M.Alk	8.49	M.Alk	7.62	L.Alk	8.62	H.Alk	8.62	H.Alk	8.31	M.Alk	7.87	L.Alk	7.89	L.Alk				
Electrical Conductivity	dS/m	0.25	M.Sal	0.14	L.Sal	0.09	L.Sal	0.29	M.Sal	0.26	M.Sal	0.14	L.Sal	0.13	L.Sal	0.12	L.Sal				

	Highly acidic		Extremely alkaline		High salinity
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Daunia Mine

Community Consultation

Plan

Progressive Rehabilitation and Closure Plan

7 June 2023



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Review tracker

Version	Date	Author	Reviewers
Draft V.1	27 March 2023	Dee Elliott	Trudy Mazucco Renee Eaton Zoe Kyriazis
Draft V.2	10 April 2023	Dee Elliott	Jasmine Cadd Jennifer Leach Craig Lockhart Melissa Millward Brett Garner
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Terms and abbreviations

Abbreviation	Term/Definition
BBAC	Barada Barna Aboriginal Corporation
BMA	BHP Mitsubishi Alliance
CCP	Community consultation plan, required to be submitted with the PRC plan
CHPP	Coal handling and processing plant
Consultation	Community consultation is a key component of the PRCP and is intended to ensure that anyone impacted by proposed rehabilitation and closure activities at the site has an opportunity to provide input to the planning process (Guideline, DES, 2019).
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DES	Department of Environment and Science. DES is responsible for assessing PRCPs and schedules
DNM	Daunia Mine
DIDO	Drive-In Drive-Out
DoR	Department of Resources
EA	Environmental Authority
EP Act	Environmental Protection Act 1994 (Qld)
EPC	Exploration Permit Coal
EIS	Environmental Impact Statement – primary approval document for major projects under the State Development and Public Organisations Act 1971 and EP Act 1994
FIFO	Fly-In Fly-Out
GM	General Manager
IAP2	International Association for Public Participation
ICMM	International Council for Mining and Metals
LOA	Life-of-Asset
LOD	Land outcomes document
MERCP Act	Mineral and Energy Resources (Common Provisions) Act 2014
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018 (Qld)
MIA	Mine Industrial Area
ML	Mining Lease
Mtpa	Million tonnes per annum
NPM	Norwich Park Mine
NUMA	Non-use management area - means an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended. Land is in a stable condition if— (a) the land is safe and structurally stable; and (b) there is no environmental harm being caused by anything on or in the land; and (c) the land can sustain a post-mining land use
OOPD	Out-of-pit spoil dumps
PDM	Peak Downs Mine
PMLU	Post-mining land use – means the purpose for which the land will be used after all relevant activities for the PRC plan carried out on the land have ended
PRCP/s	Progressive rehabilitation and closure plan - PRCPs must include a detailed description of how and where mining activities will be carried out, how consultation was undertaken and considered in development of a PRCP and any risks of not being able to rehabilitate the land to a stable condition.
QR	Queensland Rail
RMI	Red Mountain Infrastructure
ROM	Run-of-Mine
SEMLP	Saraji East Mining Lease Project
SSM	Saraji South Mine
STAC	Smart Transformation Advisory Council, a BHP-funded community engagement program in Moranbah and Dysart

Abbreviation	Term/Definition
TLF	Train load-out facility
TSF HRSIA	Tailings Storage Facilities Human Rights and Social Impact Assessment

1 Introduction

This document represents the Community Consultation Plan (CCP) to be delivered as part of the Daunia Mine (DNM) Progressive Rehabilitation and Closure Plan (PRCP). It includes:

- community consultation requirements for PRC planning;
- the objectives and desired outcomes for community consultation in PRC planning for DNM;
- the consultation process and program, including proposed frequency of consultation;
- information to be released for community consultation; and
- how community feedback will be considered in PRC plan updates.

This CCP has been compiled by Elliott Whiteing, with community consultation assistance from BHP Mitsubishi Alliance (BMA) team members. Implementation of the consultation requirements as part of ongoing rehabilitation and closure planning for the site will continue to be led by the Corporate Affairs team and the site, with support from the BMA Closure Planning team.

2 Community consultation requirements

2.1 DNM context

DNM, operated by BMA, is an open cut hard coking coal strip mine located in the Bowen Basin, Queensland. DNM is located approximately 20 km east of Moranbah and 150 km south-west of Mackay.

DNM operates under EA EPML00561913 (30 June 2022), with operations commencing in 2013.

Mining activities occur across various pits within the mining leases (MLs) ML1781 (Daunia) and ML70115 (Daunia East). ML70116 (Red Mountain) is situated to the west of the mining pits and includes the DNM coal handling and processing plant (CHPP), New Chum Creek and a rail corridor.

Associated processing and train load-out (TLO) infrastructure for DNM is located on the adjacent Stanmore Coal-owned Red Mountain Infrastructure (RMI) site, within ML70485 (New Chum Creek).

Mining activities at DNM involve the removal and stockpiling of topsoil, drilling and blasting of overburden and interburden, mining of overburden and interburden by truck and shovel fleets, and mining of the coal by truck and shovel fleets. The majority of the overburden and interburden is placed in the void of the previous strips. Coal is hauled from the pits to the CHPP run-of-mine (ROM) area, or to designated stockpiles. The coal is processed at the CHPP and a conveyor transfers the product coal to the TLO at RMI. Fine rejects from the CHPP are dewatered via belt press filters. The fine and coarse rejects are hauled and co-disposed within the spoil dumps. Product coal is transported by rail to the Hay Point Coal Terminal for export.

Current approved areas are planned to be mined until 2051. The timing of decommissioning and removal of the infrastructure within RMI's ML70485 is based on the proposed timing of the adjacent Poitrel Mine operation. However, the timing for decommissioning and removal of the conveyor from DNM, TLO facilities (and associated services to operate) and rail line, is based on the proposed completion of DNM (2051).

A portion of land within DNM's mining areas is owned by BMA, and other land holdings within the MLs include:

- freehold land within the north portion of ML1781, which is owned by J.D. and J.L. Lloyd;
- freehold land within ML70116 which is owned by B.A. Nielsen, and used by the DNM MIA;
- freehold land within the southern portion of ML1781 which is owned by A.G.H. Williams;
- a nominated access area on freehold land that is owned by D.J. and J.E. Deguara, to the east of ML70115;

- sections of the Norwich Park Branch Railway (operated by Aurizon Holdings on land owned by Queensland Rail (QR) and held as Lands Lease) in the northeast section of ML1781 and within ML70116;
- a small area of land owned by Stanmore Coal Pty Ltd within ML1781 (adjacent to the Norwich Park Branch Railway); and
- an unnamed road reserve owned by Isaac Regional Council (IRC) which transects ML1781.

Land owned by K.W. and M.M. Flohr to the west of ML70116 accommodates an access road to RMI.

DNM's land ownership is shown in Figure 1.

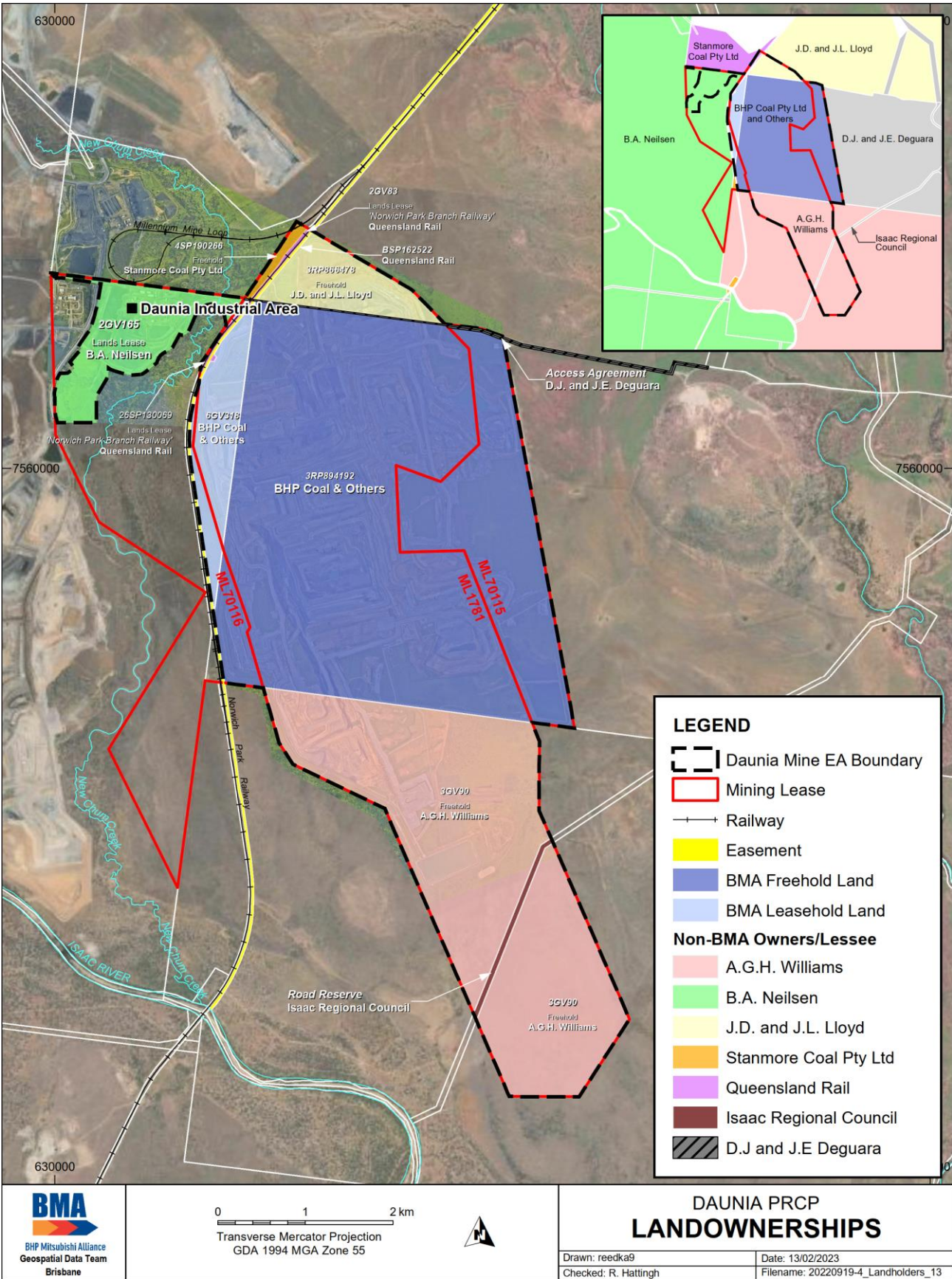


Figure 1: DNM land ownership

2.2 Regulatory requirements

2.2.1 PRCP context

DNM's PRCP - and therefore this CCP - has been prepared under the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) transitional arrangements.

A PRCP must be submitted under the MERFP Act as part of an application for an EA for a new mining activity relating to a mining lease, and when submitting an application for a Major EA amendment. The MERFP Act makes allowance for transitional provisions for existing mines, such as DNM, which includes providing a specified date by which a PRCP must be developed and submitted to the Department of Environment and Science (DES) for approval. The PRCP for DNM is required for submission to DES by 1 July 2023.

A PRCP consists of two parts: a PRC Plan and PRCP Schedule. The PRC Plan must include the information required under section 126C of the EP Act and is to provide evidence and justification to support the development of the proposed PRCP Schedule. The PRCP Schedule will include maps of rehabilitation and closure outcomes for the site and tables of time-based milestones.

The intent of the PRCP is to specify:

- site rehabilitation commitments, including the amount, type, location and time in which rehabilitation activities are to be completed; and
- mining activities, including duration, post-mining land uses and how rehabilitation will be carried out.

Transitional PRCPs are required to meet the legislative requirements in section 126C(1)(c) of the EP Act, including a community consultation plan, regardless of whether the site has an existing EA.

2.2.2 Consultation context

Environmental Protection Act 1994 (EP Act) section 126C(c) requires that, in addition to a proposed PRCP Schedule and a detailed description of how and where the relevant activities are to be carried out, the PRCP must include:

- details of the consultation undertaken by the applicant in developing the proposed PRCP; and
- details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.

The DES *Guideline - Progressive rehabilitation and closure plans* (DES, 2019) (PRCP Guideline) provides that 'community consultation is a key component of the PRC plan and is intended to ensure that anyone impacted by proposed rehabilitation and closure activities at the site has an opportunity to provide input to the planning process'. The DES Guideline requires that the applicant must attempt to consult all relevant members of the community, noting that 'the community may include, but are not limited to:

- affected landholders (such as underlying and adjoining land holders, and holders of land necessary for access to the land to which the proposed PRC plan relates);
- Traditional Owners;
- Local government; and
- local community groups'.

The Queensland Government's *Information sheet ESR/2019/5101 Version 1: Community consultation for Progressive Rehabilitation and Closure Plan (November 2021)* states that community members to be included in consultation must have a genuine, demonstrable and legitimate interest in:

- the land where the activity will occur;
- the land adjacent to where the activity will occur; or
- the land/amenities surrounding where the activity will occur that are likely to be impacted by the activity.

Genuine interest may include direct impact interest (e.g. underlying and adjacent land holders), cultural interest (e.g. Traditional Owners), land use interest (e.g. overlapping tenure holders, or local government), or heritage, environmental, recreational or health interests (e.g. state or local government or relevant community groups).

Under Section 126C(1)(d) of the EP Act, a PRCP is required to state how the PMLU is consistent with the outcomes of consultation with the community (DES, 2019). Where there are land outcomes identified in a land outcome document (LOD) the applicant must include the details of any previous community consultation undertaken (see Section 3.3).

2.3 Community Consultation Plan

A PRC plan must include details of the consultation undertaken by the applicant in developing the proposed PRC plan. This includes previous rehabilitation-related consultation undertaken as part of existing EA approvals (see Section 3), as well as the outcomes of that consultation (i.e. how stakeholder inputs have informed the outcomes stated in the PRC Plan, as described in the Community Consultation Register which is to be submitted as part of the PRC Plan).

In order to comply with section 126C(1)(c)(iv) of the EP Act, the PRC plan must include a CCP detailing how ongoing consultation will be undertaken in relation to the rehabilitation to be carried out under the PRC Plan. The CCP must include details of:

- the objectives for community consultation;
- engagement type;
- proposed consultation frequency;
- what information will be released for community consultation; and
- how feedback/comments will be considered.

The DES *PRCP Guideline* notes that ongoing community consultation is expected to continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community. Consultation is required prior to any PRC plan schedule amendments that are likely to impact the community, and the consultation register needs to be updated when this consultation is undertaken.

3 Consultation on DNM's Transitional PRC plan

3.1 Stakeholder analysis

This section summarises stakeholders considered to have a genuine interest in DNM's PRC planning. As detailed in Table 1, they include:

- Barada Barna people as the Traditional Owners;
- landholders whose land is within or adjacent to the DNM MLs;
- Isaac Regional Council (IRC), as the local government;
- the owners of utility assets within DNM's MLs;
- DNM's workforce;
- the owners of nearby mining projects and operations;
- the owners of adjacent petroleum tenements;
- local residents, businesses, and community groups and organisations; and
- relevant State departments.

Table 1: Stakeholders identified as having a genuine interest in DNM PRC planning

Stakeholder	Existing BMA relationship	Potential areas of interest
Traditional Owners		
Barada Barna Peoples, represented by BBAC	- BMA has a constructive working relationship with Barada Barna Peoples and meets with them regularly. - Barada Barna Peoples' Native Title to areas of land within the Isaac, Central Highlands and Mackay LGAs was determined by the Native Title Tribunal in June 2016. - BMA reviewed its Cultural Heritage Management Plans (CHMPs) in 2016 following determination of the BBAC's Native Title claim. BMA has also undertaken negotiations with the Barada Barna People on a comprehensive Indigenous Land Use Agreement (ILUA). DNM will fall within the proposed agreement area.	- Aspirations around rehabilitation and potential commercial opportunities as a PMLU - How operational management and/or rehabilitation could contribute to future use of the areas - Recognition and management of cultural heritage impacts - Native Title and land acquisition interests - PMLUs, NUMAs and landform/landscape - Future access to and ownership of land - Environmental management/stewardship - Employment and business opportunities in rehabilitation, environmental management and monitoring
Underlying and adjacent landowners		
Owners of: - Mavis Downs (underlying) - Winchester Downs/Poitrel (underlying) - Olive Downs (underlying) - Moorvale/Daunia (adjacent) - Wotonga (nearby)	BMA has constructive working relationships, engaging on an as-needs basis with underlying and adjacent property owners, e.g. regarding agistment licenses and access agreements.	- Environmental management/stewardship - PMLU, NUMAs and closure landforms - PRCP Schedule - Future access to and ownership of land - Water usage, quality and access to groundwater and surface water (e.g. water allocations, water pipelines, etc.) - Potential impacts on land, water, property and future business value relating to PMLUs, NUMAs and timing of impacts
Utility owners		
Corporations and Government agencies: - IRC (road reserve) - Queensland Rail (rail)	BMA has constructive working relationships and engages with utility owners and easement holders	- Impact on assets/asset value - Remediation of impacts on assets - Any service disruptions and mitigations

Stakeholder	Existing BMA relationship	Potential areas of interest
- Aurizon (rail) - Ergon Energy (power supply)	as required (issue-specific or transactional engagement). This includes engagement on: - Sections of the Norwich Park Branch Railway (owned by QR and operated by Aurizon), located within ML 1781 and within ML 70116. - The TLO and rail loop, which are owned by QR and operated by Aurizon, located within the RMI ML 70312 (owned by Stanmore Coal Pty Ltd.) - An unnamed road reserve owned by IRC, which transects ML 1781, and is subject to a Compensation Agreement with IRC. - Ergon Energy powerlines within ML 1781 and ML 70116.	- Crossing/interface agreements - Timeline for decommissioning utilities - Cost of decommissioning utilities.
BMA operations		
DNM workforce	BMA maintains ongoing communication with its workforce through 'toolbox' talks and a bi-monthly newsletter, Coal Connect.	- Timing of closure - Rehabilitation obligations - Employment continuity
Adjoining/nearby resource interests		
Mining interests: - RMI and Poitrel Mine (Stanmore) - Millennium Coal (Stanmore and Metres) - Moorvale Mine (Peabody Energy) - Olive Downs (Pembroke Resources) - Winchester South (Whitehaven Coal) - Isaac River Project (Coking Coal One Pty. Ltd. / Bowen Coking Coal Ltd)	BMA liaises with adjoining and nearby mining and resource interests on an as-needed basis, in relation to <i>Mineral and Energy Resources (Common Provisions) Act 2014</i> (Queensland) (MERCPA) requirements for petroleum overlap activities, and as part of industry associations and research partnerships.	- Future land use and ownership - Collaboration on good industry rehabilitation and closure practices - Cumulative impacts and opportunities of mine closures - Cessation of use of DNM CHPP, conveyor, and TLO

Stakeholder	Existing BMA relationship	Potential areas of interest
Petroleum (gas) tenements: Arrow Energy (CH4 Pty Ltd)		
Local residents and businesses		
Moranbah and Dysart community members	BMA utilises a wide range of communication, consultation and social investment strategies to develop and maintain relationships with Bowen Basin communities.	- Local employment and business opportunities, and future jobs - Opportunities to participate in supply chain (e.g. environmental management, rehabilitation) - With closure, loss of jobs and supply opportunities, and changes to demands for services (e.g. childcare and schools) - Potential for cumulative job losses if other mines close in a similar timeframe - Economic transformation (towards post-mining), and industry diversification - Educational and childcare opportunities - Wellbeing and health/healthcare provision - Economic and community sustainability - Environmental management - PMLUs and NUMAs - Community and economic transformation
Moranbah and Dysart Smart Transformation Advisory Council (STAC) members	The Moranbah and Dysart STACs are sponsored by BMA and represent a broad cross-section of community and business interests. The STACs meet approximately every two months.	
Local Government		
Isaac Regional Council	BMA has a long established and cooperative relationship with IRC. BMA and IRC meet at least twice each year. During 2022, BMA had two briefings with Council regarding PRC planning requirements (May 2022 and November 2022). These updates will continue.	- Local employment - Effects on Council services and infrastructure - Environmental management/stewardship - Rehabilitation progress and PRCP Schedule - PMLUs, NUMAs and closure landforms - Management of closure impacts on employment and businesses - Alignment of rehabilitation plans with local and regional planning goals, and regional transformation/diversification - Economic transformation (towards post-mining) and community sustainability

Stakeholder	Existing BMA relationship	Potential areas of interest
		Cumulative impacts of closure of multiple mining assets in a similar timeframe (e.g. job and population losses)
Government departments		
Queensland Government - DoR - Office of the Minister, Deputy Director-General Georesources, Acting Director Native Title Services and Coal Hub, Rockhampton, Executive Director, Minerals and Coal - DES - Office of the Minister, MERPF Act implementation team	BMA has constructive working relationships with DoR and DES. DoR's Deputy Director-General Georesources has asked to be kept informed on PRC planning. Consultation on DNM's PRC Plan is not expected to be required by other State Government stakeholders, but they are briefed as necessary. BHP Corporate Affairs conducts as-needed engagement with Ministers and Members of Parliament.	- Legislative compliance - Resource development - Employment and growth opportunities - Public interest - Environmental management - Economic transformation (towards post-mining) - Financial assurance - Environmental risk management - Future PMLUs, NUMAs and closure landforms - Company responses to stakeholder views - Industry best practice, and innovative future-looking approaches

3.2 PRC Plan consultation

3.2.1 Pre-PRC plan development

DNM's construction commenced in 2011 and operations commenced in September 2013. An EIS was prepared during 2008-2009 and approved by the Coordinator-General in October 2009. An Environmental Management Plan was submitted as part of the EIS process, noting the following in Section 2.3 Mine Rehabilitation:

"The proposed post-mine land use for disturbed areas is a mosaic of self-sustaining vegetation communities and grazing land using appropriate native tree, shrub and grass species, and improved pasture species as appropriate. The criteria for achieving self-sustaining final landforms will be developed during the operation..."

Since the original EA approval, the following rehabilitation and closure-related engagement has also taken place for DNM:

- during 2018, BMA engaged with DES on the PMLUs and associated Acceptance Criteria within the EA. These PMLUs and Acceptance Criteria were included in the 18 November 2019 DNM EA amendment, reflected as Table E1 (Rehabilitation Requirements);
- since 2021, BMA has been providing regular PRC planning briefings to the IRC as part of bi-annual and special purpose meetings. This has included briefing the IRC on the commencement of the DNM PRCP process (November 2022 and January 2023); and
- since 2021, BMA has also undertaken ongoing consultation with the Barada Barna Aboriginal Corporation (BBAC), who represent the Barada Barna People as Traditional Owners. This has included various rehabilitation-related aspects. BBAC's feedback has included a request to work together with BMA to understand how they can get involved in rehabilitation execution activities over time, as guided by the PRCP Schedules to be submitted for approval.

Agreements which are in place with respect to DNM include:

- Compensation Agreement in place for surface rights, as well as an agistment licence agreement for grazing;
- Two separate Compensation Agreements are in place for surface rights with two additional landowners;
- Stanmore hold a Compensation Agreement with BHP Coal and Others covering BMA leased land;
- BHP Coal and Others hold a Compensation Agreement with BHP Coal Pty Ltd covering BMA freehold land;
- Two Access Agreements for nominated access rights is in place with one adjacent landowner to allow access to DNM and to RMI; and
- a Compensation Agreement with IRC relating to an unnamed road reserve which transects ML 1781.

BMA continues to engage with neighbouring landholders on land management and lease/license conditions, and on operational matters, as required.

3.2.2 Part of PRC plan development

Consultation undertaken as part of PRC plan preparation for DNM included letters via email to:

- IRC;
- BBAC;
- underlying owners of land within DNM's MLs;
- adjacent and nearby landowners who accommodate nominated access routes to DNM and RMI;
- QR, Aurizon and Ergon Energy as the owners of utilities within DNM;
- Smart Transformation Advisory Council (STAC) members representing community members, groups and businesses in Moranbah and Dysart;
- Authorised Holder Representatives of adjacent mining operations and petroleum licenses; and

- DoR.

The following information was provided through letters to stakeholders:

- DNM location, approved activities and production;
- requirements and timing for PRC plan development;
- DNM Life-of-Asset (LOA);
- rehabilitation requirements and timing;
- approved PMLUs and NUMAs;
- publication of rehabilitation schedule as part of PRC plan;
- commitment to future engagement regarding PRC Planning for DNM; and
- contact details for the relevant BMA team (e.g. for landholders, the Land Management team) for further information, discussion or feedback.

Information was also provided to BMA employees and community and groups through the online Coal Connect newsletter (a weekly newsletter to all internal coal personnel) and the Community Connect newsletter which is a hard copy and electronic bi-monthly newsletter distributed to more than 15,000 community members' letterboxes throughout the Bowen Basin. This included:

- sustainability and progressive rehabilitation as a key focus;
- PRC plan requirements and purpose;
- timing for PRC plan development;
- commitment to ongoing engagement; and
- contacts for further information.

The results of engagement are shown in the Community Consultation Register submitted as part of the PRC plan, as outlined below.

3.3 Community Consultation Register

A Community Consultation Register has been provided as part of the PRC plan in compliance with section 126C(1)(c)(iii) of the EP Act and includes:

- identification of each community member/stakeholder;
- all recorded previous engagements with the community;
- consultation date(s);
- description of consultation type (letter, meetings etc.);
- information provided to the community;
- issues raised/discussed;
- how issues raised and the outcomes of engagement have been considered in decision making; and
- commitments made by BMA.

The community consultation register will be a live instrument for recording future consultation on DNM's PRC Plan.

4 Future, ongoing PRC Plan-related community consultation

4.1 Existing consultation mechanisms

Communities and stakeholders within the Isaac LGA are experiencing multiple demands for their participation in PRC planning. To minimise additional demands on communities and stakeholders, BMA will utilise its existing community consultation mechanisms for PRC consultation wherever possible, as described in Table 2.

Table 2: Using existing BMA consultation mechanisms

Mechanism	Mechanism and frequency
Landholder meetings	BMA's Land Management team engages regularly with underlying landowners and other landholders (owners, lessees and licence holders) adjacent to DNM's MLs. Consultation with underlying and landholders will be conducted throughout the life of the PRC plan, through regular meetings on-site or Moranbah or Dysart.
IRC meetings	Bi-annual meetings are held with IRC. The meetings have a fluid agenda based on key topics/issues at the time. As a minimum, updates on PRC Planning will be offered as an agenda item for bi-annual briefings, by agreement with Council.
Traditional Owner meetings	Bi-monthly meetings are generally held with Barada Barna People. The Indigenous Engagement and Cultural Heritage team will be provided with information to support consultation with Traditional Owners, which may include site-specific or broader PRC planning issues.
Community Connect newsletter	This monthly newsletter is distributed to more than 15,000 letterboxes throughout the Bowen Basin and will include updates on PRC planning.
Coal Connect	This weekly electronic employee newsletter will provide updates on PRC planning as relevant.

4.2 PRCP consultation program

Once the DNM transitional PRCP has been approved, consultation as part of implementing the DNM PRC Plan will be informed by the program documented in Table 3, which includes:

- consultation objectives;
- community members addressed by each objective;
- engagement type; and
- proposed frequency of consultation.

BMA will monitor progress against these objectives as part of its regular reviews of consultation commitments and outcomes.

Section 5 describes the information to be released to the community, and Section 6 describes how feedback or comments will be considered.

Table 3: Consultation program for PRC plan implementation

Consultation objective	1. To engage key stakeholders in identifying community objectives and aspirations for post-mining land use and landform, and social value opportunities to be considered in PRC planning	
Stakeholders	Engagement type	Proposed consultation frequency
- Underlying landowners - Adjacent landowner - Barada Barna Peoples (BBAC) - IRC - Moranbah and Dysart community members	Advise underlying and adjacent landowners, BBAC and IRC in writing when the PRC plan is approved.	Once-off
	Communicate with underlying landowners during the terms of BMA's leases on their land, and seek their inputs on DNM's PRCP schedule and approved PMLUs and NUMAs.	As part of future updates and/or amendments of the SRM PRC Plan
	- Meet with underlying landowners, BBAC and IRC to provide an update on the PRC plan and progress with rehabilitation, and invite their inputs and feedback on: - the approved PMLUs, NUMAs and post-mining landforms, including any particular values or opportunities in specific disturbed areas - rehabilitation methods which would optimise future woodland habitat and/or grazing opportunities, and potential land management requirements - shared value initiatives, e.g. infrastructure retention, capacity building, environmental management, or research partnerships - rehabilitation methods, schedule and progress towards milestones.	As requested, or as agreed with representatives
	- As part of bi-annual meetings with IRC, and addressing BMA's portfolio rather than individual assets: - provide an update on the status of the PRC plans and rehabilitation, and forecast upcoming PRC plan consultation for BMA assets - seek to understand Council's strategic analysis and planning for Isaac LGA and the DNM mining area - share information to support understanding of challenges, opportunities and community aspirations of relevance to mine closure and rehabilitation - co-operate if advocacy is required to achieve better PRC planning outcomes in the Isaac LGA - build in consideration of the outcomes of Smart Transformation's projects as relevant, and the IRC's intended transformation approach	Bi-annually, or as agreed with IRC
	Participate in Council, community or industry-led initiatives including research partnerships which aim to harness social value from mine closure and rehabilitation planning, and/or work towards economic transformation/transition.	As invited

Consultation objective	1. To engage key stakeholders in identifying community objectives and aspirations for post-mining land use and landform, and social value opportunities to be considered in PRC planning	
Stakeholders	Engagement type	Proposed consultation frequency
	- In cooperation with BBAC and other First Nations within Isaac LGA, and on a portfolio-wide basis: - communicate the pipeline of opportunities relating to rehabilitation work and land management - develop a shared understanding of business capabilities relevant to closure and rehabilitation works - plan and implement an Indigenous business capability development program to match rehabilitation opportunities if this is required.	Ongoing engagement process
	Via the Moranbah and/or Dysart STAC, and/or PRC plan-specific workshops or focus groups, seek the involvement of community members and groups in articulating community aspirations for rehabilitation, PMLUs and economic transformation.	To be supported by BMA-wide consultation, as required
	Provide community updates on DNM's PRCP if there are any substantive changes and associated PRCP Amendments required, via Community Connect	As relevant
Consultation objective:	2. To support transparent access to information about DNM's PRC planning and implementation, enabling opportunities for BMA personnel and communities within the Isaac LGA to provide feedback on rehabilitation and closure outcomes	
Stakeholders	Engagement type	Proposed consultation frequency
BMA employees and contractors	Keep the DNM workforce updated (via Coal Connect, a weekly email newsletter to personnel) if there are changes to the PRC plan.	Ongoing engagement process
Moranbah and Dysart community members and groups	Using Community Connect (BMA's bi-monthly community newsletter) and community forums such as interagency meetings, the Moranbah and Dysart STACs, partnership meetings and community and business networks, provide community updates on PRC Planning (DNM-specific as relevant, and portfolio wide).	Ongoing engagement process
BMA license holders	Write to agistment licensee/s using BMA land within DNM's MLs to advise of any substantive changes to the DNM PRC plan.	As relevant
Local businesses and BMA suppliers	Provide information about the pending closure of DNM and potential future supply opportunities as part of closure and rehabilitation to local businesses, Traditional Owner businesses and BMA suppliers via C-RES	Five years prior to decommissioning; subsequent consultation to be agreed

Consultation objective: 2. To support transparent access to information about DNM's PRC planning and implementation, enabling opportunities for BMA personnel and communities within the Isaac LGA to provide feedback on rehabilitation and closure outcomes		
Stakeholders	Engagement type	Proposed consultation frequency
Elected representatives and Government agencies	- Provide updates via letters and/or meetings on PRC Planning to: - Office of the Minister for Resources (Queensland) - Office of the Minister for Environment, Great Barrier Reef, Science and Youth Affairs (Queensland) - Shadow Minister for Resources - Shadow Minister for Environment, Great Barrier Reef, Science and Youth Affairs Resources - Member for Burdekin (Queensland Parliament) - DES PRCP Team - Director, Native Title Services and Coal Hub, Department of Resources - Deputy Director-General Georesources, Department of Resources - Assistant Secretary Assessments and Governance Branch, DCCEEW	As requested, or as agreed with representatives
Consultation objective 3. To engage with utility owners, and adjacent mining and energy tenement holders, to provide information about DNM's closure planning that supports them to manage their assets and interests		
Stakeholders	Engagement type	Proposed consultation frequency
BMA Asset General Managers	Involve internal BMA stakeholders in PRCP processes to build capacity for community consultation on PRCP issues and support effective delivery of PRC Plans.	Ongoing
Queensland Rail and Aurizon	Maintain correspondence with Queensland Rail and Aurizon regarding progressive rehabilitation activities as they affect the Norwich Park Branch Railway (operated by Aurizon Holdings on land owned by QR), and regarding the conveyor from DNM, TLO facilities (and associated services to operate) and rail line	As requested, or as agreed with representatives
- Utility owners: - IRC - Ergon Energy	- Engage with relevant utility owners to inform them of closure timelines and rehabilitation activities relevant to the land either: - Owned by Council as road reserve (IRC) - Electricity Services (Ergon)	Initiated three years prior to decommissioning
	Maintain correspondence regarding progressive rehabilitation and undertake consultation regarding crossing/interface agreements, as required if rehabilitation will affect utilities.	During the three years prior to decommissioning

Consultation objective	3. To engage with utility owners, and adjacent mining and energy tenement holders, to provide information about DNM's closure planning that supports them to manage their assets and interests	
Stakeholders	Engagement type	Proposed consultation frequency
• Stanmore – RMI, Poitrel Mine and Millennium Coal • M Res - Millennium Coal • Peabody Energy - Moorvale Mine • Pembroke Resources - Olive Downs Project • Whitehaven Coal - Winchester South • Coking Coal One Pty. Ltd. / Bowen Coking Coal Ltd - Isaac River Project Petroleum (gas) tenements: • Arrow Energy/CH4 P/L	• Engage with Stanmore regarding the schedule for cessation of use of the DNM CHPP, DNM conveyor, and TLO facilities • Write to advise adjacent and nearby resource interests if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the DNM PRC Plan. • At a business level, BHP will participate in industry and research partnerships of relevance to PRCP and rehabilitation.	Initiated three years prior to decommissioning As requested, or as agreed with representatives/mining operations
• Department of Resources	• Provide updates on PRCP to the Director Native Title Services, Coal Hub (Rockhampton) and the Deputy Director General (DoR); in writing or through regular meetings.	As requested, or as agreed with DoR representatives

5 Information to be released for community consultation

Whilst many stakeholders in the Isaac LGA and broader Mackay-Isaac-Whitsunday Region are well-educated about mining operations, there is less understanding of planning for life-of-mine, rehabilitation and closure planning. The CCP recognises the following social context:

- talk of closure planning leads to community concerns, requiring careful and consistent messaging;
- a range of companies are engaging with local stakeholders about PRC plans and other issues, representing considerable cumulative demands on stakeholders, and a coordinated, strategic approach will be required to manage consultation fatigue; and
- community members are becoming increasingly aware of climate change and the impacts of resource activities and energy policies on the environment. Accordingly, community and stakeholder expectations with regards to mine rehabilitation are expected to increase over time, and need to be continuously understood.

Information to be released for community consultation, as part of future, ongoing DNM PRC planning and implementation will include:

- the rationale and scope for PRC Planning;
- the approved activities, PMLUs and NUMAs for DNM;
- on-site activities and areas of disturbance;
- proposed rehabilitation methods, schedule and milestones;
- alignment with long-term transformation planning occurring through IRC, Regional Development Australia (RDA) and others; and
- opportunities for community consultation as part of the PRC Plan's implementation.

Communication tools could include:

- a holding statement for general enquiries;
- frequently asked questions and answers (FAQs) and a PRC planning fact sheet available to support consultation activities;
- face to face and virtual meetings; and
- updates and fact sheets about PRC planning for BMA assets through Community Connect.

6 How feedback/comments will be considered

As noted in the DES *PRCP Guideline*, in addition to the annual return requirements that relate to EAs, if a PRC plan schedule applies to the activities then the annual return must also include an evaluation of the effectiveness of the PRC plan schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates.

BMA will internally monitor and report on the progress and outcomes of progressive rehabilitation activities against rehabilitation milestones provided in the PRC Schedule. This monitoring will aim to demonstrate a successful rehabilitation trajectory towards achievement of the approved PMLU, and/or to inform corrective action where required.

As required, PRCP Schedule progress will be reported as part of annual return submissions to the DES.

Information about rehabilitation progress will also be delivered as part of the consultation methods detailed in Table 3, and feedback will be documented in PRC plan updates or amendments.

The PRC Plan Consultation Register will also be updated as community consultation activities outlined in Table 3 are completed. All stakeholder feedback recorded in the Consultation Register will be considered in framing and detailing future PRC plan amendments for DNM.

This may include feedback on, for example:

- vegetation species most suitable to the approved PMLUs;
- rehabilitation methods to protect cultural heritage and achieve optimal use for the PMLUs;
- the PRCP (rehabilitation) schedule;
- water management (e.g. availability for beneficial use as part of the PMLUs, or adjacent uses); and/or
- development of business capacity programs to equip local and Indigenous businesses for rehabilitation works.

BMA has sought IRC's views on consultation options to involve Council in future PRC plan consultation for BMA assets. BMA will utilise Council's preferred options to seek inputs on, for example, community aspirations for PMLU and social value opportunities. As all but one of BMA's mines are located within the Isaac LGA, this would include working with Council to understand BMA-wide rehabilitation objectives and the overall sequence for mine closures.

7 PRC plan CCP review

Review of the DNM PRC plan will be undertaken as legislatively required. Review and update of the CCP, incorporating community feedback to date, will be aligned to any PRC plan updates or amendments.

8 DNM PRC plan Community Consultation Register

Details of community members and previous engagement, PRC Plan development engagement and engagement outcomes are included in the following DNM Community Consultation Register.

Daunia Mine PRC Plan Community Consultation Register

COMMUNITY MEMBERS AND PREVIOUS ENGAGEMENT				PRC PLAN DEVELOPMENT ENGAGEMENT			ENGAGEMENT OUTCOMES			
Group	Stakeholder Title	Organisation/ Property	Previous engagement	Consultation type	Consultation date	Information provided	Issues raised/discussed	How issues were considered	Decisions/outcomes of engagement	BMA commitments
Traditional Owners	CEO	Barada Barna Peoples via Barada Barna Aboriginal Corporation (BBAC)	BMA has regular engagement with BBAC on a range of issues ranging from native title and cultural heritage to community and economic development.	Letter, via email	9/05/2023	DNM location, approved activities and production PRC plan requirements and timing for PRC Plan development DNM Life of Asset Rehabilitation requirements and timing Approved PMLUs and NUMAs Inclusion of rehabilitation schedule as part of PRC Plan Commitment to future engagement regarding PRC Planning for DNM Contact for further information	No specific issues raised with respect to DNM, but existing interest in opportunities to be involved in rehabilitation execution and post mining land forms.	BMA is considering the potential for involvement of Traditional Owners and Indigenous businesses in future mine rehabilitation works.	Traditional Owners' interest in environmental management and mine rehabilitation will be part of ongoing engagement with them, addressing portfolio-wide opportunities.	BMA will continue to consult with BBAC and seek their inputs on rehabilitation and PMLUs. BMA will engage with Traditional Owners and Indigenous businesses to understand business capabilities and the pipeline of opportunities that relate to rehabilitation work and land management, on a portfolio-wide basis.
	Property owner	Olive Downs	BMA has a long and constructive working relationship with the property owner, including with respect to a compensation agreement.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received. BMA's regular engagements with landowners indicate that their issues of interest include land access under current land access and lease agreements, and access to BMA land for grazing use whilst is not required for mining.	Stakeholder did not raise any issues. Landowners' interest in use of the land for grazing was considered in framing PMLUs.	Land within the MLs will continue to be available for grazing under existing agreements between BMA and landholders. Landholders and cattle will be excluded from affected areas whilst land disturbance is occurring. As disturbed land becomes available, it will be rehabilitated to a state suitable for the approved post-mining land use (PMLU) e.g. grazing, woodland, water courses, or managed as a non-use management area (NUMA).	BMA will continue to consult with landholders and seek their inputs on DNM's rehabilitation schedule and approved PMLUs.
Underlying and adjacent landholders (within 5 km)	Property owner	Mavis Downs	BMA has a constructive working relationship with the property owner, including with respect to a compensation agreement.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received. BMA's regular engagements with landowners indicate that their issues of interest include environmental management, land access under current land access and lease agreements, and access to BMA land for grazing use whilst is not required for mining.	As above	As above	As above
	Property owner/Manager	Winchester Downs, Poitrel	BMA has a long and constructive working relationship with the property owner, including with respect to a compensation agreement.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received.	As above	As above	As above
	Property owner	Daunia	BMA has a constructive working relationship with the property owner, including with respect to a compensation agreement.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received.	As above	As above	As above
	Property owner	Wotonga	BMA has a constructive working relationship with the property owner, including with respect to a compensation agreement.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received.	As above	As above	As above
	General Manager	Daunia Mine	BMA's Closure Planning Team is in regular consultation with Daunia Mine's General Manager.	Meeting to discuss PRC planning requirements and support for communication with personnel.	24/02/2023	As above, with information also provided on PRC Planning consultation requirements, and provision of supporting information to enable communication with contractors and personnel	PRC plan requirements Rehabilitation and post-mining land use Approved PMLUs Rehabilitation schedule	Agreement to ongoing engagement in PRC Planning	Ongoing cooperation between DNM and BMA's Closure Planning team	BMA will involve its asset managers in PRC planning processes, to build capacity for community engagement on PRC planning issues and support effective delivery of PRC Plans.
Daunia Mine personnel	Personnel	Daunia Mine	BMA communicates with its personnel on a continual basis through toolbox talks, emails, safety meetings, Community Connect and Coal Connect, which are regular newsletters.	Information provided for distribution through Coal Connect	16/04/2023	Progressive rehabilitation as a key focus for BMA PRC Plan requirements and purpose Timing for PRC Plan development Commitment to ongoing engagement Contact details for further information or queries.	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will keep the workforce updated as PRC Plans are implemented and revised.	BMA will keep the workforce updated if there are changes to the PRC plan, and as the PRC Plan reaches its renewal date. BMA will provide a communication channel for personnel to ask questions or contribute to discussions about PRC Planning and rehabilitation.
	Senior Advisor Community Engagement	Aurizon/Queensland Rail	Norwich Park Branch Railway is located on Lands Lease within the EA area. Engagement with QR and Aurizon is via routine correspondence on commercial and statutory issues, with meetings held as required on specific issues.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will advise Aurizon and Queensland Rail of any substantive changes to closure planning or the rehabilitation schedule as part of future PRC planning processes for DNM.	BMA will maintain engagement with Aurizon and Queensland Rail regarding its progressive rehabilitation activities as they affect QR assets, and undertake engagement regarding the decommissioning of the train load out facility/rail interface prior to its closure, in accordance with agreements between BMA and Aurizon at the time.
Utilities	CEO	Isaac Regional Council	There is an unnamed road reserve owned by IRC within ML70115.	Letter, via email	28/04/2023	DNM location, approved activities and production PRC plan requirements and timing for PRC Plan development DNM Life of Asset Rehabilitation requirements and timing Approved PMLUs and NUMAs Inclusion of rehabilitation schedule as part of PRC Plan Commitment to future engagement regarding PRC Planning for DNM Contact for further information	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will advise IRC of any substantive changes to closure planning or the rehabilitation schedule as part of future PRC planning processes for DNM.	BMA will maintain engagement with IRC regarding its progressive rehabilitation activities as they affect IRC assets.
	Property Projects Coordinator	Ergon Energy	Engagement with Ergon Energy is via routine correspondence on specific issues.	Letter, via email	29/05/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will maintain correspondence with ergon Energy regarding progressive rehabilitation activities as they affect Ergon Energy assets, and undertake consultation regarding crossing/interface agreements, if required.	BMA will advise and consult Ergon Energy regarding any impacts of the closure/rehabilitation activity that may affect Ergon Energy's asset.
	General Manager	Poitrel Mine (Stanmore)	DNM's GM consults with Poitrel Mine's GM as needed.	Letter, via email	26/04/2023	As above	No issues raised.	Stakeholders did not raise any issues.	DNM GM will continue engagement with Poitrel's GM on an as-needed basis.	BMA will continue to engage adjacent mining interests in PRC planning and associated stakeholder engagement processes.
Adjacent and nearby mining interests	SSE	Red Mountain Infrastructure (Stanmore)	DNM's GM consults with RMI's SSE as needed.	Letter, via email	26/04/2023	As above	No issues raised.	Stakeholders did not raise any issues.	DNM GM will continue engagement with RMI's SSE on an as-needed basis.	BMA will continue to engage adjacent mining interests in PRC planning and associated stakeholder engagement processes.
	Site Senior Executive	Millennium Coal Mine	Stanmore and M Res own and operate Millennium Coal Mine and RMI, to the immediate northwest. BMA has engaged with Stanmore Coal in respect to shared use of RMI.	Letter, via email	26/04/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will update Stanmore Coal on any substantive future changes to the PRC Plan.	BMA will advise Stanmore Coal if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the PRC Plan.

Daunia Mine PRC Plan Community Consultation Register

COMMUNITY MEMBERS AND PREVIOUS ENGAGEMENT				PRC PLAN DEVELOPMENT ENGAGEMENT			ENGAGEMENT OUTCOMES			
Group	Stakeholder Title	Organisation/ Property	Previous engagement	Consultation type	Consultation date	Information provided	Issues raised/discussed	How issues were considered	Decisions/outcomes of engagement	BMA commitments
	Site Senior Executive	Moorvale Mine	Moorvale Mine is located to the northeast of Daunia Mine.	Letter, via email	26/04/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will update Peabody Energy on any substantive future changes to the PRC Plan.	BMA will advise Peabody Energy if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the PRC Plan.
	Site Senior Executive	Isaac River Project	Isaac River Project (proposed by Coking Coal One Pty. Ltd. a subsidiary of Bowen Coking Coal Ltd), to the immediate east of ML 70115.	Letter, via email	26/04/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will update Coking Coal One Pty. Ltd./Bowen Coking Coal Ltd on any substantive future changes to the PRC Plan.	BMA will advise Coking Coal One Pty. Ltd./Bowen Coking Coal Ltd if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the PRC Plan.
	Site Senior Executive	Winchester South	Winchester South (proposed by Whitehaven Coal) to the south.	Letter, via email	26/04/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will update Whitehaven Coal on any substantive future changes to the PRC Plan.	BMA will advise Whitehaven Coal if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the PRC Plan.
	Operations Manager/SSE	Olive Downs Project	Pembroke Resources has approval to construct and operate the Olive Downs Project to the east of DNM. BMA has engaged Pembroke Resources as part of a previous BMA PRCP consultation process. There has been no previous engagement with respect to Daunia Mine.	Letter, via email	26/04/2023	As above	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will update Pembroke Resources on any substantive future changes to the PRC Plan.	BMA will advise Pembroke Resources if there are any substantive changes to the closure and rehabilitation schedule in future iterations of the PRC Plan.
Petroleum tenement holders	Tenement Manager/Authorised Holder Representative	CH4 Pty Ltd (Arrow Energy)	CH4 Pty Ltd (Arrow Energy) hold an Authority to Prospect and a Potential Commercial Area (for coal seam gas) which overlap with DNM's MLs. As the MLs were granted prior to the enactment of the <i>Mineral and Energy Resources (Common Provisions) Act 2014</i> , and ML 1781 also holds gaseous hydrocarbons rights, there is no requirement to notify CH4 Pty Ltd of activities within the MLs. CH4 Pty Ltd is considered as an adjacent tenement holder.	Letter, via email	28/04/2023	As above	Acknowledgement of engagement received.	Stakeholders did not raise any issues.	BMA will update Arrow/CH4 P/L on any substantive future changes to the PRC Plan.	BMA will advise Arrow/CH4 P/L of any substantive changes to closure or rehabilitation schedule as part of future PRC planning processes for DNM.
Community members and groups	Community members - Moranbah, and Isaac Region	Various	BMA conducts a range of engagement activities with community members, from one-off responses to enquiries, to regular community information processes, ongoing engagement process such as the Smart Transformation Advisory Councils, and partnerships with community organisations and industry bodies.	Inclusion of information in 'Community Connect' which is distributed to 15,000 households	16/04/2023	Progressive rehabilitation as a key focus for BMA PRC Plan requirements and purpose Timing for PRC Plan development Commitment to ongoing engagement Contact details for further information or queries.	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will provide community updates on PRC planning for DNM if there are any substantive changes or updates, and associated PRCP Amendments required to the PRC plan, via Community Connect.	BMA will provide community updates on PRC planning, and seek the involvement of community members and groups in understanding community aspirations for rehabilitation, post mining land use and economic transformation, as part of portfolio-wide engagement. BMA will involve IRC, community members and businesses in identifying social value as part of PRC planning processes. This will include identifying local capacity for involvement in rehabilitation work. BMA will participate in initiatives led by the Council, industry or local communities which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation.
Moranbah Smart Transformation Advisory Council (STAC)	Community members, and businesses, Moranbah	Various	The Moranbah Smart Transformation Advisory Council is sponsored by BMA and represents a broad cross-section of community and business interests in Moranbah.	Letter, via email	28/04/2023	DNM location, approved activities and production PRC plan requirements and timing for PRC Plan development DNM Life of Asset Rehabilitation requirements and timing Approved PMLUs and NUMAs Inclusion of rehabilitation schedule as part of PRC Plan Commitment to future engagement regarding PRC Planning for DNM Contact for further information	No feedback or enquiries were received.	Stakeholders did not raise any issues.	BMA will continue to provide community information and opportunities for feedback as part of future PRC planning processes.	Via the Moranbah Smart Transformation Advisory Council, and/or PRC plan-specific workshops or focus groups, BMA will seek the involvement of community members and groups in articulating community aspirations for rehabilitation, PMLUs and economic transformation
Local Government	Mayor	Isaac Regional Council	BMA has regular bi-annual meetings with Council, and meets with Councillors and officers as needed on specific issues. PRC planning updates are provided at each meeting. Issues raised during 2020-2022 meetings that discussed PRC planning included: - Council engagement in PRC planning for BMA assets - Cumulative consultation demands of PRC planning - Key principal is cooperation to get the best outcome for communities, industry and Council. - Interest in rehabilitation.	Letter, via email. Follow up at October 2023 IRC-BMA meeting	28/04/2023	As above	No feedback or enquiries were received.	BMA recognises the cumulative demands for Council involvement in PRC Plan engagement. Engagement processes for BMA's PRC plans will include a strategic approach to consultation with Council, to minimise demands on Council's time and maximise the value derived from consultation with Council.	IRC will require ongoing engagement regarding PRC planning for DNM and other BMA assets. PRC planning updates are provided at each meeting. BMA will also consult IRC on management plans if rehabilitation and/or closure activities would impact on IRC road assets or waste management/recycling facilities. Subsequent reviews of the CCP and community consultation for other assets' PRC Plans will consider Council's preferred options for engagement. Future engagement with Council will include discussion of rehabilitation methods and milestones.	BMA will engage with IRC to understand Council's strategic analysis and planning for Isaac LGA and the Daunia Mine project area as relevant. BMA will engage with IRC regarding any impacts on Council assets as part of the progressive rehabilitation and closure process, and will update IRC on PRC planning regularly. BMA will keep IRC updated on the PRC Planning schedule for its portfolio in the Isaac LGA. BMA will share the results of its research and industry partnership projects relevant to rehabilitation with Council at bi-annual meetings between Council and BMA. BMA will work with Council and other stakeholders in future PRC plan consultations to identify and implement social value opportunities.
	Councillors									
	CEO									
State Government	PRC Planning Team	DES	Meetings and correspondence regarding the preparation and delivery of the PRC Plan.	Pre-lodgement meetings	Various	Provision of draft PRC Plan and discussion of requirements	As per pre-lodgement meetings.	DES feedback was considered in the development of the PRC Plan including the Community Consultation Plan	The PRC plan will be completed in accordance with BMA's agreements with DES.	BMA will comply with the legislative and regulatory requirements for PRC Plans.
	Deputy Director-General Georesources	Department of Resources	BMA provides briefings on an as needed basis.	Letter via email	26/04/2023	DNM location, approved activities and production PRC plan requirements and timing for PRC Plan development DNM Life of Asset Rehabilitation requirements and timing Approved PMLUs and NUMAs Inclusion of rehabilitation schedule as part of PRC Plan Commitment to future engagement regarding PRC Planning for DNM Contact for further information	The Department of Resources appreciates the update on the PRC Plan for DNM and anticipates future updates from BMA on the plan.	The PRC Plan's Community Consultation Plan includes provision of annual updates to Department of Resources.	BMA will provide a copy of the DNM PRC plan to the DDG Georesources, and update the DDG Georesources on any future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Deputy Director General Georesources as requested
	Acting Director Native Title Services and Coal Hub, Rockhampton	Department of Resources	BMA provides briefings on an as needed basis, and meets and corresponds with Department of Resources regarding resource development commitments.	Letter via email	26/04/2023	As above	The Department of Resources appreciates the update on the PRC Plan for DNM and anticipates future updates from BMA on the plan.	The PRC Plan's Community Consultation Plan includes provision of updates to Department of Resources as required.	PBMA will provide a copy of the DNM PRC plan to Director Native Title Services and Coal Hub, Rockhampton, and provide updates on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Director Native Title Services and Coal Hub, Rockhampton as requested.
	Executive Director, Minerals and Coal	Department of Resources	As above.	Letter via email	26/04/2023	As above	The Department of Resources appreciates the update on the PRC Plan for DNM and anticipates future updates from BMA on the plan.	The PRC Plan's Community Consultation Plan includes provision of updates to Department of Resources as required.	PBMA will provide a copy of the DNM PRC plan to Principal Mining Registrar, Coal Assessment Hub and Executive Director, Minerals and Coal, Department of Resources, and provide updates on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Director Native Title Services and Coal Hub, Rockhampton as requested.
	Chief of Staff/Secretary	Office of the Minister for Energy, Renewables and Hydrogen and Minister for Public Works and Procurement	BMA provides briefings to the Minister's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update the Office of the Minister on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Minister's office as requested.
	Chief of Staff/Secretary	Office of the Minister for Agriculture Industry Development and Fisheries and Minister Regional Communities	BMA provides briefings to the Minister's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update Office of the Minister on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Minister's office as requested.
	Chief of Staff/Secretary	Office of the Minister for Regional Development and Manufacturing and Minister for Water	BMA provides briefings to the Minister's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update Office of the Minister on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Minister's office as requested.

Daunia Mine PRC Plan Community Consultation Register										
COMMUNITY MEMBERS AND PREVIOUS ENGAGEMENT				PRC PLAN DEVELOPMENT ENGAGEMENT			ENGAGEMENT OUTCOMES			
Group	Stakeholder Title	Organisation/ Property	Previous engagement	Consultation type	Consultation date	Information provided	Issues raised/discussed	How issues were considered	Decisions/outcomes of engagement	BMA commitments
	Dale Last MP	Queensland Parliament - Member for Burdekin	BMA provides briefings to the Member for Burdekin's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update the Member for Burdekin on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Member's office as requested.
	Chief of Staff/Secretary	Queensland Government - Office of the Minister for the Environment and the Great Barrier Reef and Minister for Science and Youth Affairs	BMA provides briefings to the Minister's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update Office of the Minister on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Minister's office as requested.
Federal Government		Office of the Minister and Dep. Sec. Environment Protection, DAWE	BMA provides briefings to the Minister's office on an as-needed basis.	Discussion of PRC plans as part of a future briefing	Future meeting as needed	As above	No enquiries have been received nor issues raised regarding PRC planning.	Stakeholders did not raise any issues.	BMA will update Office of the Minister on any substantive future changes to the PRC Plan.	BMA will provide updates on PRC planning to the Minister's office as requested.

DAUNIA MINE

Transitional Progressive Rehabilitation and Closure Plan Voids in Floodplain Assessment

Prepared for:

BHP Metcoal Holdings Pty Ltd

SLR Ref: 620.30403.00000-R01
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February 2023



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BASIS OF REPORT

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

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30403.00000-R01-v3.0	2 February 2023	H Munck	M Della	M Della
620.30403.00000-R01-v2.0	25 January 2023	H Munck	M Della	M Della
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APPENDICES

Appendix A	Pre-lodgement BHP/DES Workshop for PRCPs – Floodplain modelling and flood risks – Memorandum
Appendix B	TUFLOW Model Results

1 Introduction

SLR was engaged by BHP to undertake floodplain modelling at Daunia Mine (DNM). The modelling was undertaken to inform the Transitional Progressive Rehabilitation and Closure Plan (PRCP) for DNM.

DNM is located in Central Queensland, approximately 30 kilometres east of Moranbah, and immediately adjacent to Poitrel Mine (PTM) which is located to the west. DNM is located within the catchment of the Isaac River, which runs approximately 1 km to the south of the site. **Figure 1** illustrates the location of DNM and key surrounding features.

The assessment detailed in this document was undertaken specifically to address the voids in floodplain modelling as part of the PRCP requirements for DNM.

1.1 Aims and Objectives

Daunia Mine requires a PRCP to be completed in accordance with DNM's Environmental Authority (EA), (No. EPML00963013). The EA is held by the BHP Billiton Mitsui Coal Pty Ltd (BMC). The EA relates to DNM on Mining Leases (ML) 1781, 70115 and 70116. As part of the PRCP for DNM, it is proposed to incorporate a single final void as a Non-Use Management Areas (NUMA). **Figure 1** illustrates the location and extent of the proposed final void.

To meet the requirements of the Environmental Protection Act 1994 (EP Act) and Environmental Protection Regulation 2019 (EP Regulation), floodplain modelling is required for all relevant watercourses in the vicinity of voids, to assess the flood immunity and extents for the final landform conditions.

The scope of this project is to undertake floodplain modelling of the relevant watercourses as defined by the EP Regulation in relation to the proposed voids, including the following key tasks.

- Undertake a catchment study for each proposed void in the floodplain, including determining the pre-mining landform and developing or updating hydrologic modelling to be consistent with the requirements of Australian Rainfall and Runoff (AR&R 2019). The study includes watercourses classified as stream order four or higher, and their contributing tributaries.
- Develop hydraulic models for the purpose of identifying flood risks posed to the proposed voids. The purpose of this is to define the baseline flood risks caused by the relevant watercourse(s), which will be used to assess the inundation risk in the 0.1% Annual Exceedance Probability (AEP) flood event for each void, informed by the re-constructed pre-mining topography.
- Produce a Voids in Floodplain Model Report detailing the methodology and findings of the above assessments, including all relevant mapping of flood extents, levels and depths. GIS data and models will also be provided as an output of this assessment.

The assessments detailed in this report were undertaken and reviewed by appropriately qualified persons.



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1.2 Input Data

Data for the assessment was provided by BHP and included pre-mining topographic data, design surface data for the PRCP landform and aerial imagery for DNM.

Further data was obtained for use in the assessment from public sources, including additional topographic data, rainfall data, catchment specific hydrologic data and stream flow data. Further detail on the data utilised in the assessment is provided in **Section 3**.

1.3 Relevant Documentation

This assessment was undertaken in accordance with the following guidelines and documentation:

- *Environmental Protection Act 1994*;
- *Environmental Protection Regulation 2019*;
- *'Guideline – Progressive Rehabilitation and Closure Plans'*, Department of Environment and Science (DES), March 2021 (PRCP Guideline);
- *'Information Sheet – Environmental Protection Act 1994 – Voids in Flood Plains'*, Department of Environment and Science, March 2020 (Voids in Flood Plains Information Sheet); and
- *'Australian Rainfall and Runoff (2019)'* (ARR).

In addition to the documentation listed above, the assessment was undertaken in accordance with the methodology that was agreed between BHP and DES during the pre-lodgement workshop for PRCPs (**Appendix A**).

1.4 Assumptions and Limitations

This assessment was undertaken specifically for the purposes for undertaking floodplain modelling of relevant watercourses in accordance with the requirements of the EP Act and EP Regulation. The following assumptions and limitations apply to this assessment.

- The accuracy of the assessment is reliant on the accuracy of the utilised data, as detailed in **Section 3**. SLR has assumed all source data to be fit for purpose and sufficiently accurate for the purpose of this assessment. Except where noted, no verification of accuracy of the information has been carried out. In the event that some of the information which was relied upon for this assessment is found to be inaccurate, then some or all of the findings may change.
- Floodplain modelling was undertaken only for relevant watercourses as defined in the Voids in Floodplain Information Sheet, i.e. watercourses with a stream order of 4 or higher under the Strahler stream order classification system.
- Generation of the model landform for the assessment was undertaken in accordance with the Voids in Flood Plains Information Sheet. Due to the requirement to include artificial features outside of the subject Mine Lease, the modelled floodplain may differ from the true pre-mining floodplain in areas where adjacent artificial features effect a relevant watercourse (for example, the Isaac River floodplain is affected by the adjacent artificial features of the Poitrel Mine site).

- The hydraulic model was based on 1 Second Derived SRTM topographic data in some areas due to the limited extent of available LiDAR Data. SRTM data for the site has a vertical accuracy of +/-5-10m. The accuracy of the model results is limited to the accuracy adopted topographic data.
- Consideration was made as to the potential effects of groundwater on the floodplain extent. It was considered that groundwater will have no significant impact on the extent of the floodplain. An initial rainfall loss of 0 mm was adopted in the hydrologic studies. This assumption represents fully saturated catchment conditions (i.e. soil stores at the surface were full), which was considered to be a conservative approach.
- Although the analyses undertaken as detailed in this report were done so with the appropriate care and professionalism, this report shall only be used for the purposes intended. The analyses detailed in this report were undertaken solely for the purpose of addressing the requirements for voids in floodplain modelling for Daunia Mine in accordance with the relevant documentation as detailed in **Section 1.2**.
- This report should be read in full and no excerpts are to be taken as representative of the findings. This report has been prepared on behalf of BHP Metcoal Holdings Pty Ltd and SLR accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1.5 Document Structure

The structure of this report is set out as follows:

- **Section 2** - Relevant legislation and guidelines;
- **Section 3** - Data review and gap analysis, including details of the model landform development methodology and results;
- **Section 4** - Hydrologic modelling of the Isaac River catchment, including calibration methodology;
- **Section 5** - Hydraulic modelling of Isaac River, including results and outcomes of the floodplain modelling in relation to the proposed final voids; and
- **Section 6** – Summary of the study and conclusions.

Details of each component of the assessment are provided below.

2 Legislation and Guidelines

2.1 Relevant Legislation and Guidelines

This assessment has been undertaken in accordance with the following legislation and guidelines:

- *Environmental Protection Act 1994*;
- *Environmental Protection Regulation 2019*;
- *'Information Sheet – Environmental Protection Act 1994 – Voids in Flood Plains'*, Department of Environment and Science, March 2020; and
- *'Guideline – Progressive Rehabilitation and Closure Plans'*, Department of Environment and Science, March 2021 (PRCP Guideline).

The Environmental Protection Act 1994 states:

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

The Environmental Protection Regulation 2019 section 41C(3) also states:

"The administering authority must treat the land as a flood plain to the extent the results of the flood plain modelling show that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% AEP for a relevant watercourse under the ARR."

Further guidance is provided in the PRCP Guideline and the Voids in Flood Plains Information Sheet.

Sections 3.4 and 3.6.1 of the PRCP Guideline both require a floodplain assessment to be carried out. Specifically, Section 3.4 requires a Void in Floodplain assessment for all unapproved NUMA voids (i.e. floodplain assessment of the pre-mining landform), whilst Section 3.6.1 requires a post-mining landform assessment irrespective whether a post-mining land use (PMLU) or NUMA is proposed.

2.2 Applicability to the Project

Based on the review of the EP Act, EP Regulation, PRCP Guideline and the Voids in Floodplains information sheets, it is considered that the legislative requirements set out in **Table 1** are applicable to the project.

Table 1 Applicable Legislative Requirements

Requirement	Application to the Project	Source
For transitional sites, a floodplain assessment is required where: - A void has been identified as a NUMA in a land outcome document but the location has not been specified; or - Where there are no land outcomes in the land outcome document.	The PRCP for Daunia Mine includes a single final void which is proposed to be developed as a NUMA. Therefore, floodplain assessment is required.	PRCP Guideline Section 3.4

Requirement	Application to the Project	Source
Floodplains associated with a stream order 4 or greater are required to be modelled.	The following watercourses are of Strahler stream order 4 or greater and may affect the proposed voids: - Isaac River Therefore, the Isaac River is a relevant watercourse and floodplain modelling of the river was undertaken.	Voids in Flood Plains Information Sheet Section 5.
The modelling must not include any artificial features on the site. However, the modelling must include all existing and approved artificial features that, at the time of modelling, are located outside of the mining tenure boundary.	A Digital Elevation Model (DEM) of the area was created to be used as the model landform for the assessment. The model landform DEM was developed to represent the pre-mining topography within the Mining Lease (ML), and existing and future topography outside of the ML, including on adjacent MLs where applicable. The topography outside of the ML included existing and future artificial features, based on available data.	Voids in Flood Plains Information Sheet Section 4.
The requirement for a flood assessment under section 3.6.1 of the Guideline applies to the post mining landform across the whole site irrespective of whether a PMLU or a NUMA are proposed. Furthermore, section 3.6.1 is not only required to indicate flood risk but also to demonstrate the final landform (including waste rock dumps and diversions) will remain in a stable condition in a range of flood flow conditions.	Not included in the scope of this assessment.	PRCP Guideline Section 3.6.1.

2.3 Definitions and Terminology

Table 2 provides the definitions and terminology that are utilised in this assessment, in accordance with the PRCP Guideline and the Voids in Flood Plains Information Sheet.

Table 2 Definitions and Terminology

Term	Definition	Source
Voids	An area of land to be excavated in carrying out a mining activity. Therefore, all voids (PMLU or NUMA) are subject to the requirements of the EP Act.	Section 126D of the EP Act.
Flood plain	A void is considered to be located in a flood plain if the flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level in a 0.1% AEP for a relevant watercourse under the guideline Australian Rainfall and Runoff (2019) (ARR).	Section 41C of the EP Regulation; and PRCP Guideline Section 3.4.
Stable condition	- The land is safe and structurally stable; - There is no environmental harm being caused by anything on or in the land; and - The land can sustain a PMLU.	Section 126D(3) of the EP Act; and PRCP Guideline Section 3.6.3.
Relevant watercourse	(a) A watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or (b) If a watercourse mentioned in paragraph (a) is permanently diverted under – (i) A condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, section 98; or (ii) A water license or proposed water license under the Water Act 2000; the watercourse as permanently diverted.	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 5.
Flood plain modelling	For land the subject of a PRCP schedule, means modelling of the landform of the land – (a) Carried out under the ARR; (and) (b) Excluding any artificial features for the land	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 4.

Term	Definition	Source
Artificial feature	For land the subject of a PRCP schedule, means – (a) A structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or (b) A structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land if the relevant activities the subject of the PRCP schedule had not been carried out; or (c) A feature forming part of the landform of the land, other than the natural landform, if the feature interferes with or affects – (i) A relevant watercourse; or (ii) The natural flow of water on the land.	PRCP Guideline Section 8; and Voids in Flood Plains information Sheet Section 6.

3 Data Review and Gap Analysis

3.1 Available Data

A data package was provided to SLR by BHP for use in the assessment. The package included:

- GIS data containing watercourses with Strahler Stream Order 4 or greater;
- Pre-mining topography for DNM (2 metre interval contour data, date unknown);
- LiDAR DEM (0.25 metre cell spacing) for DNM, PTM and Isaac River Channel;
- Proposed PRCP landform DEM including final voids for DNM;
- Proposed PRCP landform DEM including final voids for the adjacent PTM; and
- DNM aerial imagery dated 1985.

Additional data was obtained from publicly available sources including:

- 1 second SRTM Derived Hydrological Digital Elevation Model topographic data (Geoscience Australia);
- Queensland road, rail and place names GIS datasets (Department of Resources (DR), 2021);
- GIS data containing watercourses for all Strahler Stream Orders (DR); and
- Historic gauged stream flow data for the Goonyella and Deverill Stream Gauges (DNRM).

The provided data was analysed for suitability for the purposes of this assessment. The outcomes of the review are detailed below.

3.2 Watercourses

A review of the existing watercourses in the vicinity of DNM was undertaken using hydrologic streamline data provided by BHP and DR. The DR dataset contained Strahler Stream Order classifications for each watercourse, which ranged from order 1 to order 7 within the extent of the data, as illustrated in **Figure 2**. The review of both datasets showed that the Isaac River was the only watercourse of Strahler stream order 4 or greater that may affect the proposed void.

North Creek, which is classified with a Strahler stream order of 4, is located approximately 3.5 km east of DNM. The proposed final voids are located outside of the North Creek catchment, therefore North Creek is not a relevant watercourse and no modelling was undertaken for it.

The Isaac River was therefore the only relevant watercourse. In accordance with Section 3.4 of the PRCP guidelines, floodplain modelling of the Isaac River was undertaken.

3.3 Landforms

The 'pre-mining' contour data for Daunia was processed into a 1 metre spaced DEM and combined with the Poitrel final landform DEM, Isaac River LiDAR DEM and 1 second hydrologically enforced SRTM DEM to create the model DEM.. The model landform DEM is illustrated in **Figure 3**.

LiDAR data or detailed survey data are the preferred elevation data for use in two-dimensional hydraulic modelling. Review of the project data showed that the provided LiDAR data did not cover the full extent of the Isaac River floodplain, although did include the river channel and immediate overbank. Therefore, the LiDAR Data was adopted as the primary DEM data source, and SRTM data was adopted in areas of the model that were not covered by either the LiDAR, pre-mining contours, or the Daunia PRCP landform DEMs.

The SRTM data in the has a vertical accuracy of +/-5-10 metres (source: '1 Second SRTM Derived Products User Guide', Geoscience Australia, 2011). Comparison of the LiDAR and SRTM DEMs showed that the SRTM elevation data was generally higher by approximately 3 to 6 metres varying across the study area. In the area of interest, the SRTM data was approximately 3.8 metres higher. Consequently, the SRTM data elevation was lowered by 3.8 metres to provide a generally consistent interface at the LiDAR data extents before being included in the model landform DEM.

3.4 Artificial Features

Existing and proposed artificial features within the model domain were identified based on the available information at the time of the assessment. A summary of the identified artificial features and relevant details are provided in **Table 3**. Consideration was made for each artificial feature to determine if the feature was necessary to include in the hydrologic and hydraulic models, based on the feature's respective influence on 0.1% AEP flooding conditions in the vicinity of the voids.

Table 3 Artificial Features

Artificial Feature / Description	Source	Hydraulic model inclusion status
On-tenure		
Pandora Pit Final Void	PRCP Landform DEM (BHP)	All on lease artificial features not included in model as per EP Regulation requirements.
Titan Pit Final Void	PRCP Landform DEM (BHP)	
Waste Rock Dumps	PRCP Landform DEM (BHP)	
Daunia Mine Infrastructure	BHP	
Off-tenure		
Poitrel PRCP Final Voids	PTM PRCP Landform DEM (BHP)	Included (hydrologic and hydraulic model)
Poitrel PRCP Waste Rock Dumps	PTM PRCP Landform DEM (BHP)	Included (hydrologic and hydraulic model)
New Chum Creek Diversion	BHP	Included (hydrologic and hydraulic model)
Goonyella System Railway	DR	Included (hydraulic model)
Peak Downs Highway	DR	Not included – no effect on 0.1% AEP flood levels in the vicinity of DNM

4 Hydrologic Modelling

4.1 Software

Hydrologic modelling was undertaken to estimate runoff hydrographs at various locations throughout the Isaac River catchment. The model was developed using the Watershed Bounded Network Model Version 2019 (WBNM). WBNM is an industry standard rainfall-runoff routing software package.

4.2 Model Setup

4.2.1 Approach

A WBNM model of the Isaac River to the point immediately upstream of its junction with Devlin Creek was developed.

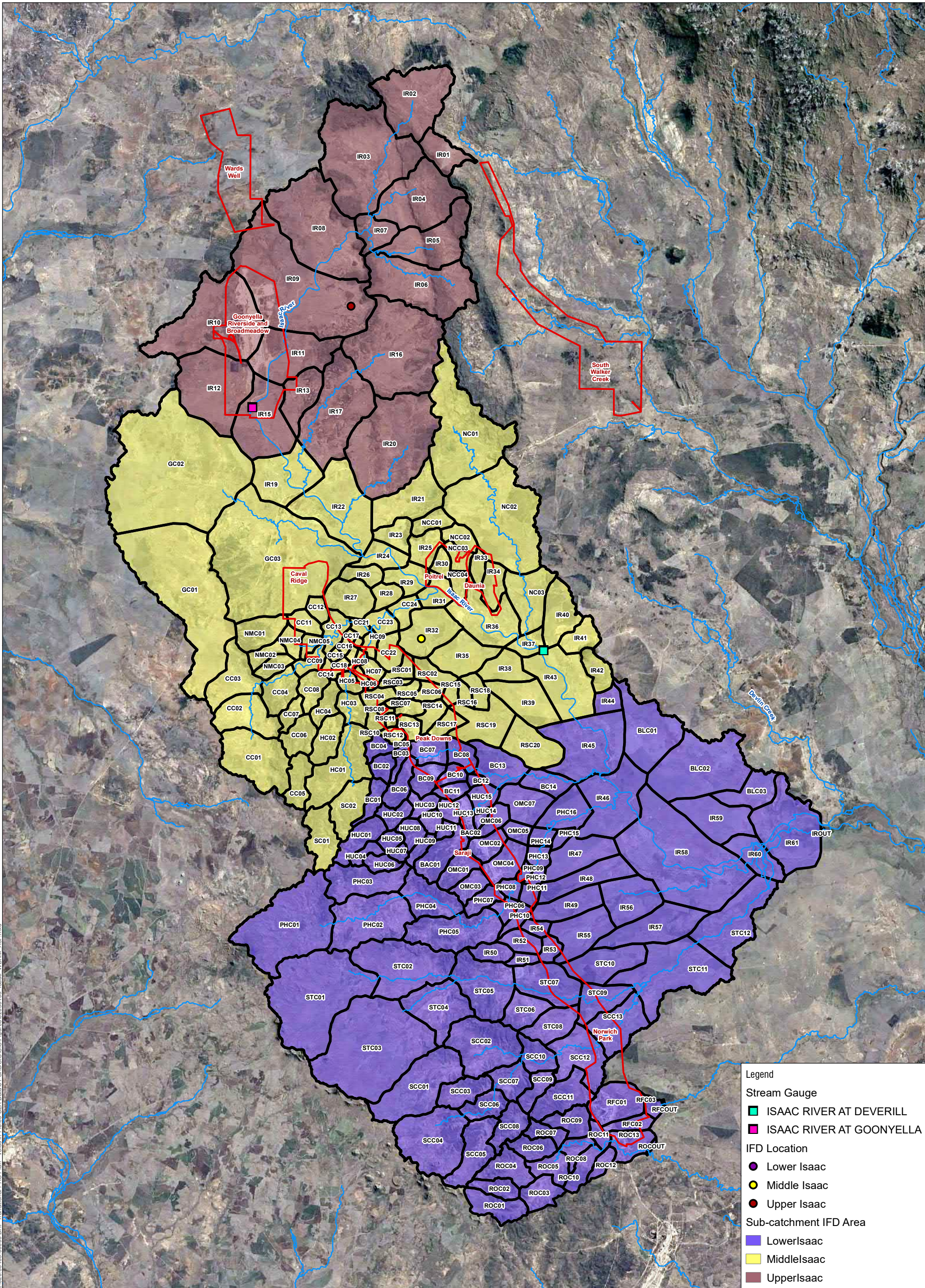
The model extent was selected to allow the model to be calibrated against the results of a Flood Frequency Analysis (FFA) undertaken at the nearest suitable location(s), being the Goonyella (130414A) and Deverell (130410A) stream gauges. This was considered appropriate given the 0.1% AEP flood event is the critical event for the assessment and the long period of record at the gauges provides the best estimation of peak flows with this exceedance probability. Further detail on the model calibration process is provided in **Section 4.3**.

4.2.2 Catchment Details

The Isaac River model covers a catchment area of approximately 8,300 km², of which sub-catchments were delineated using hydrologically enforced 1 second SRTM 30 metre DEM terrain data sourced from Geoscience Australia. The model extent and sub-catchment delineation are illustrated in **Figure 4**.

4.2.3 Intensity-Frequency-Duration Rainfall Data

Rainfall Intensity-Frequency-Duration (IFD) data for the catchment was sourced from the Bureau of Meteorology (BoM) online IFD data portal for a range of Annual Exceedance Probabilities (AEP). Spatial variability of IFD data was accounted for by sourcing data separately for the upper catchment, middle catchment and lower catchment of the model area. Each sub-catchment was allocated the IFD data of each relevant IFD location based on proximity, as illustrated in **Figure 4**.



4.2.4 Losses

Storm rainfall loss data for the catchment was obtained from the ARR data hub. The initial and continuing losses are provided in **Table 4**. Based on the ARR Data Hub data, an initial loss of 0 mm was adopted for the 0.1% AEP event.

Table 4 Rainfall Losses

Global Storm Loss	Loss
Initial loss (pervious)	0 mm
Continuing loss (pervious)	1.0 mm/h

4.2.5 Lag Parameter

A catchment lag parameter of 1.90 was adopted in the WBNM model. The WBNM documentation recommends that a lag parameter value between 1.40 and 1.80 is suitable for most catchments, however if reliable calibration data is available (as was the case for this assessment), the lag parameter should be adjusted to provide accurate calibration of the model.

4.2.6 Storm Events

The 0.1% AEP event was the primary design storm event for this assessment. In accordance with ARR, the Probable Maximum Flood (PMF) temporal pattern was adopted for the 0.1% AEP event. ARR recommends the Generalised Short Duration Method (GSDM) for events with a duration up to 6 hours, and the Revised Generalised Tropical Storm Method (GTSMR) for durations of 24 hours or more. There is no set guidance for which method to adopt for storms with durations between 6 and 24 hours, therefore the GSDM temporal pattern was adopted for all durations up to and including the 12 hour duration, and the GTSMR temporal patterns for durations of between 12 hours and 72 hours.

4.2.7 Aerial Reduction Factor

Aerial reduction factors were not applied to the model based on the catchment area draining to the Deverell or gauge (refer **Section 4.3.1**).

4.3 Calibration

4.3.1 Flood Frequency Analysis

An FFA was undertaken using recorded streamflow data sourced from the Department of Regional Development, Manufacturing and Water (DRDMW). Two gauge locations exist on the Isaac River within the catchment of the area of assessment, located at Goonyella (130414A) and Deverell (130410A). The locations of the gauges are illustrated in **Figure 4**. The Deverell gauge is located roughly 15 km downstream of DNM.

The Goonyella gauge has continuous streamflow records beginning in 1983 (38 years), while the Deverell gauge has records beginning in 1968 (53 years). It was noted during the analysis that the catchment to the Deverell gauge, including the Goonyella gauge, has been modified significantly by various mining operations since approximately 2002. The WBNM model was developed based on SRTM topographic data which generally predates 2002, therefore streamflow data from 2003 onwards was excluded from the Deverell gauge data in the FFA. With these records excluded, a total of 35 years data was available for use from the Deverell gauge. The full 38 years of record was adopted for the Goonyella gauge, as excluding the post-2002 flows would leave only 20 years of data, which was considered insufficient.

For both gauges, a Log-Pearson III (LP3) flood frequency distribution was fitted to the annual maximum data series. For each gauge, low flow outliers were excluded from the data series using the Grubbs Beck Test method, prior to fitting the distribution.

4.3.2 Calibration Results

Results of the flood frequency analysis, in comparison to the results of the WBNM hydrologic model, are illustrated in **Figure 5** and **Figure 6**.

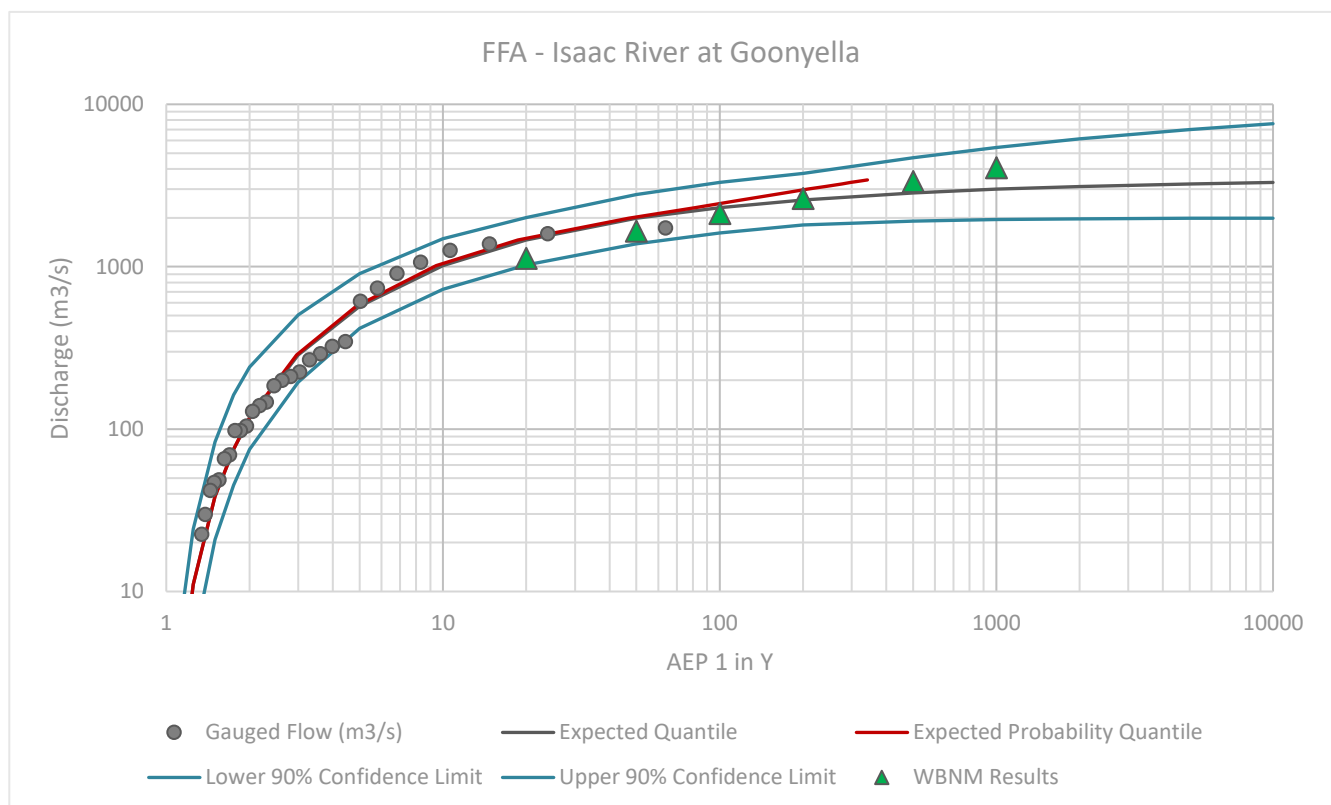


Figure 5 Flood Frequency Analysis Results – Isaac River at Goonyella Gauge

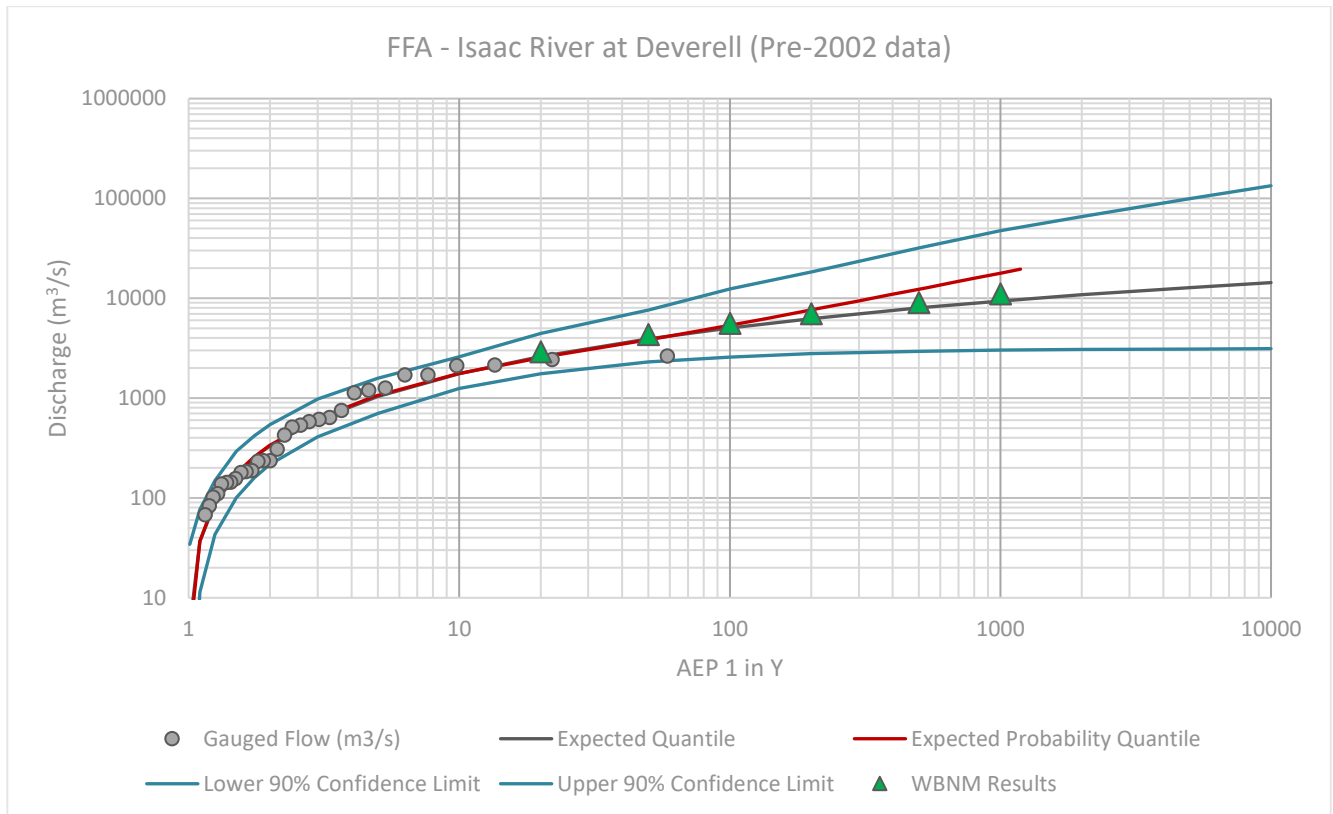


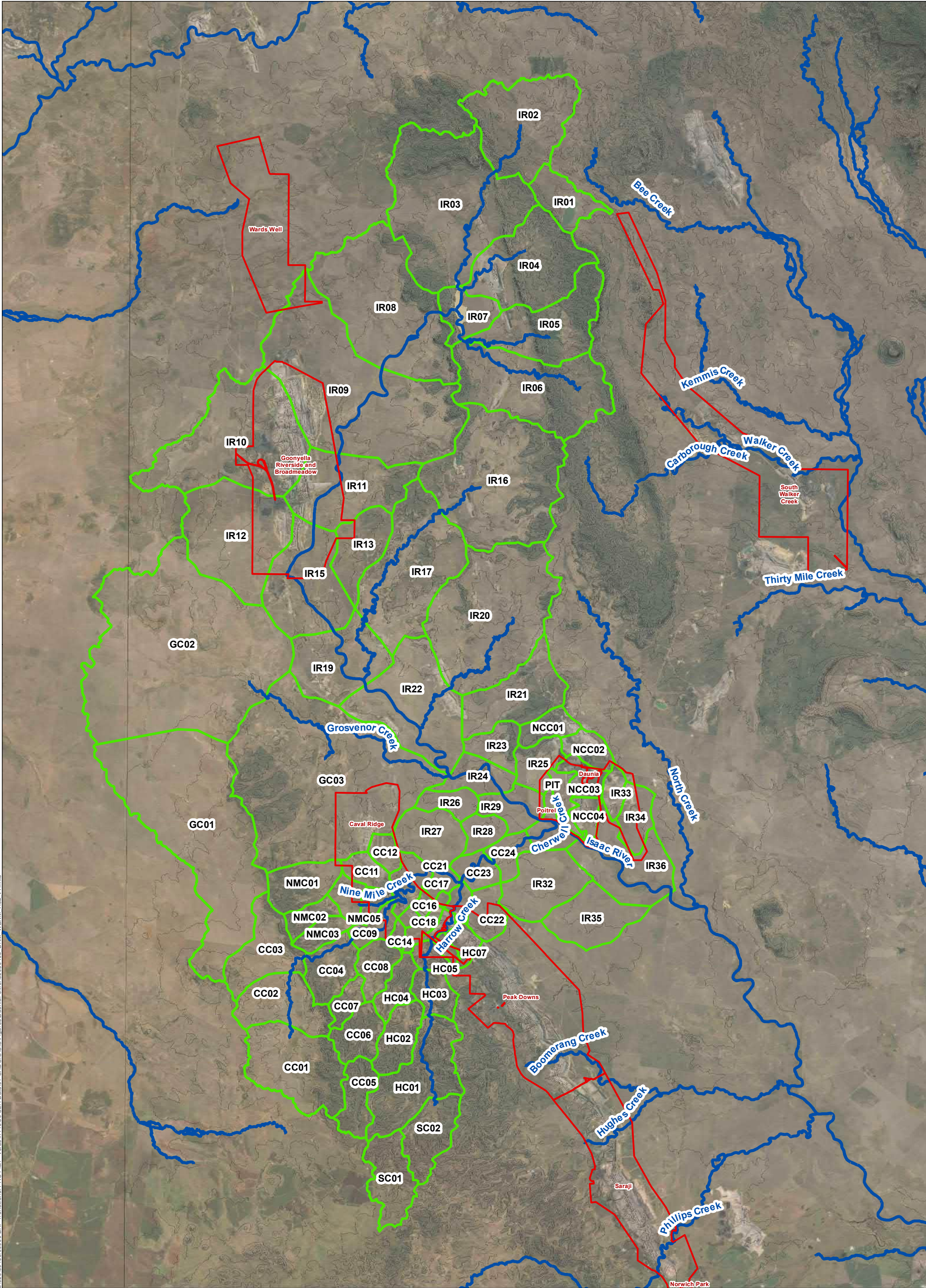
Figure 6 Flood Frequency Analysis Results – Isaac River at Deverell Gauge

As illustrated by the above, the WBNM model produced results in line with the results of the FFAs, particularly with the results of the Deverell gauge data. Therefore, the model was considered suitable for use for the purposes of this assessment.

4.4 Daunia Mine Assessment Sub-model

A sub-model of the Isaac River hydrologic model was developed for the study area to account for the changes in sub-catchment delineation due to the consideration of the artificial features of the adjacent Poitrel Mine PRCP landform. Sub-catchments downstream of the study area were also removed from the sub-model given their inclusion provides no meaningful information for the assessment of flow hydrographs in the vicinity of DNM.

All model parameters were retained from the Isaac River model. The model extent and sub-catchment delineation of the sub-model are illustrated in **Figure 7**. Flow hydrographs were extracted from the Daunia sub-model and were utilised as inflows in the hydraulic model.



5 Hydraulic Modelling

5.1 Software

A hydraulic model of the Isaac River in the vicinity of DNM was developed for the purpose of assessing pre-mining flood extents.

The industry standard hydrodynamic modelling software TUFLOW (Build 2020-10-AA) was utilised for the hydraulic modelling. The sub-grid sampling (SGS) feature of TUFLOW suited the modelling required for the assessment. SGS provides an increased definition of model terrain and flow conveyance, enabling model resolution to be improved without significant increases in model runtimes.

5.2 Model Setup

5.2.1 Topography

The model landform DEM as detailed in **Section 3** was utilised as the topography for the models. The DEMs for the model areas are shown in **Figure 9**. Drainage features of this DEM were reinforced using gully lines to ensure reasonable conveyance within the watercourses.

As detailed in **Section 3**, SRTM topographic data was utilised for areas in the model where preferable topographic data was not available. Based on comparisons to the available LiDAR data in the study area, the SRTM data was lowered by 3.8 m to interface with the LiDAR data. In some areas where the difference between the SRTM data and LiDAR data was more or less than the adopted 3.8 m adjustment, irregular steps in the model DEM were observed.

A sensitivity assessment was carried out to investigate the sensitivity of the model results to the model terrain. For the assessment, the SRTM data was lowered by 6 m from the raw data elevations. The results showed that the floodplain extent was generally consistent with the base model scenario.

For the purposes of this assessment, it was assumed that the PTM final void will be immune to inundation in flood events up to and including the 0.1% AEP event. Preliminary model results indicated that the void was subject to inundation based on the provided PRCP landform DEM. Therefore, the model terrain was modified to raise ground levels around the perimeter of the void to prevent inundation in the 0.1% AEP event.

5.2.2 Model Grid Cell Size

A grid cell size of 10 metres was adopted for the models. In combination with a 1 metre SGS sampling distance, this was considered to provide adequate model resolution for the purposes of the analysis undertaken, while providing a reasonable runtime.

5.2.3 Hydraulic Roughness

Hydraulic roughness across the model area was assessed based on the supplied aerial imagery from 1985. This was the most suitable available imagery for the area and was considered a suitable representation of the pre-mining land use. The Manning's roughness values adopted for the various land use types within the model domains are shown in **Table 5** and in **Figure 10**.

Table 5 TUFLOW Model Manning's Roughness Values

Land Use	Manning's n Value
Sparse Vegetation	0.06
Dense Vegetation	0.08
Creek Beds	0.05
Pits / Waterbodies	0.02
Bare land	0.03

5.2.4 Downstream Boundaries

The downstream model boundary was situated approximately 3 km downstream of DNM. A stage-discharge relationship was adopted based on the topography gradient of 0.1% at the boundary location. The location and extent of the downstream boundary is shown in **Figure 9**.

A sensitivity assessment was carried out on the downstream boundary assumptions. For the assessment, the model was simulated with a flood surface gradient of 1% applied at the downstream boundary. The results showed that peak flood levels in the vicinity of the site were consistent with those of the base model scenario. Thus, the adopted boundary condition did not affect the calculated results in the area of interest.

5.2.5 Model Inflows

Flow hydrographs for the model were extracted from the DNM WBNM sub-model for each sub-catchment. These hydrographs were applied as inflow boundaries, as either total or local inflows where relevant, to the hydraulic model at appropriate locations, as shown in **Figure 9**.

5.2.6 Verification

Flow results of the hydraulic model at the downstream boundary were compared with flows produced by the WBNM model at the outlet of the corresponding sub-catchment (IR36). This was undertaken for the critical duration event and indicates that the TUFLOW model calculates similar flows, and the general trends of the hydrographs were similar. **Figure 8** illustrates the comparison.

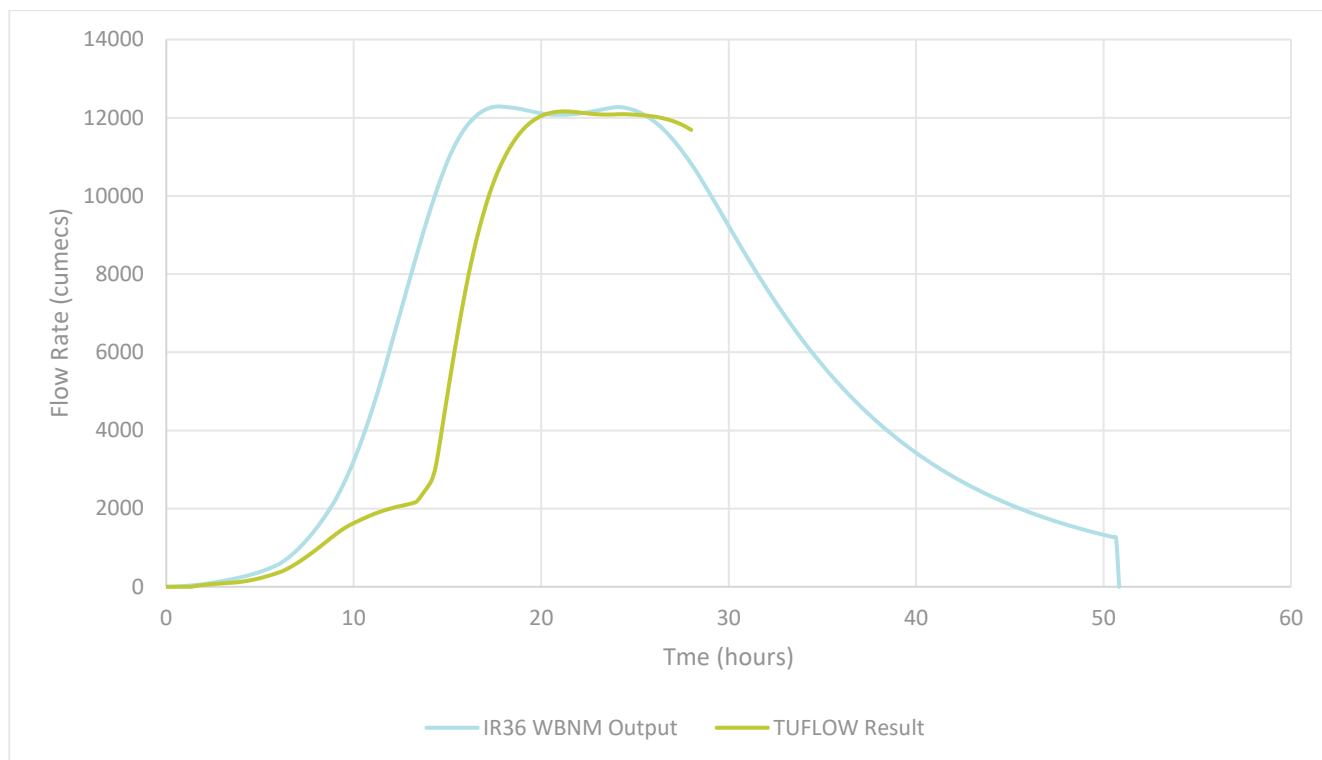


Figure 8 36 hour 0.1% AEP WBNM and TUFLOW Model Results Comparison

5.2.7 Critical Storm Durations

In accordance with the recommendations of ARR, a suite of design storm events was simulated in the hydraulic models for the 0.1% AEP event and durations between 1 and 48 hours. The results of the various storm durations were cross-referenced to determine the critical duration for the focal point of the model, i.e. the proposed void locations. The results showed that the 36 hour storm duration was the critical event for the Isaac River at in the vicinity of DNM.

5.3 Results

The results of the Isaac River TUFLOW model for peak water surface levels and depths for the 0.1% AEP event are illustrated in **Appendix B**. The results illustrate that the Titan Pit final void is located outside the modelled floodplain, however the Pandora Pit final void is located within the modelled floodplain of the Isaac River.

Figure 11 illustrates in further detail the extent of the 0.1% AEP floodplain in the vicinity of the Pandora Pit final void. The results show that encroachment of the void into the floodplain occurs in the north-west extremities of the void footprint. The majority of the void footprint is located outside of the floodplain extent.

The results of the hydraulic model are dependent on the underlying topographic data used to create the model DEM. As previously detailed, preferred LiDAR data was available in limited areas within the model domain, and large areas of the floodplain were represented in the model DEM by SRTM topographic data. If additional LiDAR data was sourced and implemented in the hydraulic model, the resulting 0.1% AEP floodplain extent may vary from the results of this assessment.

6 Summary

As part of the PRCP for Daunia Mine, it is proposed to incorporate two final voids as NUMAs. Therefore, in accordance with the EP Act and EP Regulation and specifically Section 3.4 of the PRCP Guideline, floodplain modelling has been undertaken for the Isaac River which was identified as the only relevant watercourse that may affect the voids.

Data for the assessment was provided by BHP, and sourced from various public providers including BoM, DRDMW and Geoscience Australia. The data was reviewed and modified for use where appropriate. Model landforms were developed to account for artificial features outside of the mine EA boundary, and pre-mining topography within the EA based on the information available at the time of the study.

A hydrologic assessment was undertaken for the portion of the Isaac River catchment that encompasses the Mine. The model was calibrated against the results of Flood Frequency Analyses undertaken using data obtained at Goonyella and Deverell stream gauge stations located on the Isaac River.

A hydraulic model was developed for the Isaac River in the vicinity of DNM. Hydrographs extracted from the hydrologic model at relevant locations were applied as inflows to the hydraulic model. The hydraulic model topography was created using a combination of historic pre-mining survey data, Poitrel Mine PRCP DEM, LiDAR DEM and SRTM DEM. SRTM data was utilised due to the limited extent of the provided LiDAR DEM which is the preferred topographic data source for hydraulic modelling. The accuracy of hydraulic model results was therefore limited to the accuracy of the available topographic data sets.

Consideration was made as to the potential effects of groundwater on the floodplain extent. It was considered that groundwater will have no significant impact on the extent of the floodplain. An initial rainfall loss of 0 mm was adopted in the hydrologic studies. This assumption represents fully saturated catchment conditions (i.e. soil stores at the surface were full), which was considered to be a conservative approach.

The results of the hydraulic model provided the predicted 0.1% AEP flood event inundation extent. Predicted peak flood levels and depths were also produced by the hydraulic model. The results showed the proposed Pandora Pit NUMA void is partially located within the floodplain of the Isaac River, while the Titan Pit final void is located outside of the floodplain.

APPENDIX A

Pre-lodgement BHP/DES Workshop for PRCPs – Floodplain modelling and flood risks – Memorandum

Voids in flood plains

The PRCP guideline Section 3.4 outlines considerations to be included for PRC plan submissions relating specifically to voids in flood plains. Table 1 lists the key points that will be considered based on the guideline for flood modelling for voids and subsequent inclusion in the PRC plan submissions for relevant BHP sites.

Table 1: Guideline considerations for Voids in Floodplains

Guideline Considerations	BHP PRCP Deliverables
Voids located in floodplain to be rehabilitated to a stable condition	✓
Sites with a void proposed as a NUMA will have flood plain modelling*	✓
Flood plain modelled with peak water level 0.1% AEP	✓
Flood plain modelled for relevant watercourse – stream order 4 or higher including permanent diversions	✓
Modelling carried out under the ARR	✓
Modelling to exclude any <i>artificial features</i> for the land within the tenure boundary	✓
Modelling to include catchment data outside of the tenure including all existing and approved artificial features (as per Information Sheet)	BHP to use best endeavours
Modelling to include the location of the watercourse after the temporary diversions has been removed (as per Information Sheet)	Modelling to include watercourse classified as stream order 4 or higher, or current approved permanent diversions (stream order 4 or higher). Temporary diversions are not included in this modelling.
Flood plain model report developed by an appropriately qualified person	✓
Flood model report to contain:	
Details provided of the data used to develop the model in accordance with section 4.13.3. of the ARR	✓
Identification of all <i>artificial features</i> proposed or present within the tenure boundary	✓
Identification of all watercourses within the immediate catchment with the Strahler method of stream ordering applied	✓
Identification of any approved permanent watercourse diversions within the tenure boundaries and the relevant approval of the diversion	✓
Consideration of how groundwater may impact the flood plain extent	✓
A hydrologic model	Model report only
A hydraulic model	Model report only
Model assumptions and limitations	✓
Model calibration and sensitivity analysis	✓
Spatial data outlining the extent of the flood plain.	✓

* Unless the conditions of the applicability to transitional PRC plans are met for where flood plain modelling is not required.

The PRCP Guideline Section 3.4 describes that “Flood plain modelling is required for all sites with a void proposed as a NUMA” with “the level modelled as the peak water level 0.1% AEP for a relevant watercourse”.

BHP will complete flood plain modelling in accordance with the ARR, and a model report for all sites with a void proposed as a NUMA. In accordance with the EP Regulation, the flood plain will be treated as the land where flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% Annual Exceedance Probability (AEP) for a relevant watercourse under the Australian Rainfall and Runoff Guideline (2019).

Artificial Feature

The PRCP Guideline details flood plain modelling must “exclude any artificial features for the land within the tenure boundary”. An artificial feature is detailed as:

Artificial feature, for land the subject of a PRCP schedule, means—
(a) a structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or
(b) a structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land if the relevant activities the subject of the PRCP schedule had not been carried out; or
(c) a feature forming part of the landform of the land, other than the natural landform, if the feature interferes with or affects—
(i) a relevant watercourse; or
(ii) the natural flow of water on the land.

The DES have advised that the intent of the policy is that flood plain modelling must be based on pre-mining state. Therefore, temporary structures including those that will require a level of maintenance after the land is surrendered within the tenure boundary, will not be included in the flood plain modelling. Additionally, a feature that does not form part of the natural landform and interferes or affects a relevant water course or the natural flow of water on the land will not be included in the flood plain modelling. In accordance with the definition of artificial feature, the structures or features that will not be included in the flood plain modelling may include::

- final dumps
- final voids
- final subsidence
- creek diversions (in the current temporary approved state)

If a watercourse diversion over the course of the future mine life requires further approval, then new information will be provided at that point.

Whilst the DES have confirmed their position, BHP maintain that this may result in an impracticable application of the flood plain modelling, and could fail to ensure the relevant risks associated with flood plains are properly addressed and managed.

Relevant Watercourse

BHP have confirmed with the DES and both are in agreement that the flood plain modelling will include the relevant watercourses, as defined under the EP Regulation:

Relevant watercourse means—

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

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

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

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

the watercourse as permanently diverted.

The DES have advised that the statement in the information sheet regarding “The application for voids in the flood plain of streams with a stream order of three and lower are still assessed against the decision criteria in the EP Act and may be refused”, is in relation to rehabilitation practices for flooding.

Spatial Extent of Modelling

The information sheet details the need for considering catchment data outside of the relevant tenure in determining the extent of the flood plain model and final mapped flood plain extent.

As the spatial extent of data that is required for each catchment and model is a highly technical matter. The DES and BHP are in agreement that BHP will default to the expert judgement of those performing the flood modelling in determining this extent.

With respect to artificial features outside of the tenure boundary, the information sheet details that the flood plain model includes a combination of data:

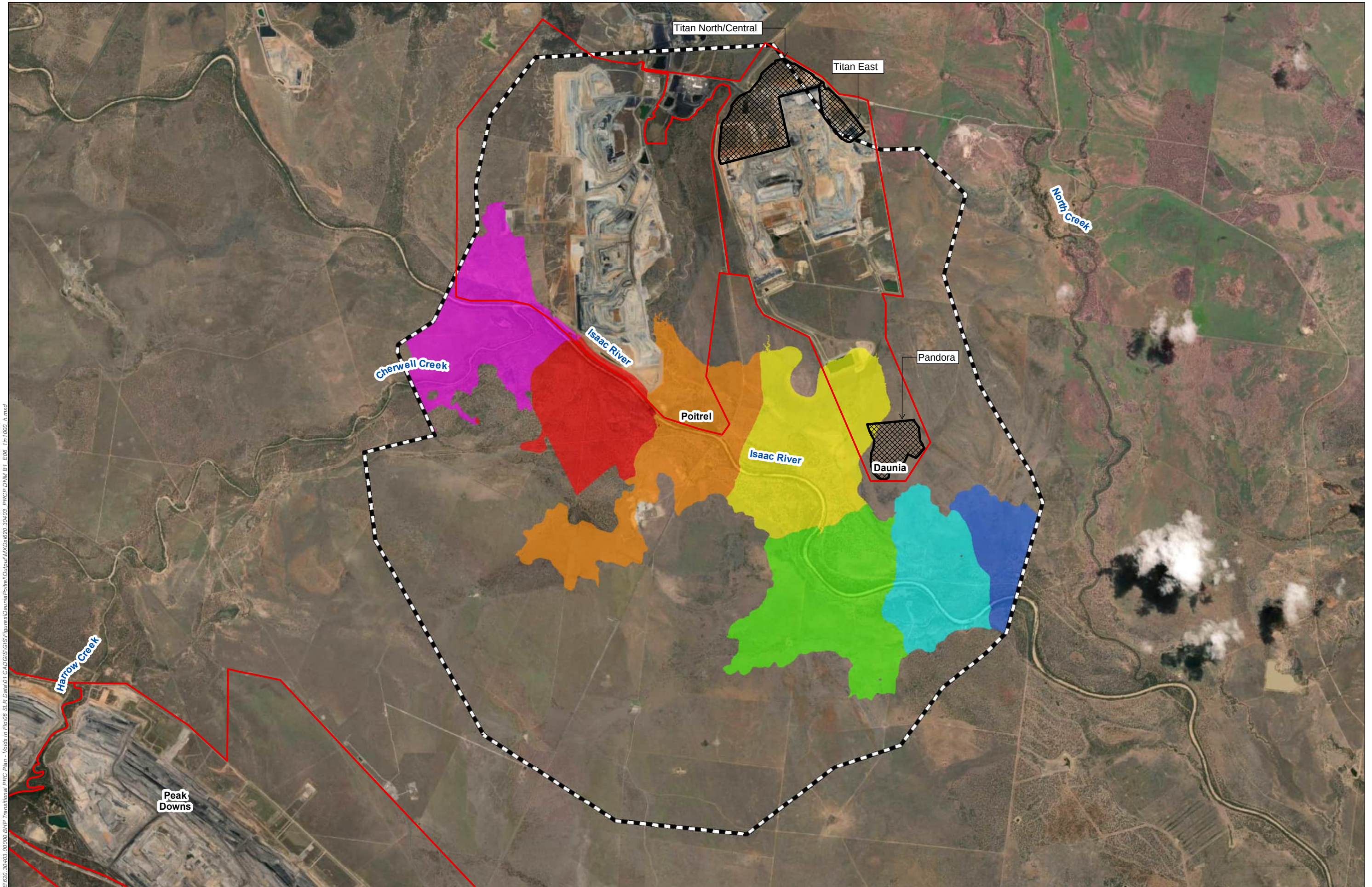
- within the mining tenure boundary, to exclude any artificial features;
- outside of the mining tenure boundary to include all existing and approved artificial features.

BHP is unclear on what is intended, because it potentially results in an unrealistic hybrid scenario containing both past and future features being modelled. For example, BMA's Saraji Mine PRCP *must not* include flood modelling with Saraji's artificial features, but also *must* include the artificial features on the adjacent BMA Peak Downs Mine. BHP has several sites this will be relevant to and foreshadows that this requirement may result in flood plain modelling results that appear unusual when compared between PRCP's. This is because every site will likely need to be modelled separately and will produce flood plain modelling results that could well differ in the flood plain extent shown in an adjacent site's PRCP. Further afield, an example is the Burton Gorge Dam operated by Peabody upstream of BMA's Goonyella Riverside Mine on the Isaac River that will be included in the model.

Nonetheless, BHP will use best endeavours to obtain information on artificial features outside of the mining tenure boundary for inclusion in the flood plain modelling. In addition to this, the flood plain modelling undertaken by BHP will include artificial features obtained outside of the mining tenure boundary based on current as at time of modelling.

APPENDIX B

Isaac River TUFLOW Model Results



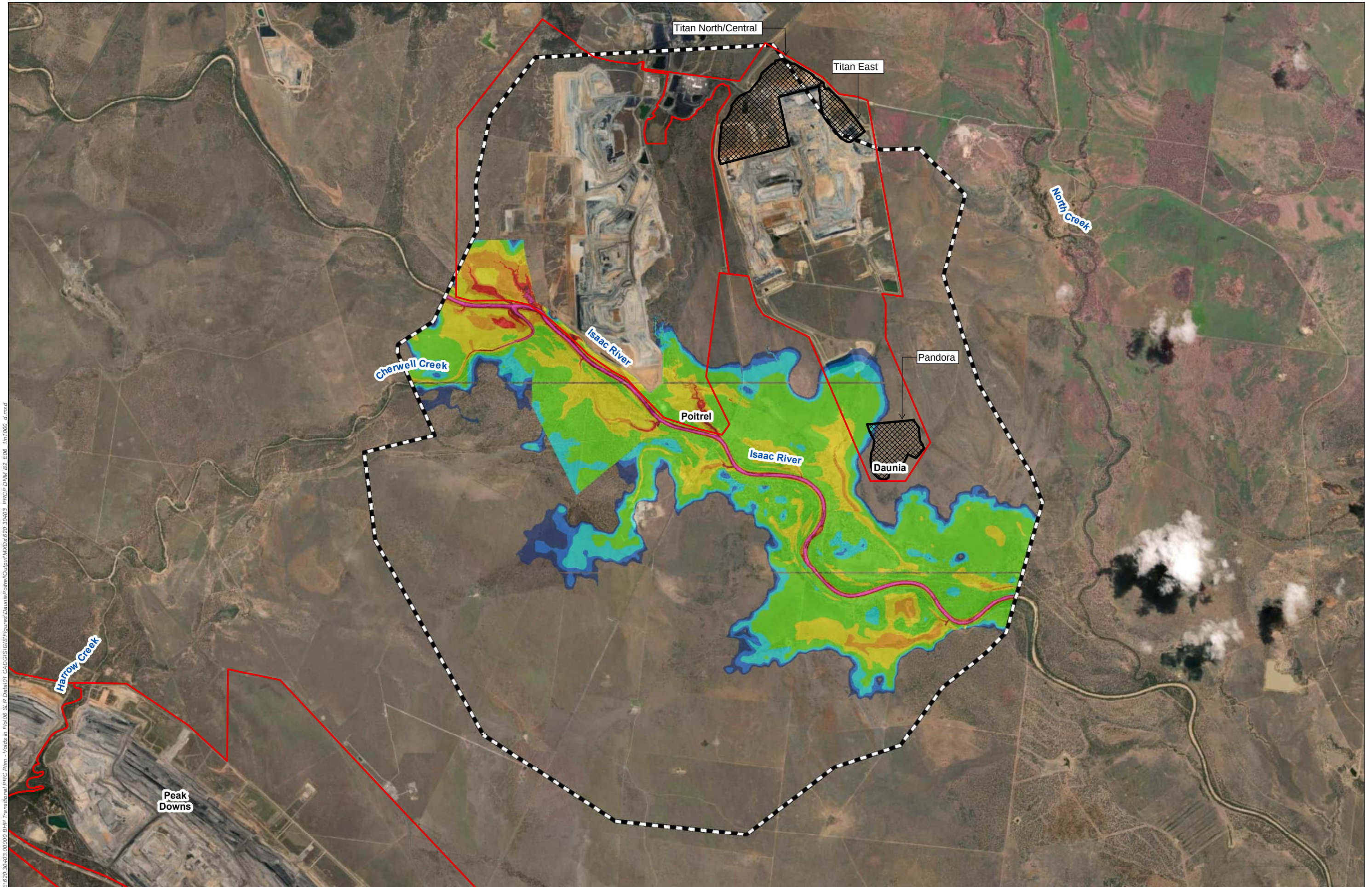
H:\Projects\SLR\620-BNE\620-BNE 620 30403 00000 BHP Transitional PRC Plan - Voids in Floodplain Modelling\DAunia\DAunia\Output\MXDs\620 30403 PRC PDNM B1 E06 1m1000 h.mxd

Legend

- Final Void Extent
- TUFLOW Model Extent
- EA Boundary

Level (m AHD)

- | | |
|---------------|---------------|
| < 185.0 | 192.5 - 195.0 |
| 185.0 - 187.5 | 195.0 - 197.5 |
| 187.5 - 190.0 | 197.5 - 200.0 |
| 190.0 - 192.5 | > 200.0 |



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